

Amtrak
Mechanical Department
Bureau of Rolling Stock Engineering

SPECIFICATION

for

PRIIA Bi-Level Passenger Rail Car

PRIIA SPECIFICATION No. 305-001
AMTRAK SPECIFICATION No. 962

Initial Release

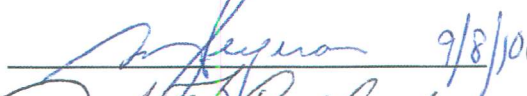
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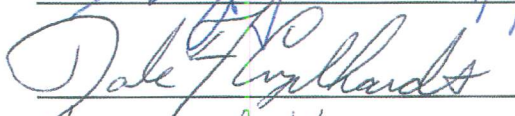
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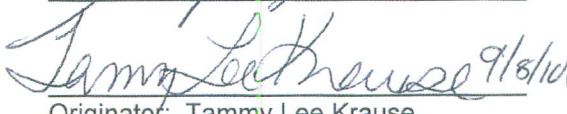
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Specification Change Sheet

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Table of Contents

1.0	Specification Summary	5
2.0	References and Glossary.....	25
3.0	Project Management.....	55
4.0	Carbody	93
5.0	Trucks	139
6.0	Couplers and Draft Gear	149
7.0	Brakes.....	155
8.0	Door Systems	169
9.0	Interior	193
10.0	HVAC System	221
11.0	Lighting System	235
12.0	Communication System	251
13.0	Electrical System	271
14.0	Food Service	291
15.0	Water and Waste System	341
16.0	Cab and Train Controls.....	355
17.0	Emergency Equipment	397
18.0	Materials and Workmanship	403
19.0	Test Requirements	475
20.0	Tools, Consumables and Spare Parts.....	545
21.0	Shipping Preparation.....	551
22.0	Training and Documentation	555
23.0	Customer Variables	577

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee
Bi-Level Passenger Rail Cars

Chapter 1

Specification Summary

Table of Contents

1.0	Specification Summary	1-2
1.1	Overview	1-2
1.2	Regulations	1-2
1.3	Concept	1-2
1.4	Summary of PRIIA 305-001 /Amtrak 962 Car Specification	1-4
1.4.1	Car Types and Arrangements	1-4
1.4.2	Capacity and Consist Performance	1-6
1.4.3	Dimensions, Clearances and Track Geometry	1-7
1.4.4	Carbody (Chapter 4)	1-8
1.4.5	Trucks (Chapter 5)	1-9
1.4.6	Couplers (Chapter 6)	1-9
1.4.7	Brakes (Chapter 7)	1-9
1.4.8	Door Systems (Chapter 8)	1-10
1.4.9	Interiors (Chapter 9)	1-10
1.4.10	Heating, Ventilation and Air Conditioning (Chapter 10)	1-11
1.4.11	Lighting (Chapter 11)	1-11
1.4.12	Communications and Passenger Information (Chapter 12)	1-11
1.4.13	Electrical (Chapter 13)	1-12
1.4.14	Food Service (Chapter 14)	1-12
1.4.15	Water and Waste (Chapter 15)	1-12
1.4.16	Cab and Controls (Chapter 16)	1-13
1.4.17	Emergency Equipment (Chapter 17)	1-13
1.4.18	Materials and Workmanship (Chapter 18)	1-13
1.4.19	Testing Requirements (Chapter 19)	1-14
1.4.20	Documentation and Training (Chapter 22)	1-14
1.4.21	Customer Variables (Chapter 23)	1-14

1.0 Specification Summary

1.1 Overview

The purpose of this specification is to define the performance and technical requirements for a fleet of new third-generation bi-level passenger rail cars for use in medium- to long-distance intercity corridor service in North America. All technical characteristics and performance parameters for these cars are contained herein, as well as the design review, inspection, testing and documentation requirements for producing and supporting these rail cars.

This specification has been developed by the Next Generation Corridor Equipment Pool Committee created to support Section 305 of the Passenger Rail Investment and Improvement Act of 2008 (PRIIA) Public Law 110-432. The goal of PRIIA is to create a bi-level intercity corridor car specification that may be used by any state or agency to procure bi-level rolling stock for intercity service.

1.2 Regulations

The PRIIA 305-001/Amtrak 962 cars shall be fully compliant with all applicable federal regulations for safety, operations, design, accessibility, testing and materials standards, as well as numerous industry standards as developed by the American Public Transportation Association (APTA), the American Welding Society (AWS) and others. A complete listing of all regulations, standards, recommended practices and specifications that are referenced in this document can be found in Chapter 2. This is not to be interpreted as a comprehensive and exhaustive list of all regulations and standards that the Contractor must adhere to in the design and manufacture of the rail cars. The Contractor shall retain sole responsibility for complying with all standards, recommended practices and regulations that apply to the design and production of these rail cars.

1.3 Concept

The Bi-Level passenger rail cars are intended to be a third-generation bi-level intercity car fleet for use in medium- to long-distance corridor service, based on the design concept pioneered in the 1990s by the *California Car*, built by Morrison Knudsen for the California Department of Transportation (Caltrans). Though Amtrak's *Superliner* fleet established the design baseline for bi-level long-distance rail equipment, including the standard for car-to-car pass-through on the upper level (at 104.5 in. above top of rail), the *California Cars* were the first full bi-level cars designed specifically for corridor service, featuring:

- Two large entry vestibules for high-volume passenger loading and unloading
- Trainline-controlled side entry doors
- Two staircases for rapid access between levels
- Full compliance with all applicable ADA requirements
- Seat spacing for comfort as well as capacity
- Workstation tables

- A lounge car with the galley on the upper level
- A cab control car and locomotive control trainlines for push-pull service

The *California Car* design was advanced to a second generation with Amtrak's *Surfliner* cars, with numerous design changes that included:

- A toilet room on the upper level
- Convenience outlets at every seat
- Reconfigured cab control layout
- More space for trash and recyclables
- Exterior crew door control switches
- Accessible toilet room adjacent to the ADA-accessible vestibule
- Checked baggage compartment in the lower level of the cab car

The PRIIA 305-001/Amtrak 962 specification creates a third-generation of the bi-level intercity car design. In order to accommodate the needs and requirements of all potential users of this specification, this document was developed with the following ideologies:

- These cars shall be designed and built for use anywhere in the United States and Canada where their use may be desired, consistent with Amtrak's bi-level clearance envelope (drawing B-066-00050, rev 1). (Note this does not include Amtrak's Northeast Corridor.)
- All specifications shall reflect operational and environmental conditions that may be encountered anywhere the cars may operate, without requiring redesigning or modification. A nationwide perspective was used when specifying component performance.
- The specification is heavily dependant on accepted industry standards, which have been referenced herein.
- Functional compatibility with other bi-level car fleets is a requirement of this specification. Existing bi-level fleets referenced include *Superliners*, *California Cars* and *Surfliners*.
- The cars as specified will be able to operate as a discreet fleet, or intermingled with other bi-level intercity cars.
- The cars shall be designed and manufactured to perform satisfactorily for a minimum of 40 years. The carbody and all its structural elements, including trucks and running gear, shall have a minimum design life of 40 years of operation at full seated passenger load. The design and the selection of materials shall prevent corrosion damage, including the effects of extreme weather conditions, during the 40-year design life.
- Safety, reliability and maintainability are primary objectives of this specification. Because Amtrak is currently the operator for state-run passenger transportation in the United States, maintenance intervals and procedures are specified to match current Amtrak preventive maintenance programs. Use of specialized tools or equipment shall be limited. Ease of access for inspection, maintenance and repairs is a major design consideration.
- One goal of the PRIIA Specification is standardization. To meet this goal, component assemblies and subsystems provided on the first build lot of cars under this Specification must be designed so as to facilitate the exchange and substitution of

alternative components for form, fit and function. Subsystem, assembly or component level for interchange will be determined by the Customer.

- Various components have been specified by manufacturer and part number in this Specification. The Contractor may propose alternate manufacturers components but the use of alternate components or manufacturers must be approved by the Customer. Proposed alternative components must be interchangeable in form, fit and function with components called out herein.
- For safety critical items, introduction of alternative components will only be considered if such components have an established record, in North America, and/or have undergone an appropriate qualification program that demonstrates an acceptable level of safety, service and reliability for intercity or commuter passenger cars. The data shall be submitted to the Customer for approval.
- Design reviews and mockups will be employed to assess all proposed designs for compliance with specification requirements including safety, maintainability, ergonomics, functionality and passenger comfort. The areas to be created in full-scale mockups for Customer review include:
 - Passenger seating area
 - Café/lounge galley, elevator and lounge seating area
 - Accessible toilet room
 - Cab control compartment
 - Side doors
 - Enclosed overhead luggage bins
 - Wheelchair lift

The mockups will allow the Customer, and those invited by the Customer, to review the configuration and layout of the proposed design, to get a feel for the workability, comfort, access and functionality and to fine-tune the design for maximum benefit.

1.4 Summary of PRIIA 305-001/Amtrak 962 Car Specification

Where conflict exists between the descriptions below and the actual chapters, the verbiage in the chapters will be used.

1.4.1 Car Types and Arrangements

This technical specification provides for three distinct types of cars – a coach car, a cab/baggage car and a café/lounge car. See Figure 1-1, Figure 1-2 and Figure 1-3 for conceptual interior layouts.

The three types of cars are summarized as follows:

The coach car is a bi-level car with revenue seating on the upper and lower levels (see Figure 1-1):

- Wheelchair access and an accessible toilet room are on the lower level.
- A smaller toilet room is on the upper level.

- Enclosed overhead luggage bins are above each seat.
- Revenue seating includes several facing pairs of seats with workstation tables, and other seats with tray tables and footrests.
- All seating areas include carpeting, curtains and convenience outlets.

The cab/baggage car is similar to a coach car with the following exceptions (see Figure 1-2):

- A full-width cab control compartment is located on the upper level at the F-end to provide locomotive control for push-pull operation.
- The lower level includes a separate room for secure checked baggage storage.
- The forward end of the cab/baggage car conforms to all FRA structural and crashworthiness for cab car forward-facing ends.
- The forward end is fully equipped for push-pull operation, including a replaceable pilot (for protection from snow, ice, grade crossings and other debris).
- All seating is rearward-facing when the cab/baggage car is moving forward, except those seats located at workstation tables, to conform to the FRA's crashworthiness and compartmentalization recommendations. All facing seat pairs shall have a workstation table between them.

The café/lounge car provides the train with food service and non-revenue lounge space as passenger amenities, as well as including revenue seating (see Figure 1-3):

- The food service galley is located on the upper level in the center of the car.
- The galley is equipped with all required food preparation appliances, including microwave ovens, toaster, freezer, ice well, coffee makers, chilled and dry storage, display case, point-of-sale terminal, hand washing and food preparation sinks and menu holders. A condiment station is located in the lounge area.
- Recycling and trash receptacles are located throughout the car.
- Commissary provisioning is via pre-loaded carts.
- Carts are loaded onto the car at the lower level service vestibule, and transferred to the upper level via a cart elevator.
- Refrigerated foods are loaded in pre-chilled carts that are kept cold while on board by self-contained chillers.
- One end of the upper level is dedicated to non-revenue lounge seating, with tables for 1, 2 or 4 passengers.
- The other end of the upper level is configured for revenue seating, which includes facing pairs of seats with workstation tables. This area could easily be reconfigured for business class or for additional non-revenue seating.
- The lower level includes an ADA accessible seating area and toilet room, a workstation for the train crew, and a secure service vestibule/elevator lobby.
- The café/lounge car only has one staircase, to maximize the amount of lounge space.

Business class may easily be developed and implemented on these cars through the use of a modular business class service station that bolts into existing seat and wall tracks.

- The business class service station includes a small refrigerator, storage for two service carts (stocked and supplied by the café-lounge car attendant), a holder for a coffee urn (brewed in the café-lounge car and brought to business class by the café attendant)

plus counter space for newspapers and breakfast foods, and trash and recycling receptacles.

- This modular design allows flexibility as to the location of the business class section - it may be located in a coach or cab/baggage car, or in the revenue end of the café-lounge car.
- Seat pitch may be adjusted due to the seat mounting in wall and floor tracks, and overhead reading lights are mounted in adjustable-pitch units on the underside of the overhead luggage bins.
- The business class section is easily redeployed to other cars if necessary, including addition to existing cars in bi-level fleets. Where there is a Business Class it will be on both upper and lower levels.

1.4.2 Capacity and Consist Performance

1.4.2.1 Capacity

As specified, the PRIIA 305-001/Amtrak 962 cars are configured to have the following passenger capacities:

Coach:	89 revenue seats 1 wheelchair parking location
Cab/Baggage:	75 revenue seats 1 wheelchair parking location
Café/Lounge:	35 revenue seats 1 wheelchair parking location 21 lounge area (non-revenue) seats 4 crew workstation seats

These capacities may be defined differently in Chapter 23, in which case Chapter 23 takes precedence. This configuration may be changed at the discretion of each customer.

1.4.2.2 Consist Performance

- Trains typically consist of 4 to 10 cars with all trainline functions operating normally.
- Maximum consist of 12 cars for all trainline functions to operate at reduced levels, as specified by the Customer.
- Maximum consist of 24 cars for brake system to operate properly.
- Cars are designed for continuous operation for up to 18 hours and 1200 miles per day.

1.4.3 Dimensions, Clearances and Track Geometry

1.4.3.1 Overall Carbody Dimensions

The cars shall be designed to meet the following overall carbody dimensions:

Overall Length:	85 ft 0 in. (over pulling faces)
Overall Height:	16 ft 2 in. above top of rail
Overall Width:	10 ft 6 in.
Truck Centers:	59 ft 6 in.
Lower Floor Height:	18.5 in. above top of rail
Upper Floor Height:	104.5 in. above top of rail
Side Door Openings:	52 in. clear opening

The cars shall be designed and built to conform to the following overall dry weight limitations:

Coach:	150,000 lbs
Cab/Baggage:	154,000 lbs
Café/Lounge:	153,000 lbs

All cars shall be weighed at the Contractor's facility, and shall have weight distribution and balance as follows:

- End-to-end balance within 5% (both at full supplies and no supplies)
- Lateral balance (side to side) within 30,000 inch-pounds (both at full supplies and no supplies)
- All cars shall be within 300 lbs of the first production car of each type

1.4.3.2 Clearances

The cars shall fully conform to Amtrak's Bi-level Clearance Drawing B-066-00050, rev 1. Conformance to this clearance diagram will permit the PRIIA 305-001/Amtrak 692 car to operate anywhere that *Superliners*, *Surfliners* and *California Cars* are authorized to operate anywhere within the continental United States or Canada, (not including the Northeast Corridor), on current Amtrak Superliner routes and elsewhere where clearance permits.

1.4.3.3 Track Geometry

- The cars shall be designed and tested for revenue operation at all speeds up to 125 mph, on all classes of track from FRA Class 1 to Class 7. Track quality shall be the minimally compliant for each class of track, per FRA regulations and AREMA standards. Ride quality standards and testing methods are specified.
- The cars shall operate on standard gauge track. Standard gauge is 56.5 in.
- The cars shall be capable of meeting the S-603 braking distances.
- The cars shall be capable of negotiating a 250 ft radius (23 degree) horizontal curve, coupled to other equipment, without damage to any portion of the car, including trucks and suspension, coupler, draft gear, air and electrical connections, carbody, diaphragm or track.

- The cars shall be capable of negotiating a 1000 ft radius vertical curve (concave or convex), coupled to other equipment, without damage to any portion of the trucks and suspension, coupler, draft gear, air and electrical connections, carbody, diaphragm or track.
- The cars shall be stable at all design speeds and at 5mph above maximum design speed, including while stationary.
- The car shall have no more than 50% wheel unloading when stopped on 7 in. superelevation.
- The cars shall be capable of operating up to 5 in. cant deficiency according to 49CFR Section 213.329.
- The cars shall be capable of safely passing other trains that are operating at maximum authorized track speed in either direction on adjacent tracks with 12 ft centers.
- The cars shall be capable of negotiating a number 8 crossover between two tracks with centers 12 ft apart, coupled to other equipment, without damage.

1.4.4 Carbody (Chapter 4)

- Stainless steel carshell with Low-Alloy, High-Tensile (LAHT) end underframe and other primary structural components.
- The design of the carshell shall contain CEM features.
- Corrugated stainless steel roof for longitudinal structure and durability.
- Carshell shall be fully compliant with FRA's requirements for structural strength, crashworthiness and testing per 49CFR Part 238:
 - Meets or exceeds 49CFR Part 238 Tier 1 structural requirements.
 - Meets or exceeds APTA Standard SS-C&S-034-99 for the Design and Construction of Passenger Rolling Stock
 - Carshell tested to 800,000 lb buff load
 - 300,000 lb collision post load test
 - All components attached to withstand longitudinal/lateral/vertical accelerations of 8/4/4g
- Each car has two side entry vestibules on the lower level (café/lounge has one public vestibule and one service vestibule).
- All cars feature large picture windows with glass or lexan panes. All cars will have emergency exit windows in full compliance with FRA regulations.
- The basic car design features two carborne powered wheelchair lifts.
- Each car has two staircases to provide access between the upper and lower levels (except the café/lounge, which has only one staircase, at the B-end of the car).

1.4.5 Trucks (Chapter 5)

- The specification provides for either cast or fabricated trucks.
- All trucks will use standard Amtrak wheelsets, with 36 in. nominal new wheels, type G outside bearings, and tread and disc brakes.
- Primary and secondary suspension is provided through the use of steel coil springs, or air springs or chevrons at the Customer's request.

1.4.6 Couplers (Chapter 6)

- All cars use energy absorbing couplers as specified in Chapter 6.
- Couplers, coupler carriers and uncoupling mechanisms shall be compliant with FRA standards and requirements.

1.4.7 Brakes (Chapter 7)

- Pneumatic air brake system uses standard Wabco 26C schedule.
- Truck-mounted air brake components shall use Amtrak standard brake shoes and pads.
- Locomotive supplies air for brake pipe and main reservoir functions
 - 110 psi brake pipe operation (for train air brake control)
 - 140 psi main reservoir operation (for auxiliary functions such as water pressure, toilet flushing, etc)
- Braking rates:
 - Full service: minimum of 1.35 miles per hour per second (mphps) deceleration from 125 mph down to 70 mph, then increasing to not less than 2.00 mphps average below 70 mph.
 - Emergency: minimum of 2.50 mphps below 70 mph.
- Tread and disc brakes on all axles. Track brakes are not used.
- Wheelslide protection provided on all axles and controlled on a per-truck basis.
- Electric and pneumatic brake applied/released indicators are provided on the side of each car.
- All cars are equipped with a handbrake, located on the upper level at the B-end. A spring applied parking brake is allowed as a car option.
- Cab/baggage cars are equipped with a pneumatic holding brake.

1.4.8 Door Systems (Chapter 8)

- All cars feature twin bi-parting side entry doors on the lower level, and sliding pocket doors on the upper level at the end passageways.
- Side doors throughout the train can be controlled from any door control station located on the same side of the car as the door control station, and can also be trainlined or opened individually.
- The door system complies with all FRA safety provisions, including obstruction detection, traction interlock, zero-speed protection, status lights and signage, emergency release, and crew control.
- Side doors feature enhanced access for maintenance of door operator hardware.
- All cars have exterior side door crew key switches for employee access.
- Upper level end doors are sliding pocket doors with upper and lower press plates (except the F-end door panel), obstruction detection, manual isolation, Type 1 glazing in the window and a removable panel in the lower half of the door, as required by the FRA.

1.4.9 Interiors (Chapter 9)

- All cars shall be equipped with reclining seats, energy-absorbing workstation tables, carpet, curtains and convenience outlets at every seat, and enclosed overhead luggage bins.
- Interior surfaces shall be made of fiberglass-reinforced plastic, decorative laminates and fabric-covered wainscot panels below the windows.
- Each car shall have two toilet rooms except the café/lounge, which will only have an accessible toilet room on the lower level.
- All cars will be fully equipped with emergency signage and low-location exit path markings, in conformance with APTA standards and FRA requirements.
- The interior and furnishing shall present a clean, pleasing appearance and require little maintenance and be easy to clean.
- Interior décor shall be developed by the Contractor, to provide a comprehensive look to the interior of the car through coordination of seat fabrics, curtains, carpet and other color palettes. The Contractor shall provide several storyboard options for the interior décor for the Customer to choose from.
- Seats shall be selected at the discretion of each Customer in order to accommodate differences in operations and passenger preferences. All seats and workstation tables shall be mounted in seat tracks for easy installation, and to allow different seat pitches at the direction of the Customer.
- Reading light units shall be installed on the underside of the overhead luggage bin, and shall be track-mounted to permit different spacing based on seat pitch.

1.4.10 Heating, Ventilation and Air Conditioning (Chapter 10)

- The Heating, Ventilation and Air Conditioning (HVAC) system will use efficient scroll compressors, environmentally friendly R400-series refrigerants, microprocessor controls and multiple temperature sensors for system operation.
- Two identical HVAC units will provide cooling and overhead heat for each car.
- The HVAC system shall maintain the car interior, including the engineer's cab, to the specified temperature of 72°F to 76°F, with the car operating anywhere in the continental United States.
- The HVAC system performance requirements specify system operations under a variety of climatic extremes, from the hot and dusty California desert to the snow-packed Midwest.
- Fresh air intake and distribution of conditioned air from one level to another is controlled by electrically powered dampers. This allows the system to control the temperature on the different levels to a more accurate degree.
- Maximum interior sound levels are specified to minimize blower and diffuser noise.
- Filters are easy to access and replace.
- Water system components are equipped with freeze protection.
- Side door thresholds are heated.

1.4.11 Lighting (Chapter 11)

- Interior lighting relies on Light Emitting Diodes (LEDs) for energy efficiency and reliability. All LED passenger lighting shall be powered from the 74Vdc battery system. Emergency lighting will have individual battery back-up. Fluorescent lights can be used in Customer approved areas. Halogen lights are not to be used. Incandescent lights are not used anywhere on the car except for marker lights and cab/baggage car headlights and crossing lights.
- The normal and emergency lighting system meets all new APTA standards and FRA requirements for charging and emergency light levels.
- Emergency lighting relies on LED lamps and high-efficiency capacitors for power source.

1.4.12 Communications and Passenger Information (Chapter 12)

- All cars will feature a Public Address (PA) system, intercom and a passenger information system.
- PA and intercoms are compliant with FRA requirements for emergency communication.
- Specifications for passenger WiFi and on-train information systems will be consistent with Amtrak nationwide standards for these systems.
- Passenger Information System (PIS) [also known as On Board Train Information System (OTIS)] provides an Ethernet-based data backbone for intra-car and car-to-car communication and data transfer. System capabilities include passenger wireless internet access, real-time ticketing and manifest generation, credit card transactions, component or system status monitoring and food inventory management.
- OTIS is compliant with ADA.

1.4.13 Electrical (Chapter 13)

- Primary power source is locomotive-provided 480 Volt Alternating Current (VAC) Head End Power (HEP).
- Power distribution system converts the HEP to 120VAC, 74VDC and 24VDC, (Cab/baggage car only) for use throughout the car.
- The batteries and battery charger system provide the low-voltage power supply for systems requiring power when HEP is lost (PA, door operators, lights, cab controls).
- All cars will be equipped with standard trainlines:
 - 480VAC HEP trainline (in compliance with APTA Recommended Practice RP-E-106-99)
 - 27-Point Multiple Unit (MU) Trainline (in compliance with APTA Recommended Practice RP-E-017-99)
 - 27-Point Communication (COMM) Trainline (in compliance with APTA Recommended Practice RP-E-017-99)
- Receptacles will be located on both sides of each car for maximum flexibility in building train consists (either end of any car can be connected to either end of any other car).
- 120Vac utility outlets will be located in all toilet rooms, equipment rooms, the electrical locker, operating cab and utility rooms, for ease of maintenance and cleaning.

1.4.14 Food Service (Chapter 14)

The café/lounge car includes the following features, in addition to those listed above:

- Chiller operation will include a constantly charging stand alone battery backup to keep chilled food cold in the event of an HEP disruption.
- Convenience outlets will be located in the revenue and lounge areas, for passenger use.
- PA and intercom located at the crew workstation, for convenience and passenger safety.
- The revenue seating area will include all elements of the seating area in a coach car, including overhead luggage bins, curtains and reading lights.
- The galley area of the café/lounge car will conform to all applicable requirements for a food preparation area, in accordance with Food and Drug Administration (FDA) regulations.
- A crew workstation will be located on the lower level of the café-lounge car, and will be equipped with extra electrical outlets, secure storage, PA and intercom station.
- A secure storage area will be provided for café/lounge employee belongings.

1.4.15 Water and Waste (Chapter 15)

- Fresh water (200-gallon storage capacity) will be used for toilet room functions such as toilet flush and hand washing.
- Particulate and antibacterial filtration will be used to provide potable water at drinking stations on both levels, as well as supply water for use in the galley of the café/lounge car (for coffee, hand washing and food preparation).
- All waste water will be captured and stored in a 250-gallon waste retention tank at the B-end of each car.

1.4.16 Cab and Controls (Chapter 16)

- Each cab/baggage car will be equipped with a locomotive control cab at the forward end of the upper level.
- The cab will be full width, and will provide seating for an engineer and an assistant.
- FRA Type 1 windshields will be provided on the end of the car for the engineer and the assistant. These windshields will be heated for defrosting and defogging. Opening windows will be provided on each side of the cab for sideways visibility.
- The cab-end forward-facing door shall be a robust hinged door with projectile-resistant FRA Type 1 glazing and large wedge latches to keep the cab weatherproof and to prevent material, liquids or debris from entering the cab in the event of a grade crossing accident. This door can be latched open for use in pass-through configuration.
- The engineer will have access to all locomotive train controls and indicators to operate the train safely in push-pull service.
- Federally mandated safety systems such as an event recorder, alerter and Positive Train Control (PTC) shall be incorporated into the design of the cab.
- The cab will be designed to allow passengers and crew to pass through the cab area when the cab/baggage car is used as a coach in mid-train. The cab areas will be secured behind partition doors when the cab is configured for pass-through. The design of the partition doors will allow the engineer and assistant engineer to quickly exit the cab in the event of an emergency.
- Secure cabinets will be located behind the cab for emergency equipment, storage of crew belongings and a refrigerator. A secure locker will be provided for data storage from the event recorder and PTC systems.
- The cab end of the cab/baggage car will include streamlined styling for reduced wind resistance, which reduces fuel consumption and enhances locomotive performance at high speeds when in push mode.

1.4.17 Emergency Equipment (Chapter 17)

- All cars will be equipped with emergency equipment as required by the FRA, including, but not limited to, fire extinguishers, pry bar, sledge hammer, first aid kit and light sticks.
- Signage for the emergency equipment shall meet all applicable FRA requirements.

1.4.18 Materials and Workmanship (Chapter 18)

All materials, parts and workmanship that go into the design and manufacture of the rail cars are subject to rigorous standards for quality, performance, method of assembly and compliance with applicable regulations and industry standards.

1.4.19 Testing Requirements (Chapter 19)

The cars will undergo extensive testing as prescribed in the Specification, to ensure that the cars meet all requirements for design, performance and quality.

Four major categories of tests are specified:

- **Material certifications**
These tests are performed on the materials that are used to manufacture the cars, to ensure that they are manufactured in accordance with all specified requirements. These are usually performed at material testing laboratories or manufacturer facilities.
- **Proof of design tests**
Proof of design tests are performed to validate the concept of a component or system, to ensure that the design of the component or system performs as intended or specified, with no adverse or unexpected consequences. Proof of design tests are normally conducted on the first components or assembled systems, and the first completed cars, so that subsequent cars or components may be redesigned to resolve design problems.
- **Production tests**
Production tests are required for all cars and selected components (such as truck frames) where safety is critical. Production tests are conducted at the Contractor's facility, and at the facility of the major component suppliers.
- **Acceptance tests**
Acceptance tests are conducted on each car at the Customer's facility to verify all car functionality, including train consist compatibility, prior to placement of the car into revenue service.

1.4.20 Documentation and Training (Chapter 22)

- Support documentation, such as maintenance and operating manuals, as-built drawings, parts lists and troubleshooting guides, are included in the technical specification.
- A training program is established for familiarizing operating, mechanical and supervisory staff on the proper maintenance, repair, troubleshooting and operation of the equipment.

1.4.21 Customer Variables (Chapter 23)

- This chapter describes those features of the car that change from one customer to another, such as exterior graphics, interior décor considerations, seats and interior layout, testing with existing fleets, and other aspects of the car design that may be exclusive or particular to a customer.
- Specific components may be called out here by the Customer, for example: trucks, HVAC units, couplers and windows.

COACH CAR LAYOUT

NOTE: Drawings are strictly conceptual.
They are subject to change for actual design.

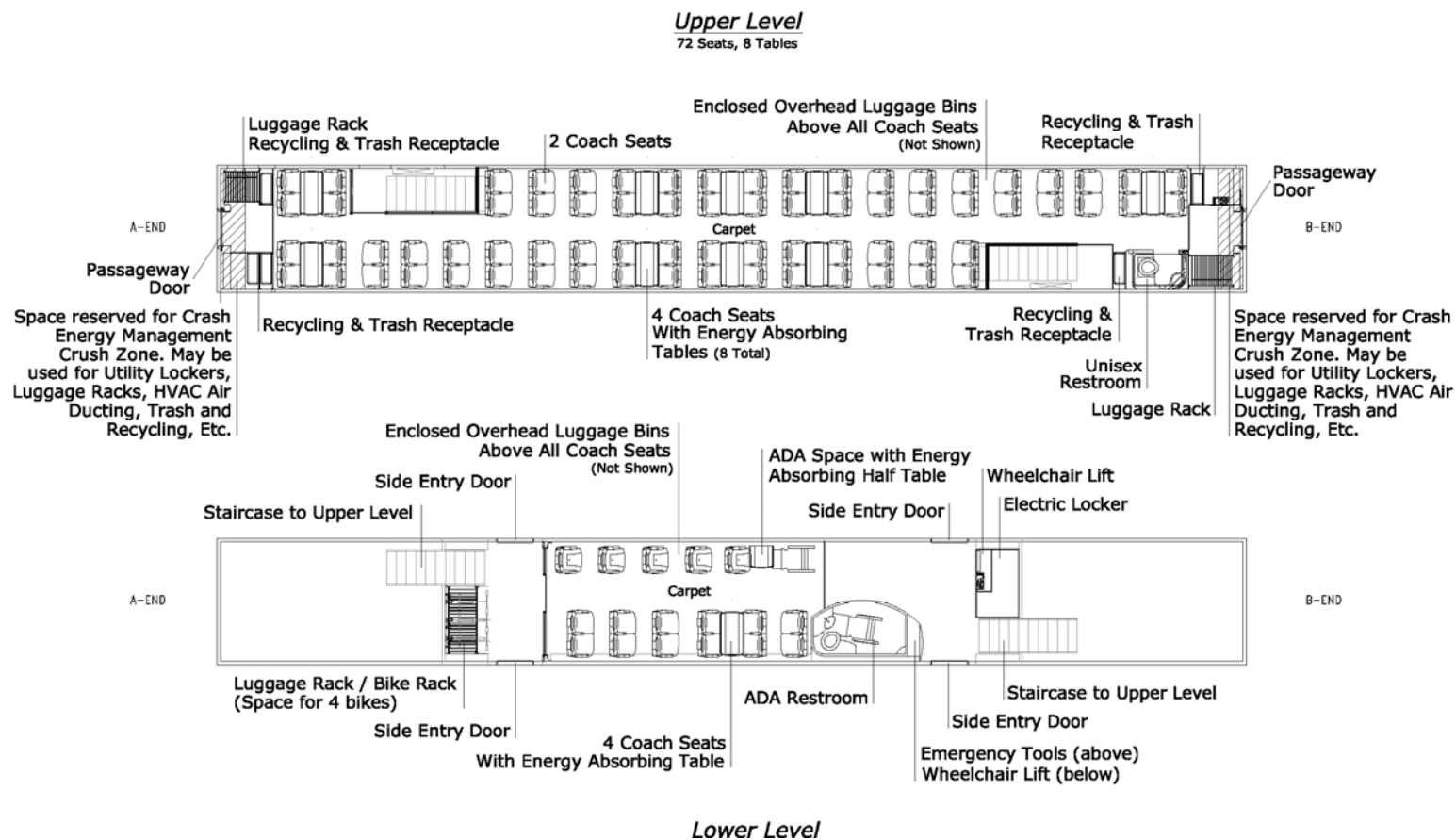


Figure 1-1: Conceptual Interior Layout of Coach Car

CAB/BAGGAGE COACH CAR LAYOUT

NOTE: Drawings are strictly conceptual.
They are subject to change for actual design.

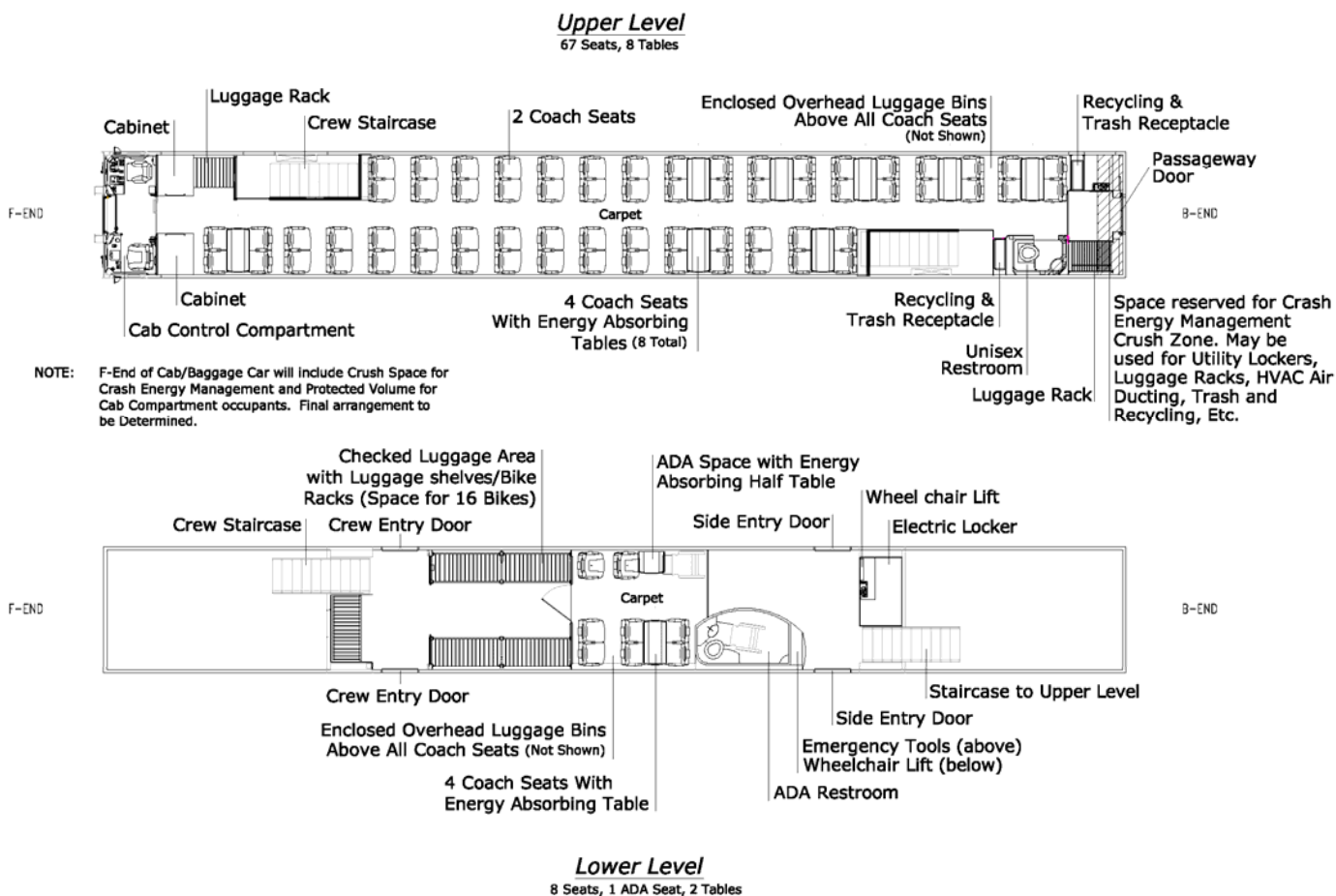


Figure 1-2: Conceptual Interior Layout of Cab/Baggage Car

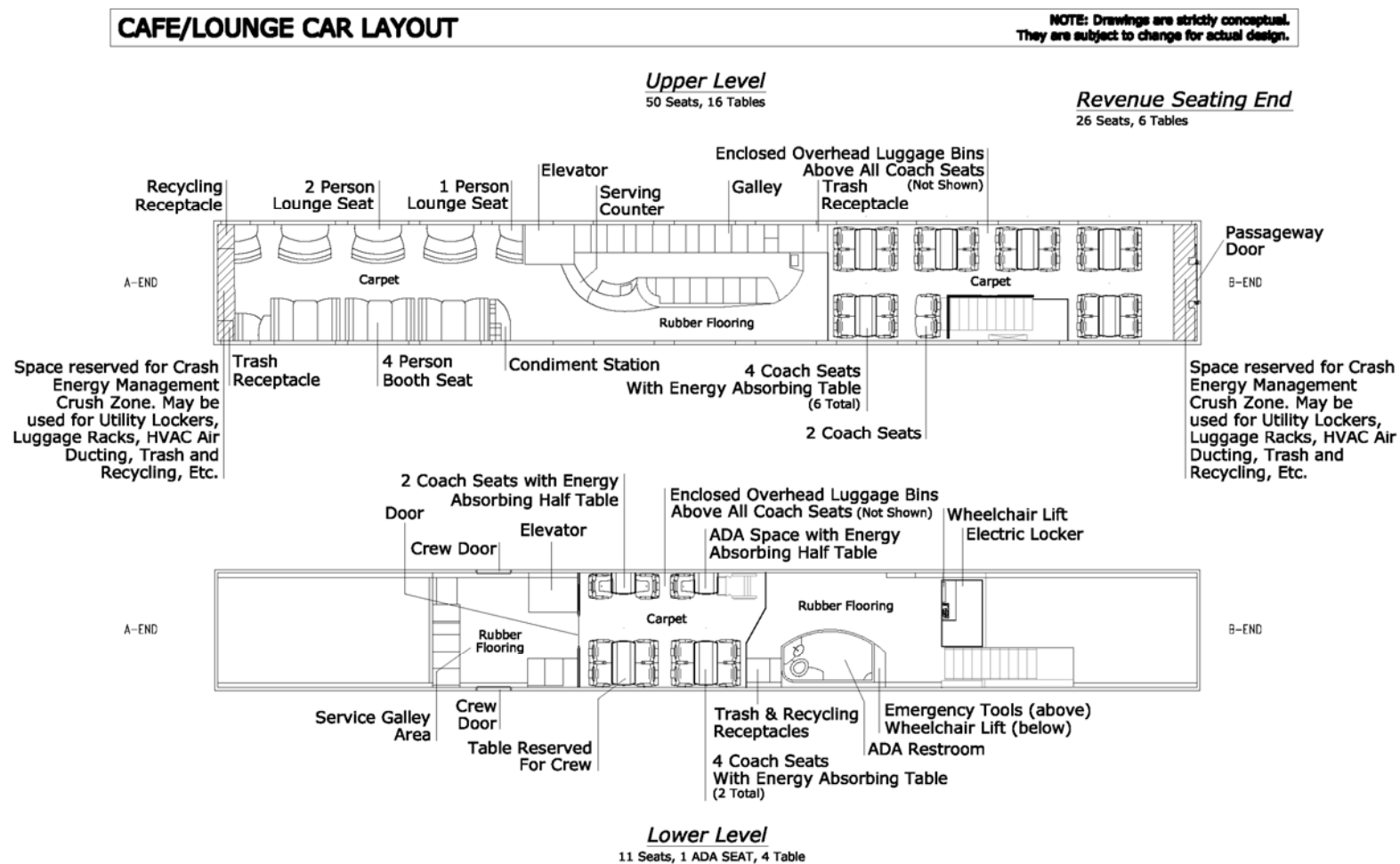


Figure 1-3: Conceptual Interior Layout of Café/Lounge Car

* End of Chapter 1 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 2

References and Glossary

Table of Contents

2.0	References and Glossary	2-2
2.1	Overview	2-2
2.2	Supplemental Regulations, Standards, Specifications and Drawings	2-2
2.2.1	Regulations	2-2
2.2.2	Standards	2-4
2.2.3	Specifications	2-8
2.2.4	Drawings	2-9
2.2.5	Supplemental Documentation	2-9
2.3	Definitions	2-10
2.3.1	Abbreviations	2-19

2.0 References and Glossary

2.1 Overview

Regulations, standards and specifications that are referenced in this document are listed below as a guide to the Contractor, but shall not be construed as complete.

Unless specified otherwise, the Contractor shall comply with the revision of the reference documents in effect at time of Notice to Proceed (NTP).

The Contractor is responsible for ensuring that all applicable regulations, standards and specifications are followed when complying with the requirements of this specification.

Nothing in this specification shall relieve the Contractor from ensuring that all applicable regulations, standards and specifications are followed. The Contractor shall provide proof of compliance for those items so governed before the first train set is accepted.

2.2 Supplemental Regulations, Standards, Specifications and Drawings

Regulations, standards, specifications and drawings, which pertain to this specification, are listed below. The following list is furnished as a guide to the Contractor, but shall not be construed as complete. When any of the following are superseded by an approved revision the revision shall apply. Unless specified otherwise, the Contractor shall be responsible for acquiring and maintaining copies of all applicable references from the appropriate source. The Customer shall not be obligated to provide these referenced documents unless specifically stated. The contractor will be responsible for determining if there are newer versions of the referenced specifications/regulations/standards and obtaining them.

2.2.1 Regulations

2.2.1.1 ADA (Americans with Disabilities Act)

49CFR Subtitle A, Figure 4: *Intercity Rail Car (with accessible restroom)*

49CFR38.101: *Lighting*

Americans with Disabilities Act of 1990 and regulations promulgated thereafter, including 49CFR27, 37 & 38.

2.2.1.2 DOE (U.S. Department of Energy)

Energy Policy Act (EPA) of 2005

2.2.1.3 EPA (Environmental Protection Agency)

40CFR82: *Protection of Stratospheric Ozone*

2.2.1.4 FRA (Federal Railroad Administration)

Title 49, 49CFR *Transportation*, Section II, Parts 200-299

213: *Track Safety Standards*

213.333: *Automated Vehicle Inspection Systems*

213.345: *Vehicle Qualification Testing*

213.57: *Curves; Elevation and Speed Limitations*

221: *Rear End Marking Device-Passenger, Commuter and Freight Trains*

222: *Use of Locomotive Horns at Public Highway-Rail Grade Crossings*

222.21: *When Must a Locomotive Horn be Used?*

223: *Safety Glazing Standards--Locomotives, passenger Cars and Cabooses*

229: *Railroad Locomotive Safety Standards*

229.11: *Locomotive Identification*

229.46 through 229.59: *Brake System*

229.115: *Slip/Slide Alarms*

229.117: *Speed Indicators*

229.119: *Cabs, Floors and Passageways*

229.121: *Cab Noise*

229.123: *Pilots, Snowplows, End Plates*

229.125: *Headlights and Auxiliary Lights*

229.127: *Cab Lights*

229.129: *Horn*

229.131: *Sanders*

229.133: *Interim Locomotive Conspicuity Measures-Auxiliary External Lights*

229.141: *Body Structure, MU Locomotives*

229.135: *Event Recorder*

231: *Railroad Safety Appliance Standards*

238: *Passenger Equipment Safety Standards*

238.103: *Fire Safety*

238.111: *Pre-revenue Service Acceptance Testing Plan*

238.114: *Rescue Access Windows*

238.115: *Emergency Lighting*

238.121: *Emergency Communication* 238.205: *Anti-Climbing Mechanism*

238.123: *Emergency Roof Access*

238.207: *Link Between Coupling Mechanism and Car Body*

238.217: *Side Structure*

238.227: *Suspension System*

238.231: *Brake System*

238.233: *Interior Fittings and Surfaces*

238.235: *Doors (Emergency Egress)*

238.303: *Exterior Calendar Day Mechanical Inspection of Passenger Equipment*

238.307: *Periodic Mechanical Inspection of Passenger Cars and Unpowered Vehicles
Used in Passenger Trains*

- 238 Appendix B: *Test Methods and Performance Criteria for the Flammability and Smoke Emission Characteristics of Materials Used in Passenger Cars and Locomotive Cabs*
- 238 Subpart C: *Specific Requirements for Tier 1 Passenger Equipment*
- 239: *Passenger Train Emergency Preparedness*
- 239.101: *Emergency Preparedness Plan*
- 239.107: *Emergency Exits*
- 571.208, Subpart 6: *Federal Motor Vehicle Safety Standards: Occupant Crash Protection*
- 2.2.1.5 FTA (Federal Transit Administration)
- FTA-IT-90-5001-02.1 of February 2002: *Quality Assurance and Quality Control Guidelines*
- 2.2.1.6 USPHS (U.S. Public Health Service)
- U. S. Public Health Service Food Code 2005*
- 2.2.2 Standards**
- 2.2.2.1 AAR (Association of American Railroads)
- M-101: *Axles Carbon Steel, Heat-Treated*
- M-107/M-208: *Wheels, Carbon Steel*
- M-114: *Helical Springs, Heat-Treated Steel*
- M-201: *Steel Castings*
- M-601: *Hose, Wrapped, Air Brake, "End Hose"*
- M-618: *Hose, Air, Wire-Reinforced*
- RP-585: *Wiring and Cable Specification*
- S-100, Section B: *Bushings, Stainless Steel Tube-Coupler Shanks and Yokes*
- S-400: *Brake Equipment-Installation Specifications*
- S-471: *Brake Pipe Restriction Test*
- S-4200: *ECP Cable-based Brake Systems – Performance Specifications*
- S-4210: *ECP Cable-based Brake System Cables, Connectors and Junction Boxes – Performance Specifications*
- 2.2.2.2 Aluminum Association
- Aluminum Design Manual*
- Aluminum Company of America (ALCOA) Technical Report 524, Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles*
- 2.2.2.3 ANSI (American National Standards Institute)
- C82.2: *For Lamp Ballasts-- Method of Measurement of Fluorescent Lamp Ballasts*
- S1.4: *Specification for Sound Level Meters*
- S3.2-2009: *Method for Measuring the Intelligibility of Speech over Communication Systems*

Z26.1: *Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways*

2.2.2.4 APTA (American Public Transportation Association)

Manual of Standards and Recommended Practices for Rail Passenger Equipment

RP-C&S-001-98: *Recommended Practice for Passenger Equipment Roof Emergency Access*

RP-E-002-98: *Wiring of Passenger Equipment*

RP-E-006-99: *Diesel Electric Passenger Locomotive Dynamic Brake Control*

RP-E-007-98, Rev 1: *Storage Batteries and Battery Compartments*

RP-E-009-98: *Recommended Practice for Wire Used on Passenger Equipment*

RP-E-012-99, Edited 4-1-04: *Recommended Practice for Normal Lighting System Design for Passenger Rail Equipment*

RP-E-014-99: *Recommended Practice for Diesel Electric Passenger Locomotive Blended Brake Control*

RP-E-015-99: *Head End Power Source Characteristics*

RP-E-016-99: *Recommended Practice for 480VAC Head End Power System*

RP-E-017-99: *Recommended Practice for 27-point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment*

RP-E-018-99: *480 VAC Head End Power Jumper and Receptacle Hardware*

RP-E-019-99: *27-Point Jumper and Receptacle Hardware for Locomotives and Locomotive-Hauled Equipment*

RP-M-001-97: *Recommended Practice for Air Connections, Location and Configuration of, for Passenger Cars Equipped with AAR Long Shank Tight Lock or Similar Long Shank Type Couplers*

RP-M-001-98: *Recommended Practice for Passenger Car Axle Design*

RP-M-003-98: *Recommended Practice for the Purchase and Acceptance of Type H-Tightlock Couplers*

RP-M-009-98: *Recommended Practice for New Truck Design*

RP-PS-005-00: *Fire Safety Analysis of Existing Passenger Rail Equipment*

SS-C&S-002-98: *Standard for Static Strength Attachment of Major Equipment to the Carbody Structure of Railroad Passenger Equipment*

SS-C&S-004-98, Rev 1: *Austenitic Stainless Steel for Railroad Passenger Equipment*

SS-C&S-006-98, Rev 1: *Attachment Strength of Interior Fittings for Passenger Railroad Equipment*

SS-C&S-011-99: *Standard for Cab Crew Seating Design and Performance*

SS-C&S-012-02: *Door Systems for New and Rebuilt Passenger Cars*

SS-C&S-015-99: *Standard for Aluminum and Aluminum Alloys for Passenger Equipment Carbody Construction*

SS-C&S-016-99, Rev 1: *Row-to-Row Seating in Commuter Rail Cars*

SS-C&S-034-99, Rev. 2: *Standard for the Design and Construction of Passenger Railroad Rolling Stock*

SS-E-005-98: *Standard for Grounding and Bonding*

SS-E-010-98: *Standard for the Development of an Electromagnetic Compatibility Plan*

SS-E-013-99: *Standard for Emergency Lighting System Design for Passenger Cars*

- SS-M-005-98, Rev 2: *Code of Tests for Passenger Car Equipment Using Single Car Testing Device (revision in effect at time of test)*
- SS-M-006-98, Rev. 2: *Standard for Parking Brakes for New Passenger Locomotives and Cars*
- SS-M-007-98: *Conductor's Valve – New Passenger Car and MU Locomotives*
- SS-M-011-99: *Compressed Air Quality for Passenger Locomotive and Car Equipment*
- SS-M-012-99, Rev 1: *Standard for the Manufacture of Wrought Steel Wheels for Passenger Cars and Locomotives*
- SS-M-014-06: *Standard for Wheel Load Equalization of Passenger Railroad Rolling Stock*
- SS-M-015-06: *Standard for Wheel Flange Angle for Passenger Equipment*
- SS-M-016-06: *Standard for Safety Appliances for Rail Passenger Cars*
- SS-M-017-06: *Standard Definition and Measurement of Wheel Tread Taper*
- SS-M-018-10: *Standard for Powered Exterior Side Door System Design for New Passenger Cars*
- SS-PS-002-98, Rev 3: *Standard for Emergency Signage for Egress/Access of Passenger*
- SS-PS-003-98: *Standard for Emergency Evacuation Units for Rail Passenger Cars*
- SS-PS-004-99, Rev. 2: *Standard for Low-Location Exit Path Marking*
- 2.2.2.5 ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)
- 41.1-1986 (R2006): *Standard Method for Temperature Measurement*
- 37-05: *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment*
- 2.2.2.6 ASME (American Society of Mechanical Engineers)
- Boiler and Pressure Vessel Code*
- 2.2.2.7 ASTM (American Society for Testing and Materials)
- A6: *Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling*
- A488/A488M-07: *Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel*
- A572, A 568, A 588, A 606, A 715, A 710: *High Strength Low Alloy Structural Steel*
- A380-06: *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*
- A53/A53M-07: *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*
- D3574-95: *Seat Cushion Testing Requirements*
- D4956-07: *Standard Specification for Retroreflective Sheeting for Traffic Control*
- E165-02: *Standard Test Method for Liquid Penetrant Examination*
- E446-98(2004)e1: *Standard Reference Radiographs for Steel Castings Up to 2 in. [51 mm] in Thickness*
- E662-09: *Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials*
- E709-01: *Standard Guide for Magnetic Particle Examination*

E709-08: *Standard Guide for Magnetic Particle Testing*

E94-04: *Standard Guide for Radiographic Examination*

2.2.2.8 AWS (American Welding Society)

AWS Welding Handbook

B2.3/B2.3M: *Specification for Soldering Procedure and Performance Qualification*

C1.1M/C1.1:2000 (R2006): *Recommended Practices for Resistance Welding*

C7.2: *Recommended Practices for Laser Beam Welding, Cutting and Drilling*

C7.4/7.4M: *Process Specification and Operator for Laser Beam Welding*

D1.1/D1.1M: *2008 Structural Welding Code – Steel*

D1.2/D1.2M: *Structural Welding Code, Aluminum*

D1.3/D1.3M: *2008 Structural Welding Code – Sheet Steel*

D1.6/D1.6M: *Structural Welding Code, Stainless Steel*

D17.2/D17.2M: *Specification for Resistance Welding in Aerospace Applications*

D17.3/D17.3M: *Specification for Friction Stir Welding of Aluminum Alloys for Aerospace Applications*

2.2.2.9 Boeing

BSS-7239: *Test Method for Toxic Gas Generation by Materials on Combustion*

2.2.2.10 Bombardier

SMP 800-C: *Toxic Gas Generation of “Flex 35 Rev. D” Rubber Compound*

2.2.2.11 CENELEC (European Committee for Electrotechnical Standardization)

EN 50128: *Railway Applications - Communications, Signaling and Processing Systems - Software for Railway Control and Protection Systems*

2.2.2.12 CSA (Canadian Standards Association)

C22.2, No. 197-M1983: *PVC Insulating Tape*

2.2.2.13 European Norms

DIN EN 13452-1: *Railway Applications – Braking - Mass Transit Brake Systems – Part 1: Performance Requirements*

BS EN 50126: *Railway Applications. The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS)*

2.2.2.14 GSA (General Services Administration)

Federal Standards

QQ-B-654A: *Brazing Alloys, Silver*

QQ-P-416F: *Plating, Cadmium (Electrodeposited) (S/S by SAE-AMS-QQ-P-416)*

TT-P-38E: *Paint, Aluminum, Ready-mixed*

TT-P-664D: *Primer Coating, Alkyd, Corrosion-inhibiting, Lead and Chromate Free, Con-compliant (S/S by SSPC-PAINT25)*

WW-C-563A: *Conduit, Metal, Rigid, Electrical, Thin Wall Steel Type (Electrical Metallic Tubing), Straight Lengths, Elbow, & Bends (S/S by UL797)*

WW-C-566C: *Conduit, Metal, Flexible (S/S by A-A-55810)*

WW-T-799F: *Tube, Copper, Seamless, Water (For use with Solder-flared- or Compression-type Fittings) (S/S by ASTM-B88)*

2.2.2.15 IEC (International Electrotechnical Commission)

60571: *Electronic Equipment used on Rail Vehicles*

2.2.2.16 IEEE (Institute of Electrical and Electronics Engineers)

16: *Standard for Electrical and Electronic Control Apparatus on Rail Vehicles*

1568-2003: *Recommended Practice for Electrical Sizing of Nickel-Cadmium Batteries for Rail Passenger Vehicles*

P1477: *Passenger Information System for Rail Transit Vehicles*

2.2.2.17 IFI (Industrial Fasteners Institute)

Inch Fastener Standards, 7th Edition

Metric Fastener Standards, 3rd Edition

2.2.2.18 ISO (International Organization for Standardization)

2631: *Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole Body Vibration*

9001:2000: *Quality Management Systems-Requirements*

15609-4: *Specification and Qualification of Welding Procedures for Metallic Materials – Welding Procedure Specification – Part 4: Laser Beam Welding*

2.2.2.19 NFPA (National Fire Protection Association)

10: *Standard for Portable Fire Extinguishers*

70: *National Electric Code*

130: *Standard for Fixed Guideway Transit and Passenger Rail Systems*

2.2.3 Specifications

The Customer will provide copies of the following documents:

2.2.3.1 Amtrak

80-276: *Specification for Composition Brake Shoes and Disc Brake Pads*

315: *Public Address/Intercom System*

352: *Flammability, Smoke Emissions and Toxicity for use on Railway Passenger Cars and Locomotive Cabs*

528: *480, 240, 208, and 120 VAC 72VDC Relay and Contactor Panel*

685: *Disposable Air Filter*

696: *National On-Board Signage Manual*

697: *Valve and Exterior Equipment Identification Tags & Labels and Operating Instructions*
700: *Schematic, Wiring and Piping Diagram Drawings*
759: *Replacement of Copper Waste Piping with Non-Metallic Pipe*
963: *Operational and Environmental Conditions for Rail Rolling Stock*
964: *Specification for Truck Design Validation and Ride Quality Testing*
967: *Manufacture and Acceptance of Passenger Seating for Intercity Rail Cars*
971: *Linear Induction Motor Door Controllers*
972: *Plug Doors*
S-603: *Braking Distance Calculations*

2.2.4 Drawings

2.2.4.1 Amtrak

A-63-7675-15: *Trainline Standard: 27 Point MU System*
A-63-7676-1: *Trainline Standard 27 PT Communication System*
B-066-00050, Rev A: *Bi-Level Clearance Drawing*
B-144: *Standard Amtrak Coach Key (J.L. Howard Part No. 2555)*
C-01-1498: *27-Pin Communication Jumper Cable*
C-63-7422: *27-Pin MU Jumper Cable*
C-63-7437: *27-Pin MU Receptacles*
C-96-7591: *Standard Trash Container (Amtrak Part No. 24-045-18737)*
D-00-1359: *Speed Sensor and Cable Assembly*
D-00-7075: *Temperature Probe and Connectors*
D-08-2269: *Axle Single Level Program*
D-12-7191: *480 VAC Jumpers and Housing*
D-63-7439: *27-Pin Communication Receptacle*
D-63-7440: *27-Pin Communication Dummy Receptacle*
D-65-7449, Rev A: *Power Transformers*
D 034-00014: *Cab/Baggage Car F-end Pilot Assembly*
D 035-00244: *Seat Track Reference Dimensions*
D 035-00245: *Door System Equipment Location and Nomenclature*
D 035-00246: *Food Chiller Units*
D-062-00108: *Bi-Level Wheelset Assembly*
E-140-2959: *Emergency Equipment Cabinet Arrangement*

2.2.5 Supplemental Documentation

<http://www.volpe.dot.gov/sdd/pubs-crash.html>

2.3 Definitions

The definitions and abbreviations defined below are used throughout this technical specification.

Wherever in the Contract Documents terms are used, the definition, intent and meaning shall be interpreted as follows:

A-End (of the car) — Defined as the end of the car opposite from the B-end of all cars except the cab/baggage car.

A/F-End (of the car) — Defined as the end of the car opposite from the B-end of all car types.

Accessible — To be compliant with the applicable standards for accessibility as defined by the Americans with Disabilities Act of 1990 (ADA) as amended.

Accessible Toilet Room (ATR) — The larger of the toilet rooms in the passenger rail cars, designed to be compliant with all applicable standards for accessibility as defined by the Americans with Disabilities Act of 1990 (ADA) as amended.

Adhesion, Coefficient of — During rolling contact, the ratio between longitudinal tangential force at the wheel-rail interface and normal force.

Amtrak — The National Railroad Passenger Corporation.

Analysis — Written report of the systematic examination of the design, performance and condition of parts, components and systems against Contract and Technical Specification requirements.

Approval — Review and acceptance, in writing, by the Customer. Customer approval in no way relieves the Contractor of meeting all requirements of the specification.

Approved Equivalent — The term "approved equivalent" shall mean an item, which is fully equivalent or superior in terms of form, fit, function, performance and properties, to the specified item.

Assembly — A collection of subassemblies and components typically performing a variety of functions within the context of a larger system.

Authorize — To give authority or power to proceed.

Availability — The percentage of the car fleet usable for revenue service at the beginning of each day's schedule. Also on per car basis, the percentage of time a car is usable for service $(MTBF)/(MTBF+MTTR)$.

Baseline Design — The design of the car or any of its components, apparatus, systems, subsystems, or materials, which has received both drawing approval and first article approval by the Customer.

Baseline Work — All activities, which shall be performed on the cars in order to comply with the requirements of this Specification.

B-End (of the car) — The end of the car where the hand brake is located on all car types.

Braking, Blended — In braking, the simultaneous control of dynamic (rheostatic and regenerative) and friction braking, with the effort of each continuously proportioned to achieve the required total braking effort.

Braking, Dynamic — An electric primary braking system on locomotives so equipped, whereby the traction motors act as generators and the current derived thereof is modulated. This includes both rheostatic and regenerative modes.

Buff — Compressive forces acting longitudinally through the carbody's primary structure.

Burn-In — Operating a component, system, or device in a test mode, often in an extreme or cycled temperature environment, for a specified period of time or distance, to confirm reliable operation.

Calibration — Comparing the performance of a measuring device of unknown accuracy against one of known accuracy.

California Car — Bi-level intercity corridor cars built by Morrison Knudsen and Amerail for use on *Capitol*, *San Joaquin* and *Pacific Surfliner* corridor service. Car-to-car pass-through is on the upper level.

Caltrans — California Department of Transportation.

Cant Deficiency — The condition when a rail vehicle's actual speed through a curve is greater than the speed at which the components of wheel-to-rail force, normal to the plane of the track, would be equalized for the outside and the inside rails.

Car/Cars — The railroad passenger cars to be provided by the Contractor pursuant to this Contract.

Carbuilder — See Contractor.

Characteristics — Any distinct property, or attribute, of the material, or services, that can be described, and measured, to determine conformance, or non-conformance, to Contract requirements.

Commissioning — Activities involved in delivering, adjusting, and testing the cars to demonstrate compliance with Specification requirements and prepare the cars for revenue service.

Component — Usually self-contained, a component is comprised of parts, devices and structure and performs a distinctive function necessary to the operation of a system or subsystem.

Concept Drawings — An initial set of drawings showing the general car layout and arrangement.

Conformed Specification — These Specifications as revised to include and reflect all approved change orders, variances and waivers implemented throughout the duration of the Contract.

Contract — The written agreement as executed between the Customer and the Contractor setting forth the obligations of the Parties, including all authorized changes to this Contract issued subsequent to the execution of the Contract.

Contract Deliverable Requirements List (CDRL) — List of documents and other deliverable items that the Contractor is required to deliver to the Customer. CDRL is also used to refer to a specific item on the list.

Contractor or Carbuilder — The prime Contractor solely responsible to the Customer for the construction, quality and proper functioning of the complete car and all of its components.

Contractor's Drawings — Items such as general drawings, detail drawings, graphs, diagrams, sketches, calculations, and catalog cuts which are prepared by the Contractor to detail his/her work.

Crash Energy Management, CEM — Carbody design such that the structures crush in a controlled manner and absorbs energy with the goal to significantly improve crashworthiness.

Customer — The organization, agency or party that is acquiring the vehicles from the Contractor through the administration of this specification and associated contract documents.

Days — Days shall mean calendar days unless otherwise specified. Business and working days shall be Monday through Friday, exclusive of federally designated Holidays.

Delivery, Delivered — The arrival of the completed vehicle at the Customer's designated facility, ready for commissioning and acceptance testing.

Defect — Any instance of non-conformance with a specification for material, appearance, finish, function, performance or manufacture.

Detrucking — The complete disconnection and removal as required of all structural, mechanical, pneumatic, and electrical connections between the truck assembly and carbody in order to facilitate the complete jacking of the car to remove the carbody weight from the truck assembly.

Equal/Equivalent — Whenever the words "equal", "approved equal", "equivalent" or "approved equivalent are used in connection with a specified component, material, system characteristic or performance requirement, the Contractor shall prepare and submit for Customer approval an analysis that demonstrates that a design, component or system characteristic as proposed by the Contractor has equal or superior appearance, performance interchangeability, availability and compliance with specification requirements to that of the design, component or system as originally specified. This equivalency shall take the form of a specification variance, and shall only be permitted with the specific written approval of the Customer. The reason for the variance request must be included in the analysis as submitted.

F-End (of the Cab car) — The end of the cab/baggage car that is equipped with the locomotive control cab, per the requirements of 49CFR Section 229.11.

Fail-Safe — A characteristic of a system which ensures that no malfunction will create a condition that is not known to be safe.

Failure — A condition in which equipment, components or systems do not function as specified, designed or intended.

Failure Mode and Effects Analysis (FMEA) — A procedure for analysis of potential failure modes within a system for the classification by severity or determination of the failure's effect upon the system.

Failure Rate — The frequency of failure, expressed as failures per hour or failures per mile. Failure rate is the mathematical reciprocal of MTBF or MDBF.

Fault Tree Analysis — A failure analysis in which an undesired state of a system is analyzed using Boolean logic to combine a series of lower-level events. This analysis method is mainly used in the field of safety engineering to quantitatively determine the probability of a safety hazard.

Field Modification Instructions (FMI) — Instructions for applying and installing engineering solutions to resolve fleet-wide defects and/or upgrade installations and/or systems to vehicles that have already been shipped from the factory.

First Article — The first one of any production component of the base vehicle that is manufactured.

First Article Inspection (FAI) — The examination and approval by the Customer of an initial part, major assembly, subassembly, system, subsystem, apparatus, or material, manufactured or assembled by either the Contractor or Subcontractors. The first article approval establishes the baseline design and the minimum level of quality.

Fleet — All cars furnished under the terms of this Contract.

Free Travel — Is defined as the vertical lineal distance between the top of rail and a car body reference point as measured under static conditions when comparing an empty car (AW0) and fully loaded car (AW3).

Head End Power (HEP) — Electrical Power (480 VAC, 3-phase, 60 Hz power) produced by a locomotive or power car, or supplied from stationary substation, which is used as the primary electrical power source by the cars.

Independent Failure — A failure which is not the result of another failure, either directly or indirectly.

Indicated — As used in this Specification, "indicated" shall be understood to mean, "as shown on the Contract Drawings, as described in the Specifications, or as required by other Contract Documents."

Inspection — The careful examination, measurement, and testing of the characteristics and performance of materials, components and systems to ensure conformance with Contract requirements.

Inspection Equipment — Any tool, gauge, fixture, apparatus, or other device used for inspection purposes.

Inspector — The person or firm designated and authorized to perform quality control inspections.

Interface — The points where two or more physical subsystems or systems meet to transfer load, energy or information.

Left-Hand Side — The side of the car on the left, when standing inside the car at the B-end facing the A-end.

Lowest Level Replaceable Unit (LLRU) — The lowest unit (component) of a system or subsystem, which is removable and replaceable from an installed position by standard attachments (e.g., bolts and nuts, quick-disconnects, etc.).

Maintainability — A measure of a car's ability to be properly maintained taking into account the ease and frequency of maintenance tasks, ability to efficiently use applied labor, and accessibility of equipment to be maintained by the Customer's maintenance staff.

Material — An all-inclusive term used to denote raw materials, parts, components, assemblies, and equipment used in the finished product.

Mean Time Between Failures (MTBF) — The mean operating time between independent failures, measured in calendar days.

Mean Distance Between Failures (MDBF) — The mean operating mileage between independent failures.

Mean Distance Between Train Delays (MDBTD) — The mean operating mileage between train delays caused by equipment or system failures.

Mileage, Operating — The total distance traveled by the car during scheduled and unscheduled movements.

Modify — To change the design, placement, or other aspect(s) of an item to provide for a different form, fit or function or to resolve deficiencies or improve performance.

New — An item, OEM or approved equal, which has not previously seen service in whole or in part.

No-Motion — The vehicle speed at or below the lowest speed detectable by the vehicle control systems. Also known as "zero speed".

Normal — As in, example, "normal operating conditions" or "operating normally" -- A condition in which relevant vehicle equipment is not in a failure mode and the environment is as specified.

Notice — A written announcement from the Customer.

Open Items — Items not resolved on the car and documented as incomplete. It is the contractor responsibility to resolve and close these issues. Open items may be documented at any time during the contract duration.

Original Equipment Manufacturer (OEM) — The original manufacturer of a hardware subsystem, component or completed vehicle.

Procurement (Work) — The furnishing of all equipment, items, materials, parts, systems, data, design, services, incidentals, labor and management and performance of the contractual requirements defined in the Contract Documents, including changes thereto, in order to produce and deliver the specified cars, spare parts, hardware and software goods, and services.

Proof (used as a suffix) — Apparatus as designated as splash-proof, dust-proof, etc., when so constructed, protected, or treated that its successful operation is not interfered with when subjected to the specified material or condition.

Push-Pull Operations — A method of controlling the actions of the propulsion, braking and other systems of a train from a control cab, located in either the locomotive or the cab car, for bi-directional operation.

Railroad — Owner(s) of the operating railroad over which the Customer's trains operate, and/or the property and/or improvements used in connection with such operating railroads, as defined by 49CFR 238.

Redundancy — The existence of more than one means for accomplishing a given function. The ability to accomplish a given function by two or more independent means.

Reliability — A term used to identify the failure rate of an item expressed as a percentage or in time of operating hours. The desired result is to have high reliability (100%) with a low failure rate (0%).

Remanufacture — To rebuild and recertify to OEM standards for functionality and appearance. Parts that cannot be remanufactured shall be renewed.

Renew — To replace with a new equivalent component (regardless of condition of part being renewed).

Repair — Correct specific damage to return to original condition or functionality.

Right-Hand Side — The side of the car on the right, when standing inside the car at the B-end facing the A-end.

Safe — Secure from potential harm, injury, danger or risk; free from danger or risk.

Safety — The condition in which persons and equipment are free from threat, danger, harm, or loss arising from improper design, manufacture, assembly or function, or a failure of the car or any of its components or systems.

Safety Critical — An action, device or system that is necessary to maintain a safe condition.

Service — (as in service use, service braking.) The operation of the cars under normal conditions.

Services — Work and incidental material specified in a contract such as inspection, nondestructive examination, calibration, testing, welding, analysis, etc.

Shipment — The physical movement of the car from the Contractor's production facility to the Contractor's designated acceptance facility or other designated destination.

Shop Drawings — Drawings or sketches prepared by the Contractor for use in its manufacturing facility, assembly facility, or shop, to fabricate, assemble, and/or install parts of the vehicles, whether manufactured by it from raw materials or purchased from others in a ready-to-use condition.

Slide, Wheel — During braking, the condition when the rotational speed of the wheel is slower than that of the actual pure rolling contact between tread and rail.

Slip, Wheel — During acceleration, the condition existing when the rotational speed of the wheel is faster than that of pure rolling contact between tread and rail.

Special Tools — Tools which have been specifically designed or developed for the purpose of repairing, maintaining, diagnosing or installing a particular component or system in a manner which cannot be performed with commercially available, “off-the-shelf” tools.

Specified or As specified — As stated in this document or other referenced documents.

Speed, Design — The specified maximum possible operating speed of the car. The car and all components shall be suitable for safe operation at all speeds up to and including this speed.

Standards and Specifications — When industry, government, association, or society standards or specifications are referred to, the applicable issue at the time of Notice to Proceed (NTP) signing shall be used.

Step, Signal — A signal having a constant value prior to the step and a different constant value immediately thereafter.

Stop, Emergency — The stopping of a vehicle or train by an emergency brake application.

Subassembly — A collection of components used to perform a distinct function, usually in conjunction with other subassemblies and components, as part of a larger system. Subassemblies are usually replaceable as units, such as circuit boards, bearings and valves.

Subcontractor — Provider to the Contractor of any services or materials for incorporation into the car design, car construction, spare parts, or other contract deliverable. The Contractor shall be solely responsible for the services or materials provided by the Subcontractor. The words “**supplier**”, “**manufacturer**” and “**vendor**” to have the same meaning.

Subsystem — A defined portion of a system.

Superelevation — The vertical difference between the top surface of the outside and inside rails of a curve.

Superliner — Bi-level Amtrak long distance passenger cars manufactured by either Pullman Standard or Bombardier. Cars have upper-level car-to-car pass-through.

Surfliner — Bi-level intercity corridor cars built by Alstom Transportation for Amtrak and Caltrans for use on *Capitol*, *San Joaquin* and *Pacific Surfliner* corridor service. Car-to-car pass-through is on the upper level.

System — A combination of hardware, people, and or software systems, in any combination which are integrated to perform a specific operational function.

Tamperproof — Fasteners are designated as tamperproof when they are selected so that they can not be easily loosened with common tools such as screwdrivers or pliers.

Tare — A term in weights and measurements which refers to the weight of an empty container. The tare weight can be subtracted when a filled container is weighed to determine the weight of the contents alone.

Test, Proof of Design — Proof-of-Design tests are engineering tests which are used to ensure equipment, as designed, meets the functional and performance requirements of the vehicle specifications.

Test Plan — A document that defines the plan and schedule for conducting all the tests required on the vehicle.

Test Procedure — A step-by-step procedure that identifies the equipment, exact sequence of events and criteria used to ensure that components and systems function properly.

Test, Production — A series of tests applied to each vehicle to ensure all systems and components perform according to design and specification.

Tight (used as a suffix) — Apparatus is designed as watertight, dust-tight, etc., when so constructed that the design will exclude the specified material from affecting the functioning condition or performance of the component or system.

Time, Warm-up — The elapsed time from application of power to an operable device until it is capable of performing its intended function.

Train — Any number of cars coupled to a locomotive and moving as one.

Train Delay — A train delay is defined as a car-related failure that causes a train in service to be: more than 15 minutes late at its destination terminal; canceled either at its originating point or en-route; or reduced in size or revenue capacity due to requiring a failed car to be removed from the train.

Tram — A condition of ideal truck geometry in which the axles are perfectly parallel and the wheels longitudinally in perfect alignment. The centers of the journal bearings represent the corners of a perfect rectangle. Tram is checked by measuring the diagonal and longitudinal distances between reference points on the axle bearing housing.

Unisex Toilet Room (UTR) — The smaller of the two toilet rooms, to be located on the upper level of the passenger rail car, that is not required to be ADA compliant.

U.S. Department of Transportation (USDOT) — Means the Secretary of the USDOT and other persons who may at the time be acting in the capacity of the Secretary, or authorized representative or any person otherwise authorized to perform the functions to be performed hereunder, including representatives of the Federal Transit Administration (FTA) and Federal Railroad Administration (FRA).

Vehicle History Book — A document specific to an individual rail vehicle containing records of technical and parts data pertinent to that individual vehicle.

Verification — Examination and testing by the QA Representative to confirm decisions made by those performing the work concerning conformance of material to Contract requirements.

Vehicle — Same as car or locomotive.

Warp, Track — The vertical distance between a plane defined by any three of four rail head contact points (two on each rail) forming a triangle and the remaining point.

Weatherproof — Able to withstand exposure to all weather and environmental conditions without damage or loss of function.

Weights, Assigned — The loaded car categories assigned by the Customer as the basis for structural repair design and for subsystem and vehicle testing as indicated. Four weight categories are assigned:

1. AWO: Actual weight of empty car, ready for revenue service, but with neither crew nor passengers aboard. Includes full fresh water supply, empty waste system and full complement of provisions in the café/lounge car.
2. AW1: Car at seated load and no standees.
 - Seated Load is defined as all the passenger seats occupied plus one crew member per car.
3. AW2: Car at normal full load.
 - Normal Full Load is defined as seated load plus one standee per 3 ft² of clear floor space.
4. AW3: Car at crush load.
 - Crush Load is defined as seated load plus one standee per 1.5 ft² of clear floor space.

Each passenger or standee is assumed to weigh an average of 180 pounds.

Weight, Dry — The measured axle weight of an empty passenger rail car (measured dry). Fully assembled but with no water or provisions.

Work (Procurement) — Where the context will allow, the term "work" shall mean the production of goods and services furnished in accordance with the Contract.

Zero Speed — See "No motion".

Whenever in the specifications or on the plans the words "**required**," "**determined**," "**directed**," "**specified**," "**authorized**," "**ordered**," "**given**," "**designated**," "**indicated**," "**considered necessary**," "**deemed necessary**," "**permitted**," "**reserved**," "**suspended**," "**established**," "**approval**," "**approved**," "**disapproved**," "**acceptable**," "**unacceptable**," "**suitable**," "**accepted**," "**satisfactory**," "**condemned**," or words of like import are used, it shall be understood as if such words were followed by the words in writing, "**by Customer**," "**to Customer**," "**the Customer**" unless otherwise specifically stated.

Wherever the words "**provided**," "**supplied**," or "**installed**" are used in the specifications in reference to work to be performed by the Contractor, it shall be understood to mean "**furnished and delivered completed and ready for revenue service**."

2.3.1 Abbreviations

The following is a list of abbreviations in this specification. The list is not intended to be all-inclusive.

AAR	Association of American Railroads
AC	Alternating Current
ADA	Americans with Disabilities Act of 1990 as amended
AED	Automated External Defibrillator
AEI	Automatic Equipment Identification
amp	ampere
ANSI	American National Standard Institute
APTA	American Public Transportation Association
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATOR	Above Top of Rail
ATR	Accessible Toilet Room
ATS	Automatic Train Stop
AWO	Empty vehicle operating weight, Ready-to-Run (Assigned Weight "0" load)
AW1	Car at seated load and no standees.
AW2	Car at normal full load.
AW3	Car at crush load.
AWS	American Welding Society
BC	Battery Charger
BP	Brake Pipe
BTU	British Thermal Unit
°C	Celsius (degrees)

CAD	Computer-Aided Design
CCJPA	Capitol Corridor Joint Powers Authority
CCTV	Close Circuit TV
CCU	Communication Control Unit
CD	Compact Disk
CDRL	Contract Deliverable Requirements List
CDT	Central Diagnostics Terminal
CEM	Crash Energy Management
CFC	Chlorinated Fluorocarbons
cfm	Cubic Feet per Minute
CFR	Code of Federal Regulations
CO	Central Office
COMM	Communication
COTS	Clean, Oil, Test and Stencil
CPE	Customer Premise Equipment
DAVW	Digital Audio Video Workstation
DB	Dry Bulb
dB	Decibel
dB/sec	Decibels per second
dBA	Decibels (Acoustic)
DC	Direct Current
DCS	Data Communication System
DNTU	Data Network Transport Unit
DR	Design Review
DTE	Diagnostic Test Equipment
DVD	Digital Versatile Disc

DVD RW	Digital Versatile Disc - Rewriteable
EAB	Electronic Air Brake
ECR	Engineering Change Request
ECSB	Engineering Change Service Bulletin
EEPROM	Electrically Erasable Programmable Read Only Memory
e.g.	exempli gratia (for example)
EMC	Electromagnetic Compatibility
EMD	Electro Motive Diesel (a locomotive and component manufacturer)
EMI	Electromagnetic Interference
EPA	U.S. Environmental Protection Agency
EPROM	Erasable Programmable Read Only Memory
ER	equalizing reservoir
etc.	et cetera (and so forth)
ETMS	Electronic Train Management System
F	Front (end of locomotive or cab car designator as defined by 49CFR Section 229.11))
°F	Fahrenheit (degrees)
FAI	First Article Inspection
fc	foot-candle
FDA	U.S. Food & Drug Administration
FDR	Final Design Review
FEA	Finite Element Analysis
FEM	Finite Element Model
FMECA	Failure Modes and Effects Criticality Analysis
FMI	Field Modification Instruction
fpm	feet per minute
FRA	Federal Railroad Administration (U.S. Department of Transportation)

FRP	Fiberglass Reinforced Plastic
ft²	Square foot
ft³	cubic foot
FTA	Federal Transit Administration (U.S. Department of Transportation)
g	Acceleration due to gravity (386.1 inches per second per second)
gal	gallon
GB	Gigabyte
GFCI	Ground Fault Circuit Interrupter
GHz	gigahertz
gpm	gallons per minute
GPS	Global Positioning System
HDMI	High Definition Multimedia Interface
HEP	Head End Power
Hg	Mercury (pressure or vacuum – measured in inches)
HPPL	High Pressure Photoluminescent
hr	hour
HVAC	Heating, Ventilation, & Air Conditioning
Hz	Hertz
i.e.	id est (that is)
IC	Intercommunication
IDR	Intermediate Design Review
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
in.	inch
IPC	Illustrated Parts Manual
IPS	Iron Pipe Size

ISO	International Organization for Standardization
ISP	Internet Service Provider
IVDN	Inter-Vehicle Data Network
IWS	Instrumented Wheelset
°K	Kelvin (degrees)
kHz	kilohertz
km	kilometer
ksi	1000 pounds per square inch (psi)
kW	kilowatt
LAHT	Low Alloy High Tensile
lb	pound
lbf	pounds of force
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LLEPM	Low Location Exit Pathway Markings
Log	Inspection and Test Log
LLRU	Lowest Level Replaceable Unit
LSA	Lead Service Attendant
LVPS	Low Voltage Power Supply
mA	milliampere
MAP	Maintenance Analysis Program
Mbps	Megabits Per Second
MDBCF	Mean Distance Between Component Failures
MDBF	Mean Distance Between Failures
MDBTD	Mean Distance Between Train Delays
mg/sq. in.	milligrams per square inch

Mhz	Megahertz
MIG	Metal Inert Gas
MIL	Military Specification
min	minute
mm	millimeter
MP3	MPEG Audio Layer 3
MPa	Megapascal
mph	miles per hour
mphps	miles per hour per second
mphpsps	miles per hour per second per second
MR	Main Reservoir
MSDS	Material Safety Data Sheet
msec	milliseconds
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
MU	Multiple Unit
mV	millivolt
N/A	Not Applicable
NAS	Network Attached Storage
NBS	National Bureau of Standards
NC	Normally Closed
NDE	Non-Destructive Examination
NEMA	National Electrical Manufacturers Association
NFL	No Field Lubrication
NFPA	National Fire Protection Association
NIC	Network Interface Card

NO	Normally Open
NPT	National Pipe Thread
NSF	National Sanitation Foundation
NTP	Notice-to-Proceed
NTSB	National Transportation Safety Board
OCU	Operator Control Unit
ODBC	Open Data Base Connectivity
ODK	Operator Display Keypad
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Health Administration
OTIS	Onboard Train Information System
oz	ounce
p/n	part number
PA	Public Address
PA/IC	Public Address/Intercom
PC	Personal Computer
PCB	Printed Circuit Board
PCMCIA	Personal Computer Memory Card International Association
PCS	Pneumatic Control Switch
PDF	Portable Document Format
PDR	Preliminary Design Review
PHS	Public Health Service
PIDS	Passenger Information Display System
PIS	Passenger Information System
PISCU	Passenger Information System Control Unit
PKO	Power Knock/Out

PM	Preventative Maintenance
POS	Point-of-Sale
ppm	parts per million
pphm	parts per hundred million
PRIIA	Passenger Rail Investment and Improvement Act
PROM	Programmable Read-Only Memory
psi	pounds per square inch
psig	pounds per square inch (gauge)
PTC	Positive Train Control
PTE	Portable Test Equipment
PTT	Push to Talk
PTU	Portable Test Unit
PVC	Polyvinyl Chloride
QA	Quality Assurance
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
RFI	Radio Frequency Interference
RFP	Request for Proposal
RGB	red green blue
rms	root mean square
S&I	Service and Inspection
SAE	Society of Automotive Engineers
SCFM	Standard Cubic Feet per Minute
sec	second
SIV	Secondary Impact Velocity
SNR	Signal-to-Noise Ratio

SQL	Structured Query Language
SSP	System Safety Plan
SSS	Sign System Server
T/L	Trainline
TB	Terabyte
TBD	To Be Determined
TCD	Train Communications Data
TFT	Thin Film Transistor
TIG	Tungsten Inert Gas
TMS	Train Monitoring System
U.S.	United States
UL	Underwriter's Laboratories, Inc.
UMLER	Universal Machine Language Equipment Register
USB	Universal Serial Bus
USDOT	United States Department of Transportation
USPHS	U.S. Public Health Service of the U.S. Department of Health and Human Services
USSC	United States Steel Corporation
UTR	Unisex Toilet Room
UV	Ultraviolet
V	volt
VAC	Volt Alternating Current
VDC	Volts Direct Current
VDSL2	Very High Speed Digital Subscriber Line 2
W	watt
WB	Wet Bulb

WiFi	Wireless Fidelity (Wireless Local Area Network protocol, IEEE 802.11b, 802.11g and 802.11n)
WLAN	Wireless Local Area Network
WMS	Work Management System
yr	year
Z	Impedance

* End of Chapter 2 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 3

Project Management

Table of Contents

3.0	Project Management	3-2
3.1	Overview	3-2
3.2	Regulations, Standards, Specifications and Drawings	3-3
3.3	Project Management.....	3-3
3.3.1	Correspondence Tracking	3-4
3.4	Quality Assurance (QA)	3-4
3.4.1	Quality Assurance Plan	3-4
3.4.2	Initiatives that Promote Sustainability in the Manufacturing Process.....	3-8
3.5	Design Objectives	3-9
3.5.1	Reliability	3-9
3.5.2	Maintainability	3-13
3.5.3	Metrication	3-16
3.5.4	Safety	3-16
3.6	Design Review	3-19
3.6.1	Customer Involvement.....	3-20
3.6.2	Approval of Suppliers	3-21
3.6.3	Configuration Management	3-21
3.6.4	Design Review Process.....	3-24
3.6.5	Component Approvals	3-28
3.6.6	First Article Inspection (FAI)	3-29
3.7	Inspection	3-33
3.7.1	Inspections and Tests	3-33
3.7.2	Contractor Provisions for Customer Inspectors	3-34
3.7.3	Scheduling of Inspections and Tests	3-35
3.7.4	Receiving Inspection	3-35
3.7.5	Manufacturing/Assembly Inspection Hold Points	3-35
3.7.6	Car Pre-Shipment Inspection.....	3-36
3.7.7	Car Shipping Inspection	3-36
3.7.8	Car Modification Inspection	3-36

3.0 Project Management

3.1 Overview

These Technical Specifications, including the conceptual drawings, describe and illustrate the criteria to be used for the Contractor's design and manufacture of the PRIIA 305-001/Amtrak 962 railcars.

The cars shall comply in all respects with the requirements of the applicable laws and regulations of the United States of America, especially the regulations of the Federal Railroad Administration (FRA). Testing will be conducted in full compliance with all FRA requirements. It is noted that while specific agency regulations and recommendations are called for in this Technical Specification, they shall not be considered to be to the exclusion of all others. The cars shall also comply in all respects with applicable standards and recommendations of the American Public Transportation Association (APTA) and the Association of American Railroads (AAR), unless specified otherwise.

The design criteria and constraints that are known to the Customer have been specified. Further definition and clarification are anticipated during the design review process. The Contractor shall not be relieved of the overall responsibility of providing an adequate design for the Customer's service conditions.

Various industry standards such as those published by AAR, APTA, ASME, ASTM, ANSI, IEC and IEEE documents mentioned in this Technical Specification are examples acceptable to the Customer. Material standards and specifications which are used by the Contractor, unless otherwise approved by the Customer, shall be of those organizations which are based in the United States, or are generally used on a commercial basis in the United States. The applicable document revision shall be that in effect on the date of contract award. The specified standards of this Technical Specification may be replaced with Customer approved equivalent standards proposed by the Contractor after Contract award. The Contractor shall be required to establish the equivalency and to obtain explicit approval from the Customer for any substituted documents.

Various components have been specified by manufacturer and part number in this Specification. The Contractor may propose alternate manufacturers components but the use of alternate components or manufacturers must be approved by the Customer. Proposed alternative components must be interchangeable in form, fit and function with components called out herein.

For safety critical items, introduction of alternative components will only be considered if such components have an established record, in North America, and/or have undergone an appropriate qualification program that demonstrates an acceptable level of safety, service and reliability for intercity or commuter passenger cars. The data submitted by the contractor will be approved by the Customer.

Component assemblies and subsystems provided on the first build lot of cars under this Specification must be designed so as to facilitate the exchange and substitution of alternative components for form, fit and function. Subsystem, assembly or component level for interchange will be determined by the Customer.

3.2 Regulations, Standards, Specifications and Drawings

The Customer takes no responsibility for the identification of applicable chapters and paragraphs of regulations and standards with which the Contractor must comply. Nothing in this specification shall relieve the contractor from ensuring that all applicable regulations, standards and specifications are followed. The contractor shall provide proof of compliance for those items so governed before the first train set is accepted.

The Contractor is responsible for ensuring that all applicable regulations, standards and specifications are followed when complying with the requirements of this document.

A summary list of regulations, standards and specifications is listed in Chapter 2 as a guide to the Contractor, but shall not be construed as complete.

3.3 Project Management

The Contractor shall submit to the Customer for approval no more than 45 days after Notice to Proceed (NTP) a program management plan. It shall contain at a minimum an organizational chart providing a definition of personnel responsibilities, the methods and communications to be used to control the program (its schedule, technical performance, program changes, subcontracts, material procurement and field engineering support) and details concerning the Critical Path Method (CPM) scheduling plan for the contract work, as described below. The program management plan shall have a live document status. All changes must be submitted to the Customer during the next monthly progress report covering the time period the change took place. Changes will be subject to approval by the Customer. **CDRL**

The Contractor shall use an approved industry standard computer driven CPM plan to schedule all activities related to this contract, including its work, and the work of its subcontractor's and major supplier's work. The CPM system shall be approved by the Customer. The CPM Plan shall have a precedence-type network, with the start date being the NTP, with every milestone listed in the Terms and Conditions being identified, including the delivery of each car. All intermediate milestones shall be shown in proper logical sequence. The CPM plan shall include all of the Contractor's work activities with sufficient detail such that all interfaces with all direct and related parties of the project are highlighted. The work of subcontractors and suppliers shall be shown on the schedule, being supplied by them and updated whenever necessary. A high priority shall be given to keeping their plans accurate and up-to-date. Major procurement activities shall be indicated, including submittal and approval of shop drawings and delivery of all material. Interruption of service, delivery of equipment, project phasing and any other specification requirements must be included. The Contractor shall require that all subcontractors and suppliers provide the information needed to properly update the plan, at a maximum period between updates of 30 days, and then provide the updated plan to the Customer. Particular attention shall be given toward the early detection of any supplier delay, to allow proper response to be made by the Contractor as early as possible.

In addition to the requirement for updated versions of the CPM plan to be submitted to the Customer, the Contractor shall submit to the Customer a monthly progress status report in the form of updated computer printouts and narrative reports. In the narrative report, the Contractor shall state the percentage of work physically completed and include a description of the physical progress during the report period; plans for the forthcoming report period; problem areas, current and anticipated; delaying factors and their impact; and an explanation

of corrective actions taken or proposed. Specifically addressed in the report shall be the status of uncompleted activities which have less than 30 calendar days float and which are either in progress or scheduled to be started within the next reporting period. At the request of the Customer, the Contractor shall participate in pre-update conferences to verify progress and review modifications to the detailed network schedule prior to the formal monthly submittal. This report shall also include the work done by major suppliers and subcontractors. **CDRL**

3.3.1 Correspondence Tracking

Following NTP, the Contractor and the Customer shall mutually agree on a common correspondence identification coding system. All correspondence shall be coded by the sender with a letter(s) from the English alphabet to designate the originator and with a unique sequence number to ensure unmistakable identity. All correspondence shall readily display the Customer's contract number, denote if a reply is required, and the identity of coded correspondence being replied to, if any. Both parties shall maintain a log to list the date a correspondence is sent or received.

All submittals shall be made solely by the Contractor through the use of written correspondence describing the purpose of the submittal, the anticipated work and response by the Customer and the specific identification of the material submitted in terms of drawing/revision numbers, document numbers, etc.

A standard format shall be used for documentation that is carried throughout the duration of the Contract.

3.4 Quality Assurance (QA)

The Contractor shall develop and implement a Quality Assurance (QA) program that conforms to FTA-IT-90-5001-02.1 of February 2002: *Quality Assurance and Quality Control Guidelines*, to assure the delivery of a quality product. The elements of the program shall encompass and control the Contractor's entire organization and all other manufacturers, subcontractors and suppliers that perform work relating to this car contract.

The QA Program shall assure that all aspects of car design, component manufacture and testing, car assembly and testing, and car commissioning are in full conformance with the design, materials and workmanship requirements provided in these Technical Specifications, and are comprehensively documented.

3.4.1 Quality Assurance Plan

A Contract-specific QA plan shall be prepared that details when and where in the manufacturing process each element of the Contractor's and major supplier's organizations will perform specific actions required by the associated QA manual using the quality procedures found therein. The plan shall also specifically identify an adequate number of qualified staff to carry out the required QA tasks and their roles and responsibilities.

The plan shall illustrate how the Contractor intends to meet the quality assurance requirements of this Technical Specification.

Required elements of the QA plan:

- Overview of contractor's QA program.
- Corporate organization chart showing how the unit responsible for QA fits into the overall corporate structure, including how it relates to other functional units such as engineering, purchasing, production and warranty, and how the QA communicates with those other functions to ensure quality objectives are met.
- Organization chart for the QA unit, including names, duties and responsibilities, and contact information for QA unit personnel.
- Specific QA policies, procedures and objectives that are implemented at all stages of the project to ensure that the highest quality is maintained through the life of the project.
- Role of the Customer in the QA process, including Customer design reviews, inspections and hold points, and the Customer's authority to require corrective action to resolve quality problems.
- Process for implementing, monitoring and revising/improving QA policies and procedures, including the means by which QA has the ability to take corrective action to resolve quality problems within engineering, production or testing, and the authority that gives QA the ability to stop production if problems go uncorrected.
- Process for engineering changes, configuration management, production control and other manufacturing tools to ensure that vendors and production are working to current revisions of all drawings, specifications, policies and parts lists.
- Process for auditing production to determine if QA policies and procedures are being implemented and maintained, and how problems are corrected.
- Process by which vendors and suppliers are verified to be in compliance with the contractor's QA program, and the process for ensuring that vendors adhere to the QA plan, including source inspections, inbound material inspections, resolving vendor quality problems, certification of parts authenticity and anti-counterfeiting efforts, and long-term parts availability in conformance with contractual provisions.
- Inspection process for monitoring quality during production, including flow chart and process for resolving defects and closing out nonconformances.
- Schedule for inspection and recalibration for all tools and devices used for measurement, testing or inspection.
- Process and objectives for defect reduction over the term of production of the vehicles, including trend analysis, engineering changes if necessary and modifications to inspection and testing processes.
- Monitoring of post-delivery performance of delivered vehicles, including evaluation and analysis of fleetwide failures, engineering changes to production, and field modifications to delivered vehicles if necessary. If a failure occurs on 10% of the component population fleet or three times on the same component within the warranty period a failure analysis will be completed and fleetwide field modification will be completed.
- The QA plan shall be submitted to the Customer for review and approval, no more than 90 days after NTP.

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The approved QA plan and supplemental manuals, procedures and instructions shall be subject to regular scheduled and unscheduled audits by the Customer.

A quality organization chart shall be included to show the reporting relationships of all QA management staff. The responsibility for the quality assurance function shall be so placed in the Contractor's organization that it is independent from production.

The QA plan shall clearly indicate that the Contractor's QA representatives shall have sufficient authority and organizational freedom to insure that a nonconforming or discrepant product or service will not be delivered. The organization of the Contractor's QA program shall report directly to the General Manager of the Contractor's facility or the Contractor's Project Manager. In any case it must be completely independent of the Contractor's manufacturing or purchasing divisions. The QA personnel shall have complete freedom to identify and evaluate problems; to recommend solutions; to verify implementation of solutions; and to control further processing, delivery, or installation of a nonconforming or deficient item until proper and documented disposition has been obtained.

The Contractor's QA personnel performing inspections and tests shall be certified for such work. Certification of personnel shall be by the virtue of those skills which are obtained by experience or training and verified by testing. All manufacturing personnel performing special processes, such as welding, brazing, etc. shall be trained and certified for such work, in accordance with applicable industry standards and practices. Records of personnel certifications shall be maintained and monitored by the Contractor's QA department. These records shall be made available to the Customer for review.

The Contractor shall, upon request, place measuring and control recordings at the disposal of the Customer and provide copies of documentation. The Contractor shall ensure that inspection and tests are based on the latest approved revision or change to drawings and specifications. A procedure shall be maintained that embraces the adequacy, completeness and updating of drawings, and the control of changes. This procedure shall be in coordination with the change control system as provided in this Specification and Contractor's configuration management system. The Contractor shall ensure that requirements for the affectivity point of changes are met and that obsolete drawings and change requirements are promptly removed from all points of issue and use. Means of recording the effective points shall be employed and made available to the Customer

The Contractor shall establish and maintain an effective and positive system for controlling nonconforming material and workmanship, including procedures for its identification, segregation and disposition. Dispositions allowing the use or repair of nonconforming material or workmanship shall require the Customer's approval. All nonconforming material shall be positively identified to prevent unauthorized use, shipment or intermingling with conforming material. Holding areas and procedures mutually agreeable to the Contractor and the Customer shall be established by the Contractor.

Corrective action and related information shall be documented and made available to the Customer upon request. Corrective action shall extend to the performance of all sub-suppliers and include as a minimum:

- Analysis of data and examination of discrepant products to determine extent and causes with corrective action implemented in an expeditious manner prior to the next shipment, order or inspection.
- Introduction of required improvements and corrections, initial review of the adequacy of such measures, and monitoring of the effectiveness of corrective action taken.
- Analysis of trends in processes or performance of work to prevent nonconforming products.

The Contractor shall, for the purposes of this Contract, designate a person who has sufficiently defined responsibility, authority, resources and organizational freedom of action to be in charge of, and implement on behalf of the Contractor, such QA as is required to ensure a proper control of the production process. The QA organization must report independently from production and have fully independent authority to reject unsatisfactory material and subassemblies regardless of any effect on the progress of the Work.

The QA plan shall also contain or refer to a comprehensive collection of standard forms to be utilized for documentation of quality control activities. These forms shall be designed to assure compliance of materials, processes, personnel and products to the approved design drawings and applicable specifications.

3.4.1.1 Subcontractor Quality Assurance Requirements

The Contractor shall require that each subcontractor establish and maintain a QA program acceptable to the Contractor and the Customer for the services and items it supplies. The Contractor is responsible for all subcontractor and supplier quality and performance.

The Contractor shall survey, audit and periodically review each subcontractor and their facilities to assure adequate capabilities to perform subcontracted efforts in compliance with the Contractor's QA program.

Each subcontractor or supplier shall have a QA system that is approved by the Contractor and fully implements the QA plan of the Contractor as it applies to the subcontractor or supplier's scope of work.

3.4.1.2 Quality Assurance Assessments

The Customer shall have the right to visit all facilities of the Contractor, subcontractors and suppliers associated with this Specification to conduct initial and on-going assessments of their QA programs to determine if the QA programs are capable of assuring product compliance with the requirements of this Specification. During these assessments, the Contractor shall provide Customer personnel reasonable assistance as they inspect production facilities, examine operations in progress and review documentation. If any deficiencies are noted, the Contractor shall ensure that the deficiencies are properly documented and the necessary corrective action is promptly implemented.

For on-going assessments, the Customer shall have free access to the production facilities of the Contractor and his Subcontractors. The Contractor shall perform periodic quality assurance audits and inspections during the execution of the car contract to ensure that all QA program obligations are being fulfilled and that all deliverables meet the requirements of the Technical Provisions and all approved drawings and procedures. Customer audits and monitoring will be performed independent of and in addition to the Contractor's quality assurance function, but will in no way replace, negate, override or lessen the Contractor's QA obligations.

3.4.1.3 Quality Assurance Audits

The Contractor shall maintain adequate records of compliance with the QA program plan for the life of the contract and subsequent warranties are in force. These records shall be made available to the Customer representative on demand, and a complete set of records shall be submitted to the Customer at the end of the warranty period. **CDRL**

3.4.1.3.1 Customer Audits

The Customer will perform scheduled and unscheduled audits of the Contractor's quality assurance activities to assure compliance with the approved QA plan. As a minimum, the following audits of the Contractor will be performed:

- During production of the first carshell (will include an audit of both the Contractor and major subcontractors)
- During manufacturing, installation of equipment, and testing
- Before acceptance of the first car

The Contractor will be notified of other audits to be performed by the Customer as deemed appropriate.

3.4.1.3.2 Contractor Audits

The Contractor shall perform periodic internal audits throughout the life of the project to verify that all aspects of the Customer-approved QA plan have been effectively implemented. The Contractor shall provide the Customer with an internal audit schedule at the onset of the project and whenever revisions to the schedule occur. Deficiencies discovered during the audit process shall be documented and corrected. Corrective actions shall include measures to preclude recurrence of the deficiency. Deficient areas shall be re-audited on an accelerated schedule.

3.4.1.3.3 Subcontractor Audits

The Contractor shall audit subcontractors to assure compliance with the approved QA plan. As a minimum, the following audits of each subcontractor shall be performed:

- Prior to a subcontracted or purchased item being delivered
- Within 30 days of the scheduled First Article Inspection (FAI), qualification test or the Contractor's acceptance of any supplies items or services

The Customer shall be notified in advance of any scheduled audit and may witness any Contractor performed audit.

3.4.1.3.4 Audit Reports and Corrective Action

The Contractor shall fully plan and document all quality audit activities performed internally and at subcontractor premises. Likewise, the Customer will provide the Contractor with an audit report within two weeks of each audit detailing any non-compliance's found during the audit, recommending corrective actions and establishing dates by which corrective action is required.

3.4.2 Initiatives that Promote Sustainability in the Manufacturing Process

The Contractor shall provide to the Customer documentation regarding initiatives the Contractor has undertaken to promote sustainability and reduce the amount of material and energy waste produced by the manufacturing process. This documentation shall extend to the strategies employed by the Contractor's suppliers and vendors. These initiatives shall identify the means by which manufacturing waste and energy consumption will be reduced, including

tangible and quantifiable goals and the method for monitoring and improving the success of the program.

The waste reduction strategies may include (but are not limited to):

- Creation and utilization of reusable packaging for the transport of materials and components between the facilities of the parts supplier and the Contractor;
- Use of recyclable materials for packaging;
- Use of recycled or renewable materials in the production process;
- Reuse or recycling of excess material created during the manufacturing process;
- Use of energy-efficient or low-emission vehicles and equipment for transportation and production purposes;
- Capture of reusable or recyclable materials such as office paper, cardboard, copier toner, beverage containers and other post-consumer recyclable material;
- Use of facilities that meet the standards of the Leadership in Energy and Environmental Design (LEED) program;
- Employee awareness campaigns that promote reduction of material and energy waste; and
- Strategies that promote the reduction of unnecessary use of materials and energy.

The Contractor's waste reduction program shall provide to the Customer quarterly reports that document the status of the program and the level of success that the program is achieving.

3.5 Design Objectives

3.5.1 Reliability

Every complete car, as well as each constituent component, assembly, subsystem and system element shall be designed in such a manner as to perform its function reliably in revenue service. Each car under all system operating conditions shall operate with a failure rate not exceeding that defined in these Technical Specifications.

The Contractor shall prepare and submit at the Preliminary Design Review (PDR) for approval by the Customer a Reliability Program Plan which shall, as a minimum, contain the following:

- Program objectives
- Reliability program schedule
- Methodology to be used in reliability analyses
- Organization of personnel responsible for managing the reliability program
- Controls for activities of subcontractors and equipment suppliers to assure compliance with reliability program methods and objectives
- Preliminary reliability demonstration testing plans for verification of compliance when calculations and analyses are inconclusive, or when past performance records are incomplete or unavailable
- Reliability demonstration program

- Reliability demonstration procedures
- Reliability database in FileMaker Pro (current revision)

3.5.1.1 Reliability Objectives

The Contractor shall provide reliability objectives that identify the Mean Distance Between Train Delays (MDBTD) and the Mean Distance Between Component Failure (MDBCF) performance levels to be met for its car design to the Customer for approval. The reliability of the cars shall be consistent with the requirements of this specification and the Contractor's maintenance plan.

The reliability objectives shall be based on single car operation at an average speed of 55 mph (88 km/hr) and a utilization of 215,000 miles/yr (344,000 km/yr).

3.5.1.2 Car Reliability Requirements

The car shall achieve a car MDBTD of at least 150,000 miles (120,000 km).

A train delay shall be defined as a car-related failure causing a train in service to be:

- More than 15 minutes late at its destination terminal;
- Canceled either at its originating point or en route; or
- Reduced in size or revenue capacity due to requiring a failed car to be removed from the train.

3.5.1.3 Component Reliability Requirements

Providing that the Contractor's specified routine maintenance is performed on the various car sub-systems and components, the following reliability (MDBCF) requirements shall be met:

System	Mean Distance Between Component Failure
Friction Braking System	300,000 miles [330,645 km]
Side and End Doors	300,000 miles [482,803 km]
HVAC System	380,000 miles [612,903 km]
Couplers	300,000 miles [411,290 km]
Trucks and Suspension	435,000 miles [701,613 km]
PA Systems	460,000 miles [741,935 km]
Auxiliary Power Systems	255,000 miles [411,290 km]
Lighting (except bulbs)	890,000 miles [1,439,516 km]
Food Service Components	300,000 miles [482,803 km]
Toilet	300,000 miles [482,803 km]
Cab Control Systems	450,000 miles [724,204 km]

The Contractor shall provide records illustrating the product history and experience of existing systems and system components to verify that the specified MDBCF requirements are achievable.

Where historical records of equipment performance, detailing equipment operations, have not yet been established, analyses shall be performed to identify weaknesses within the system hardware and software design. The analyses shall provide detailed information for the system

designs for theoretical circuit behavior, random component failures, electrical interference, systematic component failures and software errors in software-based logic. The reliability analysis shall be submitted for approval and updated periodically.

Reliability of microprocessor software shall be assessed from previous experience with similar software in railroad and rail transit revenue service, or by reliability evaluation methodology based upon the number of errors detected in each phase of the software development cycle. The improvement in operational reliability provided by fault tolerance features shall be quantified.

The MDBCF shall be defined by the following equation:

$$\text{MDBCF} = d/F$$

where d equals the total car operating distance and F equals the number of relevant failures.

A failure shall not include the following, for the purposes of calculating reliability:

- Failure due to documented instances of recommended preventative maintenance not being performed; or
- Failure due to accidents, vandalism or other physical mistreatment

3.5.1.4 Reliability Demonstration Program

The Contractor shall prepare a detailed reliability demonstration program identifying all quantitative requirements, to demonstrate that design reliability concepts and guideline objectives are in compliance with the analysis. The program shall contain failure accounting ground rules, accept-reject criteria, number of test cars, test locations, environmental conditions, planned starting dates and test duration. The reliability demonstration plan shall be submitted to the Customer at the preliminary design review.

The program shall provide a constant review of failure rate sources, de-rating policies, items with critical shelf life and prediction methods and shall identify planned actions in instances where prediction methods indicate non-compliance with the specified requirement. The program shall provide for compliance with all guidelines and provide that prohibited parts/materials are not utilized.

The program objectives shall include (but are not limited to):

- Reliability program organization, showing personnel and their responsibilities over the entire program
- Reliability demonstration schedule
- Specific tasks shall be identified for schedule development with start and completion dates, illustrating integration with major program milestones for design, manufacturing, and testing
- Reliability requirements compliance methodology to be used in reliability analyses for success-failure criteria measuring MDBCF values for individual equipment items and subsystems under demonstration
- Reliability program controls, methods and objectives to provide compliance and change control procedures for implementing design changes during the demonstration program, for failures, identifying the cause and need for corrective action.

- Establishment of a joint Contractor/Customer failure review board to classify failures, identify cause and propose corrective action, if required.
- Reliability demonstration procedures and forms for recording and submitting data, showing format, test logs, data records and date and location of test records.

The reliability demonstration program shall commence upon the conditional acceptance of the first car of the base order and shall continue to the end of warranty period of the last accepted car. The reliability demonstration program plan shall be submitted for Customer approval. During the demonstration, the cars shall be maintained by qualified maintenance personnel according to the maintenance plan and maintenance manuals provided by the Contractor.

Reliability calculations will be performed using a 12 month moving window. All equipment failures during car burn-in shall be reported and recorded, but not counted in establishing MDBCF and MDBTD values. Determination of pass or fail will be assessed only at the end of the reliability demonstration.

The Contractor shall make necessary modifications during the reliability demonstration program in order to achieve the MDBCF and MDBTD requirements. The Contractor shall submit all requests for such design changes within 60 days of the end of the reliability demonstration using the Engineering Change Request (ECR) system and shall gain Customer approval prior to the implementation of any change. All reliability-related modifications defined during the reliability demonstration program shall be implemented on all cars and spare parts within 180 days of the date of approval of the modifications by the Customer.

If at the end of the reliability demonstration it cannot be determined that all specified MDBTD reliability requirements have been met, the Contractor shall re-design and modify or replace all such systems, subsystems, components, parts or equipment as needed to achieve acceptable reliability, at the Contractor's expense, regardless of whether these items have exhibited the defect or failure and regardless of the warranty status. Should such modifications not be completed within this time, the Customer shall have the right, at its sole discretion, to perform any necessary engineering or studies, and to correct the defect or failure. All costs incurred by the Customer for such engineering and corrective work shall be at the Contractor's expense. Any items replaced by the Customer during such corrective work will be disposed of by the Customer in the manner requested by the Contractor and at the Contractor's expense. If the Contractor fails to furnish disposition instructions, the Customer will dispose of such items, at the Contractor's expense, in such a manner, in the Customer's sole judgment, is appropriate.

Cars so modified shall undertake a further reliability demonstration of at least six months duration to prove reliability. Modifications shall continue at the Contractor's expense until the specified MDBTD reliability levels are met.

3.5.1.5 Reliability Demonstration Procedures

The Contractor shall provide a set of procedures to be followed in the reliability demonstration.

These procedures shall, as a minimum, contain the following:

- Method for all equipment failures to be reported during reliability testing, including forms and reliability database.
- The reliability program shall utilize failure data collected through the warranty failure tracking process.

- Details of the burn-in period for each car. All equipment failures during the burn-in shall be reported and recorded, but not counted in establishing MDBCF values.
- Procedure for corrective action when necessary to meet reliability requirements. This shall include proposed reliability demonstration restart procedures, proposed changes, and appropriate supporting data. The proposed plan shall clearly identify a specific method for verifying the effectiveness of change(s). Credit may not be taken for time from previous failed tests, and the specified performance and other required characteristics of the equipment shall not be changed to achieve reliability requirements.
- Method for recording all relevant data necessary to calculate MDBCF values for the car and major systems and to verify successful demonstration of the MDBCF requirements.

All parts or material returned to the Contractor for repair or replacement shall be accompanied by a failure analysis report form. This form shall clearly identify the part by description and part number; identify the car and service mileage of that car, date of failure and the nature and probable cause of failure. The Contractor shall comment on the cause and proposed action (if any) sections of this report and return it to the Customer within 60 days of the failed item or system.

3.5.1.6 Reliability Database

The Contractor shall establish a computer-based reliability database that shall be utilized for the following tasks:

- Monitoring of overall car reliability on both a car and a component level
- Tracking of all component failures and identification of epidemic failures
- Tracking of all warranty claims
- Maintaining a configuration record for each car

Each record shall contain, as a minimum, the following information:

- Customer car number
- Car acceptance date
- Detailed listing of all car system equipment and major components including description, supplier's name, Customer part number, supplier part number, serial number, revision level and date of installation on car

3.5.2 Maintainability

The car shall be designed and built so as to minimize maintenance and repair time and overall costs over the car life. The following shall be considered good practice in designing for maintainability and shall be utilized in the car design:

- All systems and components serviced as part of periodic preventive maintenance shall be readily accessible for service and inspection.
- Removal or physical movement of components unrelated to the specific maintenance and repair tasks involved shall not be required.

- Relative accessibility of components, measured in time to gain access, shall be inversely proportional to frequency of maintenance and repair of the components. (Items requiring more frequent maintenance shall be easier to access).
- Assemblies and components that are physically interchangeable shall be functionally interchangeable.
- Modular or plug-in assemblies and components that are not functionally interchangeable shall not be physically interchangeable.
- Systematic fault isolation procedures shall be developed for inclusion in the maintenance manuals.
- Local built-in test points and fault/status indicators shall be provided and clearly marked for all major systems including friction braking, Heating, Ventilation and Air Conditioning (HVAC), passenger doors, auxiliary power, battery charger, Public Address (PA), toilet system and food service equipment (chillers and elevator).
- All test points, fault indicators, modules, wire terminations, piping, tubes, wires, etc., shall be identified by name plates, color coding, number coding or other means to assist the maintenance personnel.
- Component placements in equipment cabinets, enclosures or confined places shall give the most accessible positions to those items requiring the most frequent maintenance or adjustment.
- Door panels and openings shall be of sufficient quantity, size and placement to permit ready access from normal work areas.
- Standard, commercially available components and hardware shall be used wherever possible.
- Captive fasteners shall be used on covers and access panels where periodic maintenance and inspection are to be carried out. The use of special tools for removal shall be avoided.
- Access shall be provided, to the greatest extent possible, to structural components to allow inspection for cracks and corrosion.
- Major components shall be designed for ease of removal. Handles and lifting eyes shall be provided as applicable, on heavy equipment and components not readily accessible.
- Means shall be provided to verify the operability of redundant hardware components, and their switching devices, during maintenance, troubleshooting and testing.
- Requirements for special tools and fixtures shall be minimized.

3.5.2.1 Maintainability Plan

The Contractor shall prepare and submit for review at the PDR, a maintainability program plan utilizing design standards that minimize Mean Time To Repair (MTTR), cleaning and maintenance costs throughout the car's intended useful life.

The plan shall include the system MTTRs and car goal for the proposed car. An overall quantitative maintainability requirement goal for the car's corrective maintenance shall be the weighted average of the MTTR (mean time to repair) of the key system elements. Diagnostic and set-up time shall be included in the MTTR.

Preventive maintenance is defined as the maintenance tasks performed to minimize the possibility of future equipment failure, reduce or minimize wear rates, replace consumable

parts, and satisfy warranty requirements. The elapsed time required to perform preventive maintenance (exclusive of servicing) on the car shall be demonstrated.

The objectives of the maintainability program, including corrective and preventive maintenance, shall provide for:

- Maximization of car availability
- Minimization of maintenance costs, including cleaning
- Minimization of car down time
- Minimization of special and high skill levels for maintenance
- Minimization of special tools and fixtures

Components and sub-assemblies requiring occasional removal shall be plug-in units, adequately identified and secured and keyed to prevent misapplication.

The need for adjustments shall be avoided wherever possible. Adjustment points shall be readily accessible, adequately identified and self-locking to prevent inadvertent operation and drift.

3.5.2.2 Mean Time to Repair Requirements

The MTTR a car fault and restore the car to operational readiness shall not average more than 1.8 hours including diagnostic and set-up time.

This shall be the weighted average of the MTTR values for the following subsystem elements:

System	MTTR or Replace Major Module (hours)
Friction Braking System	2.0
Side and End Doors	0.8
HVAC System	2.1
Couplers	2.6
Trucks and Suspension	1.6
Auxiliary Electrical System	1.5
Lighting	0.5
Wheels and Axles	4.0
Cab Control	2.5
PA/IC	1.0
Water and Waste System	2.0

3.5.2.3 Maintainability Demonstration

The adequacy of the car design for maintainability shall be evaluated to the satisfaction of the Customer using product components and equipment, mockups and actual cars during the design, production and acceptance phases.

This demonstration shall include a shop exercise including troubleshooting, change out of components, corrective maintenance, and the use of Contractor supplied special tools and equipment.

The maintainability of following systems shall, as a minimum, be demonstrated:

- Trucks
- HVAC
- Brakes
- Wheels and axles
- Auxiliary electric equipment (including battery charger and battery)
- Side and end doors
- Couplers
- PA and intercoms
- Water and waste system
- Emergency equipment and lighting
- Cab control equipment

The Contractor shall prepare and submit a maintainability demonstration plan for Customer approval at the PDR.

During the demonstration, the cars shall be maintained according to the maintenance plan and maintenance manuals provided by the Contractor.

If at the end of the demonstration it cannot be determined that all specified maintainability requirements have been met, the Contractor shall re-design and modify or replace elements as needed to achieve acceptable maintainability at the Contractor's expense. Cars so modified shall undertake a further maintainability demonstration to prove maintainability.

3.5.3 Metrication

The designs, components and fasteners used on the new cars shall be of inch-standard units of measure wherever possible. While use of metric system of measure will be permitted where necessary, requests for their usage, defined at the subcomponent level, must be submitted to the Customer for review and approval. There shall be no mixing of metric and inch-standard fasteners within a component or subsystem. All metric fasteners used in the car shall be clearly and distinctly called out on all project documentation.

For all drawings, manuals, specifications and inspection documents, all dimensions shall be shown in inch-standard units of inches and decimals, with a metric equivalent shown in parentheses adjacent to the inch-standard dimension. If a component or subassembly uses metric units as the primary system of measurement, then SAE equivalents shall be provided in parentheses.

3.5.4 Safety

Safety shall be of primary importance in the design of the car. The car shall present a safe, hazard-free environment to passengers, crew members and the general public. Passage through the car shall be easy and safe. No sharp edges or corners or pinch points shall occur where passengers, crew, or maintenance personnel may come into contact with them. Adequate handholds shall be provided throughout the car. The operating cab shall be designed to minimize injury from impact against cab surfaces in a collision.

Passengers and crew shall not be exposed to tripping hazards, exposed electrical voltage, toxic materials or similar hazards. Location, illumination levels, colors, graphics and surface finishes shall be selected to maximize visibility of door thresholds, windscreens, controls and other objects with which the passengers and crew must interface.

Normal and emergency equipment and controls which the passenger or crew may operate shall be clearly identified, and operating procedures shall be presented in both text and graphic formats. Passenger emergency signs shall also be embossed in Braille raised typeface. Power capacitors shall self-discharge.

3.5.4.1 General Safety Design Requirements

The general safety design requirements and the guidelines listed below shall be incorporated into the design of all car systems affecting safety. Permissive conditions are those that permit an action or event to take place. Restrictive conditions are those that limit the actions or events that can take place.

- Only components with high reliability and predictable failure modes, and which have been proven in conditions similar to the projected service shall be utilized.
- All electronic circuits shall be assumed capable of failing in permissive modes.
- Software shall be considered capable of failing in an unsafe mode unless it is safety verified while operating in the proposed hardware.
- Systems shall be based on closed circuit principles in which energized circuits result in permissive conditions, while interrupted or de-energized circuits result in restrictive conditions.
- Any component or wire becoming grounded shall not cause a permissive condition. Safety circuits shall be kept free of any combination of grounds that will permit a flow of current equal to, or in excess of 75% of the release value of any safety device in the circuit.
- Circuit impedance, signal encoding, shielding, layout and isolation shall be selected to reduce the effects of interference to the extent that safety is maintained under all conditions.
- Commands that result in permissive conditions shall be propagated by no less than two independent signals, both of which must be present before the permissive condition can occur. The lack of either signal shall be interpreted as a restrictive command.
- Systems controlled by variable level signals shall be arranged such that zero signal level results in the most restrictive condition. At least one enabling signal, however, independent from the variable control signal, shall be present before the control signal can modulate the system to a more permissive level.
- Circuit breakers and fuses shall be guaranteed by the manufacturer to successfully interrupt rated currents. Circuit breakers and fuses shall be applied such that the maximum circuit fault currents cannot exceed the manufacturer's guaranteed operating ranges.
- Systems that rely on structural integrity for safety shall have sufficient safety factors such that failures are not possible within the life of the car under all possible normal conditions.
- Systems and devices subject to wear shall not wear to unsafe or permissive states within a period that is no less than three times the specified periodic maintenance

interval under the worst-case combination of duty cycle, environment and all other influences. Such systems and devices shall be clearly indicated in the maintenance manuals.

- Mechanical systems which apply force to achieve safe states shall not depend upon the application of fluid pressure or electrical energy, unless specifically approved.
- All locks, catches, and similar devices affecting safety shall be either self-engaging without application of power, or, if engaged by application of power, shall remain fully and safely engaged in the absence of power.
- All systems shall function safely under all combinations of supply voltages, fluid pressures, shock, vibration, dirt accumulation and the railroad environment.
- All safety related systems, and devices within those systems, shall be clearly identified in all operation and maintenance manuals, procedures, and training materials.
- Exposure of maintenance personnel to lethal or injurious voltages shall be minimized through compartmentalization, interlocks and similar measures.
- All equipment containing hazardous materials, lethal or injurious voltages, or other risks shall be clearly labeled on both the outside and inside of the equipment.
- No sequence of operations, or the simultaneous activation of any controls, shall result in unsafe conditions.
- All systems shall protect against unsafe conditions resulting from human error.

3.5.4.2 System Safety Program

The Contractor shall develop, implement and maintain a comprehensive System Safety Program (SSP) conforming to the guidelines and requirements of 49CFR Part 238 - Subpart B, the latest issue of the APTA Manual for the Development of System Safety Program Plans for Commuter Railroads, issued by the APTA Commuter Rail Safety Management Program. This SSP shall access, analyze and document the safety aspects of all components, systems, managements and materials used on the rail cars, and the operation, maintenance, repair and performance of those components, materials and systems, from the view point of crews and passengers.

The SSP shall identify all hazards related to the car; and shall impose design requirements and management controls, in addition to those identified in this Technical Specification, to prevent unsafe conditions by eliminating hazards or reducing risk to levels acceptable to the Customer. The SSP shall be developed in the earliest phases of the Contract and shall be continuously maintained throughout, as design and construction evolves. The formats for reports, listings, analyses and other required submittals shall be jointly determined between the Customer and the Contractor.

The SSP shall include a software safety section which applies to any embedded or external software or firmware which controls or monitors safety-critical functions.

Software safety requirements shall treat software as an integral part of a hardware/software system. Functions accomplished through the use of software shall be considered safety critical unless an independent redundant hardware means is also provided to accomplish the same function.

Features of the software safety program shall include a description of how the following shall be accomplished: definition, implementation and oversight of the software design and

verification process, integrity of the documentation, software hazard analysis, software safety reviews, software hazard monitoring, reporting and tracking, and software integration with hardware at each stage of the design and testing process for components, subsystems, systems, cars, consists and trains incorporating software for safety-critical functions.

The completed SSP shall be submitted to the Customer for review and approval prior to acceptance of the first car. **CDRL**

3.6 Design Review

Within 30 days of NTP, the Contractor shall submit an engineering plan for accomplishing the engineering design functions and objectives. The engineering plan shall include at a minimum:

- Defining the relationship of the engineering team in the overall organization of the Contractor.
- Organization of the engineering department, with identification of the subgroups as organized by function or system.
- Critical path/workflow plan for completion of all engineering functions.
- The schedule for completion of major design activities including all stages of design reviews, mock-up review, finalization of engineering, test plan development, carshell stress and structural performance analysis, proof of design testing and delivery of all required engineering documentation.
- Oversight of vendor engineering functions and integration of supplier engineering into the Contractor's design.
- Manufacturing engineering plan, including assembly station work scope, parts flow and estimated labor hours/station staffing plan.
- Carshell engineering plan, including design, finite elements analysis, quasi-static and dynamic testing, measurement of critical dimensions, acceptance and shipment, and inspection/repair procedures.
- Completed car weight control plan. **CDRL**

The design review process shall begin no later than one month after NTP. As a minimum, each design review report shall be completed including resubmission of design documents with revisions in accordance with detailed review comments, before progressing to the next review process. All design review meetings shall be held at the Contractor offices in designated location, unless another location is specified by the Customer. No less than 15 days prior to a design review session, the Contractor shall submit to the Customer, for approval, the documents (drawings, calculations, reports, etc) addressed at the meeting.

The Contractor shall be responsible for the car design including all sub-systems and materials, with appropriate review by the Customer. A system concept shall be used in the design to ensure that components, parts, and other equipment furnished by different subcontractors shall function as intended when installed. Design review activities shall continue throughout the entire pre-production period, with each succeeding stage presenting greater amounts of detail and reflecting the progress of the designs. In addition to his own designs, the Contractor shall submit the design of all components being purchased for review and discussion at the design review sessions. In all submissions and at all sessions the Contractor and supplier presentations shall be organized so as to show exactly how the design meets each specific requirement of the Technical Specification.

The Contractor shall provide equipment meeting all specified performance levels and be compatible with all elements of the railway system on which the Customer will operate the equipment, for the useful life of the equipment.

Safety, reliability, ease of maintenance and compatibility with other bi-level intercity rail equipment shall be primary design considerations.

The vehicle design and construction shall be subject to monthly progress reviews/program meetings.

The Contractor will record the minutes of the meetings, and shall provide, within one week of the meeting, a minutes package that shall include a copy of all documents presented/discussed at the meeting. Also included shall be matrices showing status of the following:

- System design reviews
- Schematics
- FAI and follow-up
- Master test plan, procedures and test schedule
- Manual status
- Training action plan
- Manufacturing status

Items shall be referred to as “open items” if action or a decision is pending at the time of the minutes are issued. A summary of all Specification changes and “open items” shall be included.

3.6.1 Customer Involvement

The Customer shall be an integral part of all aspects of the design, inspection, testing and approval program for the rail cars. This involvement shall include design review and evaluation, supplier selection, QA program review and approval, first article inspection, inspection of all phases of car production, witnessing tests and vehicle acceptance, post-delivery training, and warranty administration.

The Customer shall designate to the Contractor those individuals and organizations that are participating in the design review and inspection process on behalf of the Customer. These individuals may include employees of the Customer’s organization, consultants, representatives of the Customer’s operating and maintenance providers, constituent groups, or others as designated by the Customer. Only those designated as representing the Customer shall have the authority to take actions on behalf of the Customer that govern the contract, including approvals and acceptances, design review comments, witnessing of tests, and other activities that the Customer shall participate in. The Contractor shall not recognize the actions of those individuals with no designated Customer authority in the contract.

Representatives of regulatory agencies shall be afforded all desired access to the project, including inspections, design reviews, witnessing of tests and audits, as requested by the regulatory agencies. The Contractor shall advise the Customer of all comments and direction received from regulatory agencies regarding the project.

The Customer shall have the right to invite or permit to participate in any inspection, design review, audit or test anyone the Customer deems desirable or necessary. The Customer will give the Contractor reasonable notice of participants, but reserves the right to include participants with no notice.

3.6.2 Approval of Suppliers

The Contractor shall be responsible for pre-qualifying all proposed subcontractors to the Customer's satisfaction and approval.

Within 30 days of NTP, the Contractor shall supply a complete list identifying each major supplier and their product proposed for use on the car. Along with this, a listing of names and addresses of other users of similar equipment from that supplier, including the two most recent customers, shall be submitted to the Customer. This list shall have been updated and approved prior to building of mockups.

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3.6.3 Configuration Management

The Contractor shall develop and submit to the Customer for approval a configuration management plan within 45 days after NTP. The plan shall illustrate how the Contractor intends to meet the configuration management requirements and shall include as a minimum:

- Flow charts of paperwork for design changes prior to and following design reviews and drawing approvals.
- Forms to be used to convey, track and account for the design changes whether approved or not.
- A description of the methods and communications to be used to control hardware configuration identification for purposes of receiving inspection, installation, test, retrofit, reliability, safety and inventory control.
- A description of the forms and methods to reflect the current modification status of every car.
- The method to be used to make required revisions to publications, drawings, education programs, photographs and any other program software.

The configuration management plan shall have a live document status. Any and all changes must be submitted to the Customer during the next monthly progress report covering the time period the change took place. Changes will be subject to approval by the Customer.

The Contractor shall maintain accurate and current configuration records which shall be available to the Customer throughout the period of the Contract and for a three year period after final Contract payment. The Contractor shall ensure that his supplier's equipment incorporated in the car design complies with all the related provisions that follow. The guidelines provided by DOD-STD-480A and MIL-STD-483 shall be adapted to the program in a responsible and disciplined manner consistent with good maintenance practices. The Contractor's technical documentation shall be capable of defining the approved configuration of hardware and computer software under development, test, production, or in operational use. The technical documentation shall identify the configuration to the lowest level required to ensure repeatable performance, quality and reliability.

3.6.3.1 Engineering Changes

If required, the processing of Engineering Change Requests (ECRs) and Field Modification Instructions (FMIs) shall control changes to drawings and specifications resulting from the performance of the work contained in this Contract. An ECR to modify, delete, add or substitute any part, assembly, or equipment shall be designated as a Class I change when one of the following criteria shall be affected:

- Interchangeability and availability
- Changes that require modifications to operating or maintenance manuals
- Changes that require modifications to periodic maintenance schedules
- Changes to parts manuals
- Mechanical or electrical form, fit, or function
- Reliability or maintainability
- Electromagnetic interference characteristics
- Safety
- Spares provisioning
- Sources of repairable items (source control drawing)
- Vehicles delivered
- Weight
- Wiring and or electrical function

All other changes shall be designated as Class II changes.

All Class I ECRs, together with supporting documentation, that contain the full details, instructions, tool list for post-production changes, parts list, procedures and drawings necessary for the performance of the work, shall reference all software (publications, drawings, education program, etc.) which must be changed giving the revised information, and also describe any needed revisions or modifications for interim use shall be submitted to the Customer for review prior to approval and implementation.

Class II ECRs are informational in nature; corrections to drawings and documentation that do not affect the functionality of the vehicle. All class II ECRs shall be submitted to the Customer for information, provided that changes do not deviate from the Specification requirement. The Contractor shall maintain an engineering change status report, which shall list all ECR changes, their status and completion dates. Engineering change status reports shall be submitted monthly. Implementation of an ECR shall be incorporated in all cars. Any ECRs not performed on every car must include supporting rationale and shall be subject to the Customer's approval.

Documentation will be generated showing the date when each car was modified, and the technician's signature identifying the work was performed. Design and/or specification changes made after the completion and acceptance of rebuilt cars will be retroactively applied to those completed cars through a FMI process that shall be included in the Contractor's QA program. Any action or cost necessary to correct problems in the product or documentation arising from the Contractor's misclassification shall be borne by the Contractor. The Contractor shall also be responsible for classifying and controlling changes originating from his subcontractors.

3.6.3.2 Documentation Requirements

All documents shall, as a minimum, contain the following:

- A title page with a clear and concise title block, which includes all pertinent references to the Contract and an accurate description of enclosed information.
- Display approval signatures of the original document on the title page to serve as an easy reminder of the approval signatures required for all future revisions.
- Display the Customer's contract number on the title page.
- Display the originating company's name and address on the title page.
- Display the overall revision level on the title page and display the varying revision level on each consecutive page.
- Display the unique document number on each page of the document.
- Record the specific changes of a revision on a dedicated page that includes space for new approval signatures for that revision without requiring the removal of previous approval signatures.
- Record the revision levels of individual pages on a dedicated page for verification of proper document composition.
- Contain a table of contents and an itemized listing of tables and figures.

Submittals requiring the Customer's approval prior to implementation shall be reviewed and classified by the Customer as follows:

- **Approved** — The Customer concurs with the information in its submitted form. The material may be incorporated into the program.
- **Conditionally Approved** — The Customer conditionally agrees with the submitted information in principle, but insufficient information was provided to allow a complete review, or some details must be revised to make the information fully approved. The material must be resubmitted in revised form for Customer approval.
- **Disapproved** — Means the Customer does not concur with vital details. The Contractor shall not incorporate the material into the program. The Customer's objections must be reconciled, and the material must be resubmitted in revised form for Customer approval is specified by the Customer.

An approval shall not be construed as:

- Permitting any departure from the Contract requirements; or
- Relieving the Contractor of the responsibility for any error including details, dimensions, materials and calculations.

Classification by the Customer will be assigned within 30 days from the day the submittal is received based on a rate of submittal that is reflective of the pace of an orderly, properly managed program. Priorities will be given to special cases when possible. However, the Contractor shall consider the 30-day requirement and the time requirements involved for mailing when scheduling submittals. The days used by the Customer in design review meetings or in travel to or from such meetings shall not be included in the 30 day figure.

After reviewing the submitted material, the Customer will provide to the Contractor its review comments on each submittal within 15 working days. If necessary, subsequent meetings shall

be scheduled and organized by the Contractor for the purpose of clarifying and discussing design issues. The Contractor and the Customer will mutually develop and distribute an agenda of topics for such meetings in advance of the meeting date. If so requested, the Contractor shall present an overview of the design information at the meeting, using sample articles, standard engineering drawings, specifications, catalog cuts and other similar material, and respond to comments raised by the Customer in its review. At the conclusion of the meeting, the Customer will identify any remaining problems to be resolved. Prior to termination of the design review meeting, a list of action items and assigned responsibilities will be decided upon by the Customer and the Contractor.

The Customer reserves the right to request additional design review data as it, in its sole discretion, deems necessary where information is lacking or is needed to clarify design issues, and the Contractor shall furnish material requested within the time agreed to during the design review.

Additional information requested in writing by the Customer to clarify specific issues shall be provided by the Contractor within two weeks of receipt of written request. In such cases, the time allowed the Customer for completing the design review shall be extended accordingly.

3.6.4 Design Review Process

Four types of design reviews will be conducted depending on the status of the designs: Preliminary Design Review (PDR), Intermediate Design Review (IDR), Mockup Review and Final Design Review (FDR). The requirements for these Design Reviews are as follows:

3.6.4.1 Preliminary Design Review (PDR)

Preliminary Design Review (PDR) of system components shall be made at the 30% level of designs. The PDR shall include a review of the design concept, written descriptions of the functionality, schematics of the system wiring, and drawings of each component showing dimensions and structural elements. The Customer retains the right to redline, comment, and request changes to improve design and/or functionality.

PDR submittals and activities shall comprise but are not limited to the following:

- CPM — The Contractor shall submit a first version of the CPM schedule in accordance with specification requirements giving particular attention to the entire design review program portions of the procurement. The CPM is to be updated by the Contractor every 30 days.
- Compliance Matrix — The Contractor shall provide a matrix showing all technical requirements, the Contractor's proposed design and/or vendor and a determination as to whether the proposed design is compliant with the specification or not.
- Drawing Schedule — A drawing schedule for all distinct releases covering the design of all areas and subsystems of the cars in conformance with the Contractor's configuration management plan shall be prepared at the start of the PDR and submitted to the Customer for approval. Each release shall be given a proper title for the top drawing and a drawing number. Arrangement drawings to be developed during the PDR shall also appear on this schedule with a title and number. The drawing schedule shall be immediately updated to reflect any revisions.
- Arrangement Drawings and Related Documents — During PDR arrangement drawings and related documents of the cars and all major subsystem hardware items as

described above shall be submitted to the Customer for review and approval. Drawings shall show at a minimum:

- Overall dimensions, orientation, center of gravity, weight, points of normal support, and method of support during mounting and removal.
- Location of all doors, access panels and covers in relation to any enclosed equipment.
- Required space for opening of all doors and access panels.
- Location and space requirements for ventilation intake and exhaust openings and cable entrances.
- Location and space requirement for all major equipment.
- Detailed Technical Specification — Within 60 days following the start of the design, the Contractor shall submit detailed technical specifications for all major systems and components.
- Review Program — The Contractor shall submit to the Customer an interim detailed technical specification covering the methods, materials and arrangements proposed for construction of the pilot cars. The document shall be similar in style and format to this Technical Specification, which shall take precedence in the event of any differences. An appendix shall give a complete tabulation of all suppliers and the products they are supplying, and shall also include an update to the pre-award buy America submittal, indicating any revisions to the manufacturer of goods, country of origin, and cost data. After approval by the Customer, it shall be updated by the Contractor every 30 days to continuously represent the current configuration of the details of the car, including all specification changes and addendums. A monthly revision sheet shall contain a complete listing of the original and revised text, and details of the approval given by the Customer.
- Weight Analysis — After receipt of the approved minutes of the first design review meeting, and then monthly until the complete weighing of the pilot cars the Contractor shall submit to the Customer a report on the estimated car weight. This shall include the most recent weights for the carbody without trucks, each truck and the complete car. It shall also include a list of weights for every subsystem on the car, indicating its percentage of the total car weight, and if these subsystem weights are based on actual scale weights of complete equipment. The Contractor shall make scale weighings of all components as early as possible.

3.6.4.2 Intermediate Design Review (IDR)

An Intermediate Design Review (IDR) shall be held when the design of the car is at approximately 60% complete. This shall represent an advancement of the design of the cars from the preliminary design stage to development of draft production drawings, arrangements, component and material specifications and schematics for all systems, subsystems and components on each car type, which will be used by the Customer to evaluate the proposed design of the car to a level of detail sufficient that the Contractor shall be able to proceed with the development of the car design to the 95% draft final stage.

Storyboard palettes shall be provided proposing a variety of interior décor schemes for fabrics, patterns and colors to be used throughout the car.

Customer comments from the PDR stage shall be reviewed, and the Contractor shall provide documentation that the Customer's comments were incorporated into the car design. All

drawings, specifications, schematics and other project documentation shall be updated for the IDR.

Once reviewed, the drawings and designs shall be updated to incorporate Customer comments. The drawings as revised after the IDR shall be used as the basis for the development and assembly of all required mockups.

At the IDR, the Contractor shall provide the finalized mockup review plan for Customer review and comment. The mockup review plan shall describe all mockups to be developed by the Contractor, including the locations where the mockups will be built and reviewed and the schedule for completion and review of the mockups.

3.6.4.3 Mockup Development and Review

Upon the completion of the intermediate design review stage of the design review process, the Contractor shall complete the assembly of full-size hard mockups of the following areas and systems of the cars; according to the drawings as reviewed and approved at the IDR, for Customer review and comment:

- A representative area of the passenger seating area shall be built, including:
 - Two facing 2-person passenger seats
 - Workstation table between the facing seats
 - Overhead luggage bin, including reading light unit
 - Wall panels, window and window mask
 - Curtains
 - Convenience outlets
 - Heater grilles and diffusers
- A fully functional example of an enclosed overhead luggage bin shall be provided mounted at the design height and including the adjacent ceiling panel, built so that the loading and removal of baggage may be performed.
- The wheelchair lift unit and installation shall be built to verify the function of the design.
- Café/lounge car:
 - A hard mockup of the upper level galley area shall be constructed, and shall include all galley equipment and countertops and a full complement of simulated carts and chillers installed. Carts shall be functional to simulate circulation and loading of the carts in the galley area.
 - The lounge area booth seating on both sides of the lounge area shall be simulated.
 - The lower level elevator lobby and storage area shall be mocked up sufficiently to simulate access to elevator controls, galley equipment, cart circulation, door swing and storage.
- Cab/baggage car:
 - A full mockup of both sides of the cab control compartment shall be built, with all controls, gauges, indicators, windshields, and car structure simulated for evaluation of visibility to gauges and indicators as well as to the front and sides of the car. Controls shall have simulated operation to evaluate the range of motion and effort

- required to operate the control equipment. Seats shall be installed to evaluate circulation, ease of getting into and out of the cab, and knee/leg room under desktop.
- The bike rack/baggage room shall be mocked up for the purpose of evaluating ease of operation, quantity of bikes and baggage to be carried, and circulation.
 - Accessible toilet room:
 - A fully equipped Accessible Toilet Room (ATR) shall be assembled, for the purpose of evaluating and confirming that the design arrangement of the ATR meets all ADA requirements for layout, circulation and access to controls and appliances.
 - Unisex toilet room:
 - A fully equipped Unisex Toilet Room (UTR) shall be assembled, for the purpose of evaluating layout, circulation and access to controls and appliances.
 - Equipment rooms:
 - The A-end, B-end and F-end equipment rooms shall be mocked up to simulate the layout of the components located in each room. Details including conduit, air and water lines, component fasteners, brackets, valves, switches, gauges, lights and operating equipment shall be provided so that the access, circulation, maintainability and safety can be thoroughly evaluated.
 - Electrical locker:
 - The electrical locker shall be mocked up with all switches, breakers, relay panels, access panels, doors, controls, indicators and components simulated to evaluate access, visibility, maintainability and removal. Each electrical locker arrangement shall be mocked up.
 - Vestibule wall and ceiling panel area for access to door equipment:
 - The vestibule ceiling and wall area shall be mocked up to simulate access to all side door equipment that requires inspection, adjustment, maintenance or lubrication. All wall and ceiling panels shall correctly simulate the means of attachment, removal and operation, to ensure that the ceiling panels are safe and easy to use by maintenance personnel.

All mockups shall be constructed of materials with sufficient strength so that they can be evaluated safely and thoroughly by the Customer. This includes the ability to sit on seats, lean on countertops, open and close doors, simulate operation of controls, appliances and equipment; and view the mockup from a variety of angles. The mockups shall include all finishings, colors, patterns, textures, fasteners and hardware as designed.

The mockups shall be built at the Contractor's facility, or the facility of subcontractors or other locations as determined by the Contractor. Comments from the mockup review shall be incorporated into the car design and presented to the Customer at the final design review.

The Contractor may build additional mockups for Customer review at different points in the design review process, to assist in the development of the car design.

3.6.4.4 Final Design Review (FDR)

The Final Design Review (FDR) of the system components shall be held at the 95% or greater percent level of design. The FDR shall include a review of all documents and plans for the design as revised, including the written descriptions of the functionality, schematics of the system wiring, drawings of each component showing dimensions and structural elements.

Redlines and comments from the IDR and mockup review shall be reviewed. The Customer retains the right to provide additional comments during this process as production progresses and concerns are brought to the Customer's attention.

FDR submittals and activities shall comprise but are not limited to the following:

- The continuation and updating of all activities specified as ongoing in the PDR, IDR and mockup review, i.e., CPM, weights analysis, detailed technical specification, car functional analysis, drawing schedule, arrangement drawings and supplier identification.
- Detailed Drawings and Related Documents — The Contractor shall submit as a minimum the following detailed drawings and related documents to the Customer for review and approval:
 - All top and associated sublevel release drawings, properly dimensioned, detailed, to scale and in accordance with the approved drawing schedule.
 - Single line control schematic and functional block diagrams for each subsystem, and electrical wiring diagrams and schematics for all electrical circuits. All test points shall be displayed. The functional block diagrams shall identify the "normal" functional paths as well as the functional paths made available through cutouts, bypasses and redundant circuits. The diagrams shall identify, as a minimum, the critical hardware that permits safe movement of the car, safe ingress/egress of passengers, and essential environmental needs of the passengers and Operator. The functional block diagrams shall display the levels of hardware (as defined in Military Specification MIL-STD-280A) that identify the Lowest Level Replacement Unit (LLRU).
 - A complete set of drawings related to clearance. These shall include static and dynamic envelopes relative to the wayside allowances, including clearances for all parts of the truck, and general arrangement drawings with all static dimensions including camber, low level platforms, high level platforms, curves, etc.
 - Single line piping and flow diagrams for all pneumatic circuits, displaying all valves and control components. All test points shall be displayed.
 - Graphs and curves giving response and functional characteristics of the car, subsystems and major items.
 - Manufacturer's data and specification sheets on all control items.
 - Maintenance requirements and necessary procedures for all equipment in each subsystem. These shall be listed from daily inspection and 92 day inspection to complete overhaul, with frequency and time needed to service being tabulated, and shall highlight all FRA-required inspections.
- Stress Analysis — A stress analysis of the carbody shall be submitted to the Customer for approval.

3.6.5 Component Approvals

All vehicle components, except as listed in this document, shall be subject to approval by the Customer. The goal is to use, as much as possible, components known by the Customer to perform successfully in the North American intercity passenger railroad environment. This is not intended to prevent the use of innovative concepts, provided the advantages outweigh risks in the judgment of the Customer.

The Contractor may proceed with design pending receipt of design review comments, but at its own risk. Regardless of whether a comment has or has not been provided, the Contractor shall meet all requirements of the Contract Documents.

3.6.5.1 Component Substitution

The Contractor is responsible for the selection of all components, parts and materials that are to be used in the design and manufacture of the cars, except where a specific component, material or technology is designated. In the event that a component, material or type of technology is not available as specified, or cannot meet the requirements of this specification, the Contractor shall propose an alternative that meets all applicable specification requirements and is available for use on the rail cars. The proposal shall be submitted to the Customer for approval in the form of a contract variance, and shall include, at a minimum:

- Identification and description of the specified part or material that is not available or not specification compliant.
- Reason the part is not available or not specification compliant.
- Part or material that is proposed for substitution.
- Characteristics of the part proposed for substitution, including performance, history of use, supplier or manufacturer, equivalency to the part originally specified, compatibility with other parts and systems in use on the car, and other relevant information necessary for the Customer to determine the adequacy and equivalence of the proposed component.

3.6.6 First Article Inspection (FAI)

The Contractor shall perform First Article Inspection (FAI) of all major components, subassemblies and fully assembled cars. The Customer or its representatives shall be present to witness all FAIs. The Contractor shall perform a satisfactory preliminary FAI on each article prior to notification of the Customer of an FAI.

These inspections shall be conducted at the facilities of the Contractor or subcontractor.

3.6.6.1 FAI Process

Within 90 days of NTP the Contractor shall provide to the Customer, a list of assemblies and subassemblies subject to FAI along with their projected schedule. The FAI inspection plan shall include the following requirements at a minimum:

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- A tracking system shall be developed and maintained which will identify each FAI subject and accurately reflect the present status of each inspection.
- FAIs shall be performed on an actual sample considered to be complete by the manufacturer and reflecting the approved baseline drawings. Successful completion of engineering tests for the subsystem is a prerequisite for conducting the FAI.
- The FAI shall be performed using the approved baseline drawings in conjunction with the Technical Specification reflecting specific requirements of the subject along with any special tools and/or equipment needed to verify the design requirements, configuration and operation (if applicable) of the item being inspected.
- All technical data required for maintenance manual and or parts catalogs shall be submitted as initial drafts prior to the full acceptance of the FAI. The initial drafts shall

contain enough information to adequately maintain the equipment during the pilot program and initial production car delivery.

- The Customer shall be given notice of an upcoming FAI at least 30 days before its schedule date.

This document shall be updated monthly and presented as an attachment to the program meeting minutes.

For equipment that requires an FAI, the equipment shall not have passed the FAI unless the Customer participates in the inspection to its satisfaction. Should the equipment fail inspection, the problem(s) shall be corrected and re-inspected to the Customer's satisfaction before the FAI is considered passed and production released. An inspection that requires the Customer participation but is conducted without a qualified Customer representative shall not be considered as having passed.

None of the material and/or parts listed in this section of the Technical Specification shall be installed on the equipment unless the FAI has been performed and approved by the Customer.

3.6.6.2 Systems Requiring FAI Approval

A listing of proposed FAI items shall be included in the QA plan submitted to the Customer for approval. This shall include as a minimum the following:

- Carshell (including all major subassemblies)
- Floor panels
- Door leaves
- Door hardware, latches
- Manual doors
- Power doors, operators and controls
- Wheelchair lift
- Windows
- Trucks-frame
- Trucks-fully assembled
- Wheel and axle assemblies
- Couplers and draft gear
- Air brake system
- Wheel slide control system
- Major fiberglass interior components and hardware
- Seats (including cab seat)
- Tables (workstation and lounge)
- HVAC system, controls and temperature controls
- All external and internal lighting systems
- Communication system

- Electrical lockers
- All electrical panels
- Batteries and charging system
- Food service equipment including refrigeration system
- Toilet room (modules)
- Waste collection and retention system

FAI for Cab Car Only

- Pilot
- Cab seat
- F-end frame door
- Alerter/speedometer/overspeed
- Event recorder system
- Positive Train Control (PTC) system
- Windshield wipers

The final approval of colors and finishes shall also be subject to FAI and acceptance by the Customer.

Equipment shall be shipped from the point of manufacture only after the FAI has been approved. The Contractor shall provide notice of each FAI inspection to the Customer at least 30 days prior to the inspection.

Audits will not be performed unless the design drawings, production processes, production tooling and any other relevant documentation required for the item to be inspected have been conditionally approved or approved.

Approved FAI items shall establish the quality of workmanship for the remainder of the same items being produced and for the car. That quality shall be well documented. Samples of welds, fit-ups, finishes, and colors, photographs, FAI documentation, etc., shall be retained for the duration of the production phase in a secure area at the Contractor's facilities for reference by the Contractor's and Customer's representatives. Changes, modifications or adjustments to this baseline must be approved by the Customer and will be cause for initiating another FAI by the Customer.

Availability of the information in a timely manner is essential to ensure that the appropriate level of the Customer's technical expertise is available for the FAI and that the individuals have sufficient prior information to inspect the equipment. The Contractor shall provide the following information to the Customer at least 15 working days before a scheduled FAI:

- A complete list of the equipment and its bill of materials to be inspected.
- Identify each completed assembly along with the configuration in which it is to be presented.
- A copy of the technical Specification for the equipment and the subcontractor's scope of supply.

- A complete drawing package with current drawing approvals. The drawing package should be in sufficient detail to inspect, at a minimum, the fit and finish of the assembly and subassemblies, wire and pipe routing, clearances between components, ergonomic considerations, and any other details that are required to ensure that the equipment is acceptable for the intended purpose.
- System schematics, electrical, fluid, pneumatic and piping, with current approvals. The schematics shall be sufficient to determine that the equipment will operate as intended.
- All instruction manuals, operating manuals, maintenance procedures and heavy repair shall be presented at the FAI for review.
- A report by a recognized independent testing laboratory certifying that all materials used in the equipment comply with the 49CFR Part 238 Appendix B requirements and NFPA 130, as applicable.
- A Customer-approved inspection and acceptance test procedure and a Customer approved qualification test procedure to which the equipment will be inspected. A functional test shall be required as part of the FAI.
- All pertinent calculations or analyses to show that the design is adequate for the purpose intended.
- The Contractor shall submit to the Customer a complete stress analysis and summary, in sufficient detail for the Customer to analyze, of stress analyses of the car structure, trucks and major equipment supports, to show compliance with strength level requirements. This stress information shall be submitted at least 30 days prior to the beginning of the compression test, or vertical load tests. If a new truck design is proposed, a complete stress analysis and summary, in sufficient detail for the Customer to analyze, of the trucks shall be submitted at least 30 days prior to the beginning of the truck fatigue test.
- Should any of the above documents be incomplete or otherwise unacceptable to the Customer, this shall be grounds to delay the FAI until they are made right. The burden of any delay shall be with the Contractor.
- All manufacturing variations of specified materials that vary in color, texture, pattern, etc., shall be presented, for approval by the Customer, at FAI. Samples of acceptable variation extremes will be retained for reference in future inspections.
- The FAI sample shall be retained by the equipment manufacturer until the completion of production of all cars.

3.6.6.3 FAI Findings

The Contractor shall provide, within one week of the inspection, a package, which includes a copy of all the documents presented/ discussed at the meeting. The Contractor shall include an action plan to correct all deficiencies discovered during the FAI. The FAI will remain open until all action items are completed to the Customer's satisfaction. Depending on the severity of the deficiency, follow-up FAI may be required.

The Customer shall provide an FAI report within ten days of the inspection. It shall include the findings of the inspection, tests and deficiencies.

The Contractor shall provide color photographs on 8.5 in. by 11 in. size paper and in a digital format within 30 days of the FAI, of each item subject to FAI. A second set of these photos shall be compiled into an album for the Customer's reference for future car inspections and will be supplied to the Customer with the delivery of the first car.

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3.7 Inspection

The Customer shall, at all times, have the right to inspect the work. The Contractor shall grant the Customer access to the facilities of the Contractor, subcontractors and suppliers to conduct initial and on-going inspections and assessments of the work to determine if it is being performed in accordance with the Contract documents. During these assessments, the Contractor, subcontractors and suppliers shall make every reasonable effort to assist Customer personnel.

Inspection or lack of inspection, approval or acceptance of any portion of the work by the Customer shall not relieve or release the Contractor from its obligations to fully comply with all requirements of the Contract documents.

The Contractor shall correct any portion of the work not meeting the requirements of the Contract documents at the Contractor's expense to the satisfaction of the Customer.

The Customer at any time before issuance of final acceptance for any car may order re-inspection of any portion of the work.

3.7.1 Inspections and Tests

Inspection of components to be used by the Contractor in performance of the work under this Contract shall be the responsibility of the Contractor, preferably performed at the plant of the subcontractor at which such component is manufactured. This is to give such subcontractor every opportunity to correct, under factory conditions, any inadequacies found. Inspection of components shall be performed again at the Contractor's plant to identify any damage in transit. The Customer may also inspect selected items at any time, whether or not accompanied by the Contractor's representative, which shall in no way lessen or delete the Contractor's responsibility to make proper inspection.

The Customer shall have the right to inspect any materials, processes, assembly and testing of equipment at subcontractor manufacturing facilities, deemed necessary to ensure compliance with the Contract and technical specifications.

The Customer shall have access at all times to those parts of the plants of the Contractor and/or subcontractors in which any portion of the work is performed for the purposes of inspecting materials and workmanship, and of determining conformity to the Specification during the progress of construction and assembly of the equipment.

If any portion of the car shall become hidden by subsequent work contrary to the specific request of the Customer, that portion of the car shall be made visible for Customer inspection by the Contractor at the Contractor's expense.

The Customer shall be allowed to participate in all Contractor and/or subcontractor tests and inspections of all components of the equipment, at the Contractor's and subcontractor's plants, for the purpose of QA. Such right to participate shall include the Customer's right to supplement its on-site inspector with additional experts as necessary according to the particular nature of the test or inspection involved.

The presence of the Customer in the plant of either the Contractor or subcontractor shall not, in any way, supplant or relieve the Contractor's responsibility for making proper inspections or meeting the requirements of the Specification. The Customer shall have the right to reject all materials and workmanship that do not conform to the Specification. When repetitious

rejections occur above 10%, the Contractor shall prepare a written report for the Customer detailing the problem(s) discovered during inspection and the efforts to be taken to remedy the problem(s). No further acceptance or production shall take place until the Contractor notifies the Customer in writing that the problems have completely resolved.

The Contractor shall document the results of both inbound material inspection and outbound car inspection and testing for each car. Likewise, a "traveler" shall be attached to each car to track QA functions as the work progresses through the shop. A copy of the report must be attached to each car through conditional acceptance.

An Inspection and Test Log (Log) shall be maintained by the Contractor during equipment assembly. The Log shall be submitted to the Customer for review before each car will be released for shipment to the delivery site. All Contractor and Customer in-process inspection sheets and test data records for that car shall be contained in this Log, which will be provided in the vehicle history book.

For those routine inspections and tests of components that are typically performed solely by the Customer, the Contractor shall give at least 72 hours notice of such inspections or tests to the Customer. The Customer shall be allowed to participate in such Contractor or subcontractor inspections or tests at the Contractor's or subcontractor's plants for the purposes of QA.

The Contractor must maintain office copies of all records, and they must be accessible to the Customer, not more than five days after such notice is given.

3.7.2 Contractor Provisions for Customer Inspectors

From NTP continuously through production, the Contractor shall provide office facilities for Customer representatives at no additional cost to the Customer. Office facilities will be required at the car construction plants, including the final assembly site and the carshell fabrication site (if a separate facility), as well as similar facilities at any car or equipment qualification testing sites for the duration of the tests. These office facilities shall enable convenient inspection of materials, work and equipment under this contract. The office facilities shall be secure, heated, cooled, and adequately lighted private office for a minimum of three people, with access to toilets and a private conference area, and shall be furnished with desks, chairs and lockable locker facilities. Desks and file cabinets shall be lockable and all keys submitted to the Customer. Three dedicated telephones with an outside line, high speed Internet connection, access to a photocopy machine capable of high quality copies shall be provided either within the Customer's office or nearby (adjacent) area

Reserved parking places shall also be provided for all Customer representatives assigned to the Contractor's facility.

Copies of all drawings, manufacturing procedures, test procedures, test reports, test equipment calibration certificates, welder certifications, diagrams, schedules, changes, deviations, revisions and data shall be furnished to the Customer at the same time these are made available to the Contractor's QA department and in advance of any work being performed. Data shall be sufficient to verify design, construction, assembly, installation, workmanship, clearance, tolerance and functioning of the cars.

3.7.3 Scheduling of Inspections and Tests

Inspection and testing activities by Customer staff will normally be conducted during normal daytime shifts and will not be conducted on Saturdays, Sundays or any holidays observed by the Contractor. Customer staff may be made available in extenuating circumstances outside normal hours, provided a fully substantiated request is made at least 48 hours in advance in writing and is approved by the Customer. This request will include compensation by the contractor to the Customer for this additional expense

All inspection and tests shall be submitted to the Customer not less than 72 hours before that scheduled test or inspection. Inspections and tests outside of the United States and at subcontractors' facilities are subject to the terms listed below.

For inspections and testing activities in the Contractor's facilities, the Contractor shall present a written schedule of activities to the Customer's inspectors at least 72 hours before the activities are to take place.

For inspections and testing activities at subcontractor's facilities in the US, after written notice is submitted to the Customer 10 working days prior to the activities, the Customer will advise within five calendar days whether a representative will attend the inspection or test.

For inspections and testing activities at subcontractor's facilities outside of the US, after written notice is submitted to the Customer 30 working days prior to the activities, the Customer will advise within 5 calendar days whether a representative will attend the inspection or test.

3.7.4 Receiving Inspection

The Contractor shall provide for the inspection of all incoming systems, subsystems, components, parts, equipment and materials to insure their conformance with procurement documents and condition. All material certifications and test reports used as the basis for acceptance shall be reviewed for compliance with specifications, retained by the Contractor and kept readily available for inspection by Customer personnel.

3.7.5 Manufacturing/Assembly Inspection Hold Points

The Contractor shall establish inspection hold points in the car manufacturing process to provide for critical inspections by the Contractor's quality staff and the Customer's representative of completed operations/installations or to inspect items that are about to be covered by succeeding assembly operations.

As part of the QA Plan, the Contractor shall submit a list of hold point inspections for review and approval, which shall include as a minimum the following:

- Each carshell section before painting
- Each carshell section after painting
- Each truck frame
- Each assembled truck, prior to installation under a car
- Each car underfloor area prior to receiving trucks

- Each carshell watertightness test prior to installation of insulation and interior finishings
- Each car final watertightness test
- Each car interior wiring and components before being covered by panels
- Each car underfloor area and connections prior to concealment
- Each finished car interior
- Each finished car exterior

The Contractor shall provide the Customer 72 hours advance notice of each such inspection.

The Contractor and Customer representatives shall use inspection forms to record any discrepancies noted during inspection. Nonconforming products shall not be released from a hold point area until all discrepancies have been corrected. The inspection forms shall be posted at or near the point of inspection for each car and included in the vehicle history book when all discrepancies have been eliminated.

3.7.6 Car Pre-Shipment Inspection

After all work, including factory static and dynamic testing as per Chapter 19, is completed, the Contractor shall perform the car pre-shipment inspection according to a Customer approved procedure. All manufacturing or testing non conformance reports shall be closed out and no configuration upgrades will be pending before pre-shipment inspection begins. The vehicle history book as specified in Chapter 22 shall be complete and ready for review and approval signature by the Customer. The Contractor shall provide a qualified supervisor to accompany the Customer during inspection to assure that proper corrective action is taken. The Contractor shall provide the Customer labor and appropriate tools to remove or open and reapply covers and doors. During inspection, all systems shall be operational with use of approved types of special equipment or power supplies.

The Contractor shall provide the Customer 72 hours advance notice of each such inspection.

3.7.7 Car Shipping Inspection

Following pre-shipment inspection, the Contractor shall ensure the car is properly prepared, protected and loaded for shipment in accordance with approved procedures. For shipments by sea, this shall include all necessary preparations for shipment below decks. The Customer representative will then perform a cursory walk through inspection to confirm that the car has been adequately prepared for shipment before issuing a Release for Shipment document to the Contractor. The Contractor shall provide the Customer 72 hours advance notice of each such inspection. See Chapter 21 for additional shipping requirements.

3.7.8 Car Modification Inspection

The Contractor shall provide written procedures for Customer review and approval, for the inspection of any car changes or retrofits arising from engineering changes implemented either at the Contractor's facility or on Customer property. Upon completion of the change, the Contractor shall verify satisfactory completion and modify any quality assurance documentation affected by the change, including the Vehicle history book.

The Contractor shall provide the Customer 72 hours advance notice of each such inspection.

* End of Chapter 3 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 4

Carbody

Table of Contents

4.0	Carbody.....	4-3
4.1	Overview	4-3
4.2	General Requirements.....	4-3
4.3	Arrangement	4-3
4.3.1	Dimensions, Weights and Under Car Clearance.....	4-5
4.3.2	Physical Requirements	4-5
4.3.3	Carbody Materials	4-6
4.3.4	Carbody Exterior Finish	4-6
4.3.5	Fabrication.....	4-7
4.4	Structural Design Details	4-8
4.4.1	Level.....	4-8
4.4.2	Camber	4-8
4.4.3	Carbody Strength	4-8
4.4.4	Underframe Structure	4-9
4.4.5	End Frames.....	4-12
4.4.6	Side Structure	4-14
4.4.7	Roof.....	4-16
4.4.8	Jacking Pads	4-17
4.4.9	Lifting Eyes	4-18
4.4.10	Stairways	4-18
4.5	Truck-to-Carbody Attachment	4-19
4.6	Bolster Anchor Rods and Brackets	4-19
4.7	Doorways and Passageways	4-20
4.7.1	Doorways	4-20
4.7.2	Side Entrance Area.....	4-20
4.7.3	Carbody End Doorways	4-20
4.7.4	Passageways.....	4-20
4.7.5	Threshold and Door Track.....	4-20
4.8	Diaphragm.....	4-20
4.9	F-End Pilot.....	4-21
4.10	Safety Appliances	4-21
4.10.1	Exterior	4-21
4.10.2	Interior Passenger Grab Handles	4-22
4.11	Mobility Aid Accessibility.....	4-22
4.11.1	Wheelchair Lift	4-22
4.12	Underfloor Equipment, Equipment Rooms and Access Doors	4-23
4.12.1	General	4-23
4.12.2	Equipment Rooms and Enclosures	4-24
4.12.3	Equipment Room Doors and Hardware.....	4-25

4.12.4	Ladders	4-27
4.12.5	Floor and Roof Penetrations.....	4-28
4.12.6	Equipment Boxes	4-28
4.13	Windows	4-28
4.13.1	Glazing Materials.....	4-29
4.13.2	Side Windows	4-29
4.14	Insulation	4-30
4.14.1	Acoustical Insulation.....	4-30
4.14.2	Thermal Insulation	4-31
4.15	Exterior Finish	4-31
4.15.1	Painting-Exterior	4-32
4.15.2	Post Painting	4-32
4.16	Graphics and Labels	4-32
4.16.1	Exterior Graphics	4-32
4.16.2	Labels	4-32
4.17	Automatic Equipment Identification (AEI) Tags.....	4-32
4.18	Summary of Load Cases for Structural Design Requirements	4-33
4.19	Stress Analyses	4-33
4.19.1	Stress Analyses and Test Plan	4-34
4.19.2	Finite Element Model Report	4-35
4.19.3	Carbody and Truck Stress Analyses	4-36
4.19.4	Validation of Stress Analyses.....	4-39
4.19.5	Stress Analysis Report.....	4-39
4.20	Crash Energy Management (CEM) Design	4-41
4.20.1	Protected Operator Cab Space	4-42
4.20.2	Sequence of Operation of CEM Functions	4-43
4.20.3	Cab Car Interaction Evaluation	4-43
4.20.4	Cab End Crush Zone	4-43
4.20.5	Non-cab End Crush Zone	4-44
4.20.6	Analysis of Passenger Volume Strength	4-44
4.20.7	CEM System Validation, Analysis, and Testing	4-44

4.0 Carbody

4.1 Overview

This chapter describes the characteristics for the design and manufacture of the carshell, and the installation of major components associated with the carshell including glazing, safety appliances, diaphragms, equipment room components and access doors, wheelchair lifts and exterior graphics. The major structural elements of the carshell are described, and the requirements for the performance of the carshell structure are defined.

The carshell shall be manufactured of stainless steel, except for the end underframes which shall be constructed of Low Alloy High Tensile (LAHT) steel. The design of the carshell shall contain Crash Energy Management (CEM) features and comply with all strength and testing requirements as identified, and shall keep the carshell weight to a minimum subject to the car maximum weight limitations.

4.2 General Requirements

The carbody shall be designed to the normal and expected base set of requirements established by 49CFR Part 238, APTA Standard SS-C&S-034-99 and this specification. The Crash Energy Management (CEM) recommended practice in Section 6 of APTA Standard SS-C&S-034-99, rev 2 shall be met with the crush-based approach specified in this Specification. Crash Energy Management (CEM) features are required as an overlay on the base set of requirements. CEM requirements are based on the results of FRA research to date as described in the various FRA technical papers and presentations that can be found on the Volpe Center website listed in Chapter 2.

The completed carbody structure shall be designed and constructed in full accordance with all applicable Federal and State rules, regulations and requirements for cars operating in trains, at speeds of up to 125 miles per hour (mph).

4.3 Arrangement

The carbody structure shall provide for the mounting of all ancillary equipment; the applicable mounts and the applicable equipment shall be designed and constructed in accordance with requirements of the FRA regulations, and the APTA Standards (reference Section 5.7 of APTA Standard SS-C&S-034-99, Rev. 2).

Apparatus requiring frequent inspection or attention shall be readily accessible and replaceable, including any element of the CEM system that requires periodic inspection to confirm serviceable condition. The frequency of required service shall govern the degree of accessibility. Apparatus requiring attention more frequently than every 120 days, or in emergencies, shall be accessible from the side of the car or from the inside of the car unless specifically approved by the Customer. All other underfloor apparatus shall be arranged to provide ready access from maintenance pits and/or from the side of the car. Large apparatus shall be capable of ready replacement by forklift truck from the side of the car, or by overhead crane through appropriately sized roof access panels. The general arrangement shall be

similar to the existing carbody. Proposed arrangement shall be submitted to the Customer for approval at the design review.

The general arrangement of the subcomponents shall be approved by the Customer during the mockup and design review process described in Chapter 3. Apparatus supports and housings shall be incorporated into the underframe structure, equipment compartments and equipment lockers so that the apparatus, as supplied by the manufacturers, may be mounted interchangeably.

All protective devices on the car that are not specifically required to be located inside the carbody, or to have provisions for resetting from within the carbody, shall be located undercar at the side or in the overhead equipment compartments or other equipment compartments approved by the Customer. Provisions shall be made for access to such devices without encroaching upon the clearance limit outline. For purposes of this paragraph, protective devices shall include air brake cut outs, circuit breakers, fuses, latching protective relays and other devices requiring replacement or resetting to move the car or cause auxiliaries to function. Locations for all protective devices shall be identified on arrangement and installation design drawings and approved by the Customer.

All specified equipment on the car shall be arranged so that the proportion of the vehicle tare weight carried by each truck of the car shall be within 5% of each other. Similarly, the lateral imbalance shall not exceed 30,000 inch-pounds.

A sufficient number of jigs, fixtures and templates shall be used to assure interchangeability of components and uniformity of structure throughout the fleet. Parts of the bodies, such as underframes, side frames, end frames and roofs shall be built on jigs. All weld and bolt patterns shall be identical on all cars. All equipment hangers shall be interchangeable on all cars without the use of shims or elongated holes.

The vehicle shall be designed for at least, but not necessarily limited to, the worst loading case arising out of the possible simultaneous combinations of the following loads acting on the vehicle:

- Car tare weight (AW0)
- Crush passenger load (AW3)
- Vertical, lateral and torsional dynamic load due to wheel/rail interaction
- Loads due to vehicle pitching caused by braking
- Snow or ice loads
- Aerodynamic load
- Train passing wind loads: Compressive and lateral loads caused by another train passing in the opposite direction on an adjacent track with relative speeds of 220 mph
- Buff load

4.3.1 Dimensions, Weights and Under Car Clearance

The completed car shall have the following overall dimensions:

Length (over coupler pulling faces)	85 ft 0 in.
Height (maximum) (ATOR)	16 ft 2 in.
Overall Car Width (maximum)	10 ft 6 in.
Carbody Width (excluding side handholds)	10 ft 2 in.
Truck Centers	59 ft 6 in.
Upper floor height (ATOR)	8 ft 8.5 in.
Lower floor height (ATOR)	1 ft 6 in.

The completed car shall fully conform to Amtrak Clearance Drawing B-066-00050, rev 1.

The final car dry weight shall not exceed the following weight restrictions:

Coach Car	150,000 lbs
Cab/Baggage Car	154,000 lbs
Café/Lounge Car	153,000 lbs

Except for the pilot, the completed car shall comply with the minimum allowable clearance above top of rail for the carbody and all associated components under the worst combination of conditions, including fully worn wheels, solidly compressed or broken springs, AW3 passenger load, carbody deflection below zero camber and environmental conditions including wind, snow and ice.

4.3.2 Physical Requirements

The carbody structure shall be designed to prevent water, snow or dust ingress when operating at any permissible speed under all weather conditions consistent with the worst case climatic data as specified in Amtrak Specification 963.

The carbody shall be designed to provide watertight performance without requiring topically applied sealant. Where sealant is used to enhance the watertight performance, it shall be applied in compression between assembled parts. Sealants shall have a service life of at least 40 years.

Housings for externally mounted equipment shall be completely watertight when covers are in place, excluding battery boxes, which are ventilated. Drain holes shall be provided to prevent the accumulation of water.

4.3.3 Carbody Materials

Materials used in carbody construction shall be in accordance with the provisions of APTA Standard SS-C&S-034-99, Rev. 2 and requirements of this Specification. The carbody shall be constructed of stainless steel. End underframes shall be constructed of LAHT. All welding shall conform to the requirements of Chapter 18.

Where welded stainless steel fabrication is required, only austenitic stainless steel (AISI type 201 or 301 stainless steel) with a carbon content not exceeding 0.03%, or with proven weldability that resists atmospheric corrosion shall be used. Stainless steel parts attached to other parts by mechanical fasteners may be constructed of AISI types 201, 202, 301, 302, 304, 316, or 430 stainless steel.

LAHT shall be used for the end underframe assembly, irrespective of the carbody material - stainless steel or LAHT. The LAHT steel shall comply with all requirements of Chapter 18. Dissimilar metals shall not be used at connections requiring disassembly for removal and replacement of equipment.

Cross sectional views shall be provided on carshell drawings and must be submitted for approval at the design review.

Carshell drawings shall show the location of all principal framing members, their cross sectional area, material and metal thickness. Thickness of all sheathing materials shall be provided. The information shall be sufficient to manufacture structural parts for the repair of any damage to a car.

The Contractor shall submit for Customer approval the types of materials and their respective locations to be used in the components of the carbody.

A corrosion-resistant coating shall be applied to the entire underframe and to the inside of the side and end sheets. A corrosion resistant coating is not required on stainless steel members. The method used by the Contractor to prevent corrosion from the inside surfaces of closed structural sections (i.e. inside of tubular sections) shall be reviewed at the design review. At a minimum, each element shall include a drain hole.

4.3.4 Carbody Exterior Finish

Specifications and samples for all external surfaces shall be submitted for review and approval.

Stainless steel carshells shall be unpainted, except as specified for exterior graphics. Side sheets shall have a horizontal, 36 grit sanded finish. End sheets shall have a vertical, 36 grit sanded finish. All sanded surfaces shall have the same finish whether applied by hand or machine. Corrugated stainless steel shall have a 2B finish. All stainless steel parts shall undergo a process of passivation in order to maximize the inherent corrosion resistance of stainless steel as per ASTM Standard A380-06.

All sheet metal, exposed to view, shall be as smooth as possible on the outside with a maximum variation from a straight line on flat surfaces, measured in any direction, of 0.125 in. and 0.0625 in. over a distance of 36 in. and 12 in., respectively, on the sides of the car and 0.1875 in. and 0.125 in. over a distance of 36 in. and 12 in., respectively, on the roof. The slope of any such deviation shall not exceed 0.1875 in. in 12 in. Dents, gashes or other surface imperfections shall not be permitted.

For carshell exteriors, all exterior surfaces shall be free of ripples and buckling. Maximum allowable variation from a straight line or the designed curved line shall be as follows:

- All exterior side and roof surfaces not hidden by covers or shrouds shall have a maximum 0.09375 in. variation (peak to valley) in 3 ft measured in any direction.
- Areas within 8 in. of the side doors and vehicle ends may have a gradual slope towards the doors and ends with a maximum deviation of 0.1875 in. from the side sheet contour.
- Exterior surfaces hidden by covers and shrouds shall have a maximum 0.3125 in. variation (peak to valley) in 3 ft measured in any direction.

4.3.5 Fabrication

The carbody structure shall be assembled by welding. Connections of LAHT 0.125 in. or greater shall be designed in accordance with AWS Standard D1.1, while connections in thinner material shall be designed in accordance with AWS Standard D1.3. Connections of stainless steel shall be designed in accordance with AWS Standard D1.9. Refer to Chapter 18 for structural welding practices.

Where the carbody structure must be assembled with mechanical fasteners, the fasteners shall be high-strength lock-bolts.

All weld, bolt patterns and bonds shall be identical on all cars, to the maximum extent practical.

Bolts, rivets or welding may be used to join secondary structure or for attaching brackets and equipment to primary structure in subassembly. Otherwise, attachments that are not part of the carbody structure shall be attached to the structure with mechanical fasteners.

Sheet metal screws and self-tapping screws shall not be used to attach access panels or other frequently removed items.

Rivets, blind rivets and lock-bolts shall be set with power tools.

All holes for mechanical fasteners shall be clean and free of burrs.

Adequate drainage shall be provided in all body structure members. Enclosed structural cavities shall be vented to prevent condensate build up. Any enclosed structural cavities of steel members shall be treated with a rust-inhibiting coating as specified in Chapter 18.

The proposed construction tolerances of the finished vehicle shall be submitted for review and approval.

Where used, shims shall be permanently attached to the carbody structure.

All mechanically fastened connections shall be designed using a factor of safety of 1.5 based on the proof load of the fastener. Clamping force friction shall be ignored in the design and analysis of mechanically-fastened connections.

All bolts supplied shall be a minimum SAE J429, Grade 5, or equivalent, including markings. All nuts shall be per SAE J995 and shall match the strength of the bolts.

Tapping plates may be used if approved by the Customer, and if used, shall be attached to the car structure by welding or with mechanical fasteners unless considerations of reduced material properties and stress concentrations have been considered in the original design and analysis. The tapping plate shall be equal to or greater in thickness than the diameter of the bolt for which the tapping plate is intended, and clearance hole shall be drilled in the structure for the bolt. Tapping plates shall be designed to the same strength standards as the equivalent nut.

Intermittent fillet welds on tension members, or in the areas that experience fatigue are prohibited. Plug or slot welds on tension members, or in areas that experience fatigue are prohibited. Intermittent groove welds are prohibited. Stud welding to carbody structure is prohibited; however, stud welding to non-load carrying members and secondary structure shall be permitted.

4.4 Structural Design Details

4.4.1 Level

The difference in height Above Top of Rail (ATOR) of the four corners of the finished car shall not exceed 0.375 in. measured at the end sills. The measurement shall be made on the completely assembled and equipped car mounted on its completed trucks. The measurement may be made from any suitable structural member of the underframe, and shall be documented in each vehicle history book.

4.4.2 Camber

Carbody camber shall be defined as its vertical curved shape as viewed in side elevation, and shall be a smooth arc from end-to-end of the carbody. Camber shall be measured from a datum line drawn between the intersections of the arc with the centerline of the body bolsters to a line tangent to the arc midway between bolsters.

The car shall have a positive camber not to exceed 0.5 in. under AW1 conditions and must be designed so that under full load, AW3, (and for the life of the car) a negative camber shall never occur. The maximum difference between the cambers of each side sill, measured at the location of maximum deflection, shall not exceed 0.125 in. The Contractor shall evaluate and submit camber values at AW0, AW1 and AW3 load for approval at the design review.

4.4.3 Carbody Strength

The strength of the carbody shall equal or exceed the requirements of 49CFR Part 238, Subpart C and APTA Standard SS-C&S-034-99. In addition, the carbody shall be designed with CEM features as specified herein.

The carbody structure shall be designed to absorb kinetic energy as specified to minimize passenger accelerations and preserve occupant volume.

4.4.3.1 Fatigue

The carbody strength shall be sufficient to permit operation with up to AW3 loading for the design life of the car (40 years) without structural damage, including fatigue cracks. The carbody shell shall meet the static and dynamic strength requirements stated in this section.

Allowable fatigue stress of welded elements shall be determined from AWS Standard D1.1, for steel. Where insufficient information is available due to the lack of published data on this subject, the allowable fatigue stress shall be determined experimentally through testing by the Contractor.

The completely equipped carbody shall be designed to carry its AW0 carbody weight (not including truck weight) plus a uniformly distributed passenger load equal to the passenger portion of AW3. The stresses in the carbody, under an applied AW3 load less the truck weight load, shall not exceed the lesser of 50% of the guaranteed minimum material yield strength, or the buckling strength. The inelastic buckling strength of structural members subjected to any combination of compression and shear shall be calculated. The variation in the stainless steel compression modulus with stress shall be addressed in calculating compressive stability of stainless steel members. The buckling values shall be used as the basis for the allowable stress values for the specified load cases. Any structural member in any of the elastic static analyses with a calculated compressive stress equal to, or greater than, 35% of its material's yield strength shall be included.

Notwithstanding the previous paragraph, for each joint design, the static stress at the AW3 carbody load shall be less than the stress that determines the allowable fatigue stress range. The allowable fatigue stress range shall be computed by multiplying the static stress at the AW3 load by the dynamic factor (fatigue load range). This stress range shall be within the design fatigue stress range (fatigue limit) obtained from AAR Standard C-II, Section 7.2, or AWS Standard D1.1, and as approved by the Customer.

The Contractor shall conduct fatigue tests to determine allowable fatigue stresses for joint designs not covered by AAR Standard C-II, Section 7.2, or AWS Standard D1.1.

The dynamic factor shall be determined by the Contractor and shall not be less than 20%. The fatigue design shall be based on applied and allowable fatigue stress ranges at 10 million cycles.

4.4.4 Underframe Structure

The underframe shall be composed of the center sill, if used, end underframes, floor stringers, subfloor, cross bearers and side sills. All parts of the underframe shall be constructed of stainless steel or LAHT, except the end underframe which shall be constructed of LAHT steel.

Side and center sills shall connect the end underframe assemblies and support the transverse floor members. Side sill materials shall be compatible with the side sheet materials.

4.4.4.1 End Underframe

The end underframe assembly, at each end of the car, shall be a weldment comprising the body bolster, draft sill, end sill, coupler support structure, buffers and other adjacent structure.

The coupler and draft gear carriers shall be included in the assembly. The end underframe shall be constructed of LAHT steel.

Fusion welding of one sided joints in the fabrication of the end underframe shall incorporate the use of back-up strips where 100% penetration of a single beveled weld is desired. The single bevel weld shall be reinforced by the application of an additional fillet weld where joint strength requires it. All welds in the end underframe assembly, where 100% penetration is desired, shall be non-destructively tested in conformance with AWS.

The end underframe weldment shall provide for continuity of flanges and webs at any place where load-bearing members intersect. The end underframes shall be designed so that, in case of excessive impact, failure shall be by buckling or crushing of structural elements rather than by shearing of structural elements or by failure of connections between elements.

The end underframe shall be constructed of LAHT, assembled by arc welding, in accordance with Chapter 18 and AWS Standard D1.1, using AWS pre-qualified complete-joint penetration groove welded joints as defined by AWS Standard D1.1, wherever primary loads are carried across the joint in tension or compression. AWS pre-qualified partial joint penetration groove welded joints may be used, when approved by the Customer, where primary loads are carried in shear along the length of the weld. Fillet welds may be used in joints which do not carry primary loads.

If heat treatment is required for stress relief, the assemblies shall be heat treated after welding in accordance with AWS Standard D1.1.

In order to avoid difficulties in attaching the light-gauge floor pans to heavy underframe members, brackets or clips may be provided on the underframe for subsequent attachment of floor pans.

4.4.4.2 End Sill

The end sill shall include the buffer beams, the anti-climbing arrangement and the collision post stubs and shall be securely attached to the collision posts, side sills and the draft sill. The collision post stubs shall extend down to the bottom plate of the end sill and shall be securely welded to both the top and the bottom plates.

4.4.4.3 Anti-climbing Mechanism

The carbody design shall provide an anti-climbing arrangement at each end of each car designed in accordance with 49CFR Section 238.205 and Section 5.5 of APTA Standard SS-C&S-034-99. The analysis of the anti-climbing mechanism shall include an analysis of the attachment of the coupler/draft gear and draft gear carrier plate to the underframe.

4.4.4.4 Coupler Carrier

A coupler carrier shall be provided as part of each end underframe assembly, and shall be designed in accordance with the requirements of 49CFR Section 238.207 and Chapter 6. The coupler carrier, and those portions of the carbody to which it is attached, shall be designed to withstand the loads caused by supporting one end of the car on the coupler carrier, with the truck attached, such might occur during emergency jacking or lifting with a crane in the event of a derailment. Under this coupler carrier load, the allowable design stress of the coupler

carrier, or any part of the carbody structure to which it is attached, shall be the yield strength, the critical buckling stress or 80% of ultimate tensile strength, whichever is lower.

4.4.4.5 Body Bolster

The body bolster shall be designed to transmit loads between the truck and the carbody, and between the draft sill and the body and side sills. The design shall provide clearance for the truck in all positions and accessibility for truck maintenance and de-trucking. Positive stops shall be provided on the carbody and truck bolsters to limit the vertical and transverse movement of suspended trucks when the carbody is lifted. The stops shall comply with APTA Standard SS-C&S-008, Section 5.0.

The design and construction of the bolster shall consider the high fatigue environment in which it will be operating. Welding shall be as per AWS Standard D1.1.

4.4.4.6 Draft Sill

The draft sill shall extend longitudinally from the end sill to the body bolster and shall include the coupler support structure. It shall be designed to transmit the specified loadings from the anti-climber and coupler into the body bolster. The draft sill shall be compatible with the CEM design.

4.4.4.7 Side Sill

Side sills shall be provided on both sides of the car and form a structurally continuous bottom chord for the side frame.

4.4.4.8 Cross Bearers, Floor Beams and Floor Pans

Cross bearers shall be provided to transfer the applied vertical loading from the center sill (if used) to the side framing, or between side sills. Floor beams shall be provided to transfer the vertical floor loads to the side sill and side framing. The cross bearers and floor beams shall be fastened to the center sill, if used, so that they stabilize the center sill against column failure, both vertically and laterally.

A stainless steel floor pan shall be provided underneath the lower floor throughout the length and width of the car and in the equipment room. The floor pan shall be securely fastened to the bottom flanges of the floor beams and to the draft sills and side sills, and shall be sealed in a manner approved by the Customer. Between the carbody bolsters, the floor pan shall be attached to the above mentioned members in a manner to allow for easy replacement of damaged panels and yet provide the attachment and sealing required to meet the structural, car pressurization and fire safety requirements. If the floor pans are separate sheets, they shall be securely fastened to the car structure. A weatherproofing sealant shall be applied to the edges of the sheets immediately before installation. The fastening and sealing system shall prevent moisture, dirt, dust and debris entry into the sub-floor for the life of the vehicle and shall be approved by the Customer.

The floor pan shall contain the underfloor thermal and acoustic insulation. The pans shall be suitably reinforced for structural rigidity and to prevent resonant noise and vibration and “oil canning” under any operating condition.

4.4.4.9 Subfloor and Floor System

Floors for both the upper and lower levels shall be designed and manufactured so that no permanent deformation or soft spots shall occur during the required service life of the vehicle. Floors shall be resistant to spills, washing solutions and moisture; the floor panel system shall be waterproof and resistant to degradation. Floor system panels shall be as large as possible (to a maximum of 60 in. longitudinally and the car interior width laterally), shall not form part of the vehicle shell structural strength and shall have no joints in the doorways. To the extent possible, floor panels shall be interchangeable throughout the vehicle and between vehicles.

Under a dead load and a maximum passenger loading of AW3, the floor panels shall deflect by no more than 1/360 of the short span between members, up to a maximum of 0.0625 of an inch, without permanent deformation. Floor panels shall be attached to the carbody structure using an approved fastener system.

Plymetal panels 0.75 in. thick with butt joints shall be used for the lower floor. The sub-floor for upper and lower floors shall be aluminum honeycomb core or phenolic composite panels 0.75 in. thick. These panels will be constructed in a "clean room" to ensure adequate assembly quality and panel strength. The insulation core on each panel will be tested for dryness prior to hot pressing to insure proper bonding. Prior to installation each panel will undergo a thorough inspection to determine that no delamination has occurred. All exposed edges shall be waterproofed and sealed.

On the upper and lower level, the honeycomb sub-floor and its attachments to adjacent structural members shall be capable of resisting the shear resulting from the specified compression loading without permanent deformation. All joints shall lie on supporting structure. The ends of the panel shall be sealed against moisture. Anti-squeak tape shall be applied between floor panels and supporting structure.

One-eighth inch elastomeric anti-squeak tape shall be applied between floor panels and supporting structure. Panels shall be attached to floor structure using approved flathead fasteners in formed countersunk holes. The floor material shall have shear strength not less than 400 pounds per square inch (psi) and shall be capable of passing ASTM E119 fire test. Tapping plates for above-floor equipment shall be suitably attached. Carpeting or composite floor covering, where specified, shall be installed over the top of the floor panel system.

4.4.5 End Frames

The car end frames shall consist of two corner posts, one each at the juncture of the front end and side frames, two collision posts located at the approximate third points of the end frame width, but in any case not more than 40 in. apart, an end door, a structural shelf, framing posts and sheet metal sheathing connected to the structural framing members as necessary. It shall be designed to resist the specified vertical, transverse and torsional loads as required by APTA Standard SS-C&S-034-99.

The door posts and header shall be designed to carry the end door while maintaining weather tightness. Corner posts shall be continuous from the end underframe to the side rail at the side frame/roof connection.

The A and B-end sheets shall be of the same material as the side sheets and be securely framed to the car structure.

The F-end sheet on the cab/baggage car shall provide projective resistance equal to or greater than that specified for FRA Part 223 Type I glazing where adjacent to the cab control compartment.

The end sheets shall be of the same material as the side sheets and securely framed to the car structure.

4.4.5.1 Collision Posts

The car end structures shall be provided with vertical collision posts at both sides of the end openings, fastened securely into the roof structure at the top and welded to the top and bottom plates of the end underframe. The collision posts shall be constructed of stainless steel or LAHT.

The collision posts shall be continuous closed sections from the bottom of the end sill to the top of the roof.

If reinforcement is used to provide the specified collision post shear strength at the floor, it shall be designed to transmit the specified shear and other loads into the end underframe.

At a minimum, the cab end reinforcement shall be continuous from the bottom of the end sill up to at least 30 in. above the top of the underframe, then gradually taper to a point not less than 42 in. above the top of the end sill. The non-cab end reinforcement shall, at a minimum, be continuous from the bottom of the end sill up to at least 18 in. and then taper to a point at 30 in. If shear reinforcement is not used, the post shall be arranged to penetrate the end underframe unit and weld to the top and bottom plates of the end underframe unit.

The connections and supporting structure at the tops of the collision posts shall be designed to develop sufficient horizontal, vertical and bending strength, so that if one or both posts, whichever is more critical, is overloaded in bending to ultimate strength, the post top connections and supporting structure, if stressed beyond their yield strengths by the resulting horizontal, vertical and bending loadings, shall deform plastically by buckling and bending of the members to accommodate the post plastic bending failure. The ultimate strength of the connections and welds shall be sufficient to prevent their failure, even with severe plastic deformation of the collision posts and of the top connecting and supporting structural elements.

Structural energy absorption capacity of the collision post and connecting structure as per the requirements of APTA Standard SS-C&S-034-99, Rev 2 shall be designed into the structure and shall be demonstrated to the satisfaction of the Customer. Compliance may be demonstrated as per Appendix F of 49CFR part 238, if approved by the Customer.

Overload of collision post bottom connections shall result in buckling and crushing of the underframe structural members to which the collision posts and any collision post reinforcements are attached, rather than by shearing or fracturing of the posts.

For the stress analysis for bending in the plastic range of the material, the reduction in modulus of elasticity and its effect on the stability of the post compression flange shall be considered and included in the strength calculations. The calculation method outlined in the *AAR Manual of Standards and Recommended Practices*, Section C, Part II, Paragraph 4.2.2.16, or another method approved by the Customer shall be used. The calculations shall be based on extended stress strain curves determined experimentally by the Contractor if these data are not otherwise available.

Lifting eyes shall be installed at the extreme top edge of each collision post.

Preliminary layout drawings and supporting calculations of the cab end frame members shall be submitted for approval before the end frame design is finalized. The drawings shall be clearly marked to indicate conformity to the requirements of this section.

The stress analysis as required shall include an analysis of the collision posts and corner posts together with their connections and supporting structure.

4.4.5.2 Corner Post

A structural post shall be installed at each corner of the car. The posts shall be continuous closed sections from the bottom plate of the end sill to the roof. The posts shall be connected to the top and bottom plate of the end sill, side frame, roof structure and intervening structural shelves. The attachment of each corner post at the bottom shall be sufficient to develop its full shear value.

Overloading of the corner posts at the level of the top of the end sill shall result in the buckling and crushing of underframe members to which the posts are connected rather than the shearing-off of the posts themselves.

Structural energy absorption capacity of the corner post and connecting structure as per the requirements of APTA Standard SS-C&S-034-99, Rev 2 shall be designed into the structure and shall be demonstrated to the satisfaction of the Customer. Alternately, compliance may be demonstrated as per Appendix F of 49CFR Part 238, if approved by the Customer.

The corner post shall be connected to the side frame, end frame, and roof structures such that the yield strength of the connections and the supporting structure will not be exceeded when the corner posts are loaded to their yield strengths, as described above. In addition, the roof and roof connections shall resist, without failure, the top load of the corner post, when the corner post load is increased to the ultimate bending strength of the post.

The corner posts shall be continuous closed sections from the bottom of the end sill to the roof unless shear reinforcement is used. If shear reinforcements are used, the corner posts shall be welded to the shear reinforcement at the floor, to the intermediate side frame rails and sheathing, and to the roof rails to develop the full strength of the posts.

4.4.5.3 Structural Shelf

A structural shelf shall be provided just below the cab end windows, connected securely to the corner post and the collision post. The shelf may be integrated with the control console in the cab control compartment.

4.4.6 Side Structure

Side frames shall consist of vertical members such as window posts and door posts, and longitudinal members such as roof rails, side sills, window top rails and belt rails. It shall include sheathing and internal skin stiffening members. Structural posts shall be located at the sides of door and window openings and elsewhere as required, to limit deflection and fatigue stresses. Structural posts shall be continuous between side sill and roof rail if the upper level floor support side rail is not designed to be a primary load carrying member. All posts shall be formed sections. If the upper level floor support side rail is designed to be a

primary load carrying member, the side posts shall be continuous from the lower side sill to the upper side sill and continuous from the upper side sill to the roof rail. At the upper side sill, gussets shall be used to reinforce connections to effectively make the posts continuous between the lower side sill and the roof rail. Where longitudinal rails are interrupted by posts, gussets shall be used to reinforce connections to effectively make the rails continuous. All gussets shall be full height. The side frame posts or stub posts (between side sills and belt rails) shall transmit applied vertical loadings from the body bolster ends, cross bearer ends and jack pads into the side frame sheathing.

The belt rail on both upper and lower levels (the horizontal rail member at the bottom of the window openings in the side frame) and its supports shall be designed to resist the specified side load in accordance with APTA Standard SS-C&S-034-99 and shall comply with the requirements of 49CFR Section 238.217.

Intermediate structural elements between the side frames shall transfer all seat and floor loads to the side frame posts. Passenger seats shall be supported on the wall side by continuous structural members fastened to the side frame posts.

The carbody side and side frame posts shall be capable of supporting AW3 loads with a minimum safety factor of 2.0, based on yield strength, without permanent deformation, at a deflection not to exceed 0.125 in.

4.4.6.1 Side Sheets

All the exterior surfaces of the carbody shall be stainless steel or LAHT steel. The required appearance of exposed welds shall be as described in Chapter 18. Three samples of all exterior finishes shall be submitted to the Customer for approval. These samples shall be used throughout the program to maintain quality. Dents, gashes or other surface imperfections shall not be permitted. Samples of the exterior finish specifying the direction of the grain and the flatness shall be submitted for approval at the design review.

Side sheathing shall be resistance spot welded to the outside of the side frame posts between the side sill and the roof. Smooth side sheets shall be stiffened by corrugations or similar sections resistance welded to the inside face of the side sheet. Weld spacing shall be in accordance to Chapter 18. Flat side sheathing shall be a minimum of 0.059 in. thick. Sheets under the windows, if corrugated, shall be of 0.042 in. thickness.

Horizontal lap joints shall be permitted where flat side sheets are connected to corrugated side sheets provided the direction of the joint sheds water and the joint is seam welded.

The ends of corrugations shall be permanently sealed against air and water by capping or controlled crushing. Additionally, they must be sealed with an approved sealing compound. Samples of the method must be submitted for approval at the design review, and maintained until notified otherwise by the Customer.

Side sheets below the windows shall be continuous sheets or longitudinal corrugated sections running the entire length of the car.

The side sheet shall be attached to the side sill by a continuous fillet weld or by a series of resistance welds. If resistance welds are used, they shall develop the same strength as a continuous fillet weld. Strength in tension and shear shall be reviewed in the stress analysis.

Smooth side sheets stiffened with corrugations welded to the hidden surface shall be provided in the window area. All exterior surfaces shall be free of ripples and buckling. Flatness standards previously defined shall be met.

There shall be no less than two spot welds per node of corrugation or where attaching corrugated panels to framing members.

4.4.7 Roof

The roof shall be constructed with corrugated sheets. The car roof framing shall consist of carlines (transverse) and purlins (longitudinal), all suitably fastened to the side and end framing to provide a strong, rigid, integrated structure. The roof shall be properly reinforced and braced with the structural members to carry the weight, stress and vibration due to roof mounted apparatus. The roof shall meet 49CFR Section 238.123, 49CFR Section 238.215, APTA Recommended Practice RP-C&S-001-98 and APTA Standard SS-C&S-034-99.

All members of the roof framing shall be designed and arranged to permit the installation and fastening of roof wiring, lighting fixtures, equipment, ventilation ducts and other required apparatus in a secure manner. The roof framing shall be arranged to allow the replacement and maintenance of overhead mounted equipment through removable interior ceiling panels without disturbing the carbody structural members. Ducting for the circulation of conditioned air shall be coordinated with the roof framing arrangement and configured to be consistent with the air distribution requirements of the heating and air conditioning system.

The roof shall be framed and reinforced around openings. All reinforcement shall be welded stainless steel. Reinforcements and joints on the roof shall be made watertight by welding or soldering. Horizontal lap joints shall be permitted where flat side sheets are connected to corrugated side sheets provided the direction of the joint sheds water and the joint is seam welded. No through-roof mechanical fastening is permitted. The roof sheathing and structure shall be designed to support the specified roof loads. Both ends of the roof shall be designed to support the tops of collision posts and distribute the specified collision and corner post loads.

Flat surfaces or plates shall be provided on the roof for all roof-mounted appliances such as antennae. Roof penetrations for wiring or piping to roof-mounted equipment shall be suitably sealed, and all wiring and piping shall be routed to roof-mounted equipment through conduit. All roof-mounted equipment shall be mounted on the longitudinal centerline of the car unless otherwise specified.

All parts of the roof structure, sheets, equipment covers, roof walkway, screens and other guards shall have sufficient strength to withstand, without exceeding the yield strength, 80% of ultimate strength and critical buckling stress under the following conditions:

- Three concentrated loads of 250 lbs spaced 30 inches apart, each applied over a 3 in. by 3 in. area, such as might be applied by maintenance personnel working on the roof. The placement of the loads shall be such as to produce the worst-case condition for the roof structure, and
- A uniform load of 15 psi limited to a 20 sq. ft area over any region of the roof.

The design loads for equipment and apparatus attached or mounted to the roof, including gutters, air scoops, antennae, lights, equipment supports and supporting roof framing shall meet the carbody fatigue requirements in this Specification.

Equipment mounted under the roof suspended from the roof structure shall be bolted to the framing members. The framing members shall be reinforced in subassembly to accept the equipment load.

4.4.7.1 Emergency Access "Cut Zone"

Roof emergency access shall be in accordance with FRA 49CFR Section 238.123 and APTA Recommended Practice RP-C&S-001-98. Perimeter of the cut-zone shall have a retro-reflective sign demarcating the opening, and clearly indicating the purpose, instructions and other emergency signage per APTA Standard SS-PS-002-98.

4.4.7.2 Gutters and Deflecting Plates

Water deflecting gutters shall be installed on the entire length of the roof on both sides of the car. They shall prevent water from dripping into or in front of the side door opening when the car is stopped. Gutters shall also deflect water off the entire end of the car.

Deflecting plates shall be installed at the ends of the roof to direct water between cars. The design arrangement and installation of roof equipment shall not permit accumulation of water. Drainage provisions must be submitted for approval at the design review.

Gutters and deflecting plates shall withstand regular passage through a car wash. Gutters shall be made from the same material as the shell, roof and side sheets.

Alternative gutter designs that meet the Specification requirements shall require approval of the Customer.

4.4.8 Jacking Pads

Eight jacking pads, with anti-skid plates, shall be provided in approved locations to lift the car, with trucks attached, at or inboard of the bolster for maintenance and at the extreme ends of the car in the event of a derailment. The car shall be designed to permit jacking for truck removal or re-railing with one end of the car resting on its truck, without damage to the truck attachments, underframes or any of the underfloor equipment

It shall be possible to jack up a complete car, or either end of a car, utilizing portable jacking devices and to subsequently support the car with portable stands with trucks remaining on the rails and remove the portable jacks. It shall be possible to manually roll the trucks from under the end of the car when supported on jack pads.

The jack pads shall be a minimum of 32 in. ATOR. The jack pads shall be 8 in. wide and 5 in. deep (width is parallel to car's side sheet) with a suitable surface to avoid slippage. The pads shall extend 0.50 in. to 1 in. below the bottom of the side sill.

The design vertical load for each jacking pad shall not be less than one half the empty weight of a ready to run (AWO) car. The design horizontal load shall be 10% of the design vertical load. The horizontal load shall be applied simultaneously with the vertical load in any direction to produce the worst stress condition. The allowable design stress shall be yield or 80% of ultimate, whichever is lower or the critical buckling stress of any part of the jack pad or the structure to which it is attached. Jacking pads shall extend a minimum of 0.50 in. below the bottom of the side sill.

There shall be no permanent deformation when the car is symmetrically jacked from any combination of pads with the car at AW0 with the trucks attached.

The empty carbody, with trucks attached (AW0), shall be capable of being lifted on the outboard most diagonally opposite jack pads without resultant permanent deformation on any element of the carbody structure.

An analysis of the carbody structure under torsional loading of the diagonal jacking, all symmetric jacking, and all lifting conditions shall be included in the stress analysis.

4.4.9 Lifting Eyes

Lifting eyes shall be installed at the extreme top edge of each collision post of both ends of all cars to allow lifting the car with overhead cranes or a boom. Procedures and designs shall be submitted to the Customer for approval during the design review of the car. The lifting eyes shall be arranged such that they are readily accessible. The top of the collision posts, including lifting eyes, shall not extend above the surface of the roof.

The collision post lifting area may have a suitable removable cover sealed to prevent ingress of water. It shall not require special tools to remove the cover.

It shall be possible to lift the car at AW0 load with an overhead crane or boom at only one end with trucks attached and supported by the opposite end truck, without exceeding 50% of the yield strength of the material.

The stress analysis shall include an analysis of the collision post lifting eyes under all torsional loading showing all stresses on the carbody and all attachments during lifting of the car in, AW0 condition, from either end or both ends when ready-to-run in the following conditions:

- Car upright
- Car lying on left hand side
- Car lying on right hand side

For lifting from either the left hand side or the right hand side, the car shall be analyzed with equal lifting load applied to one collision post lifting eye on each end of the car. Stresses shall not exceed yield with a load factor of 1.1.

4.4.10 Stairways

Two stairways, parallel to the carbody, shall be provided adjacent to each entranceway to connect the lower and upper levels of the car, (except the café/lounge car, see Chapter 14). Stairwell framing treads and risers shall be constructed of stainless steel and mounted securely to upper and lower floor. Open risers shall not be permitted. The Contractor shall design for safety and ergonomics when determining the riser height, tread depth, slope of the stairway and headroom. The step tread width shall be a minimum of 32 in. Tread widths and riser heights shall be uniform on all stairways.

4.5 Truck-to-Carbody Attachment

An approved truck safety mechanism and truck rotation stops shall be provided in accordance with 49 CFR Section 238.219 APTA Standard SS-C&S-034-99.

The construction shall also provide a connection between the carbody and trucks so that the trucks are raised with the carbody, unless intentionally detached. The truck safety mechanism shall not interfere with normal suspension elements for any possible condition of shimming to accommodate for wheel wear variances.

Distance between truck centers shall be 59 ft 6 in.

4.6 Bolster Anchor Rods and Brackets

Bolster anchor rods and brackets shall be provided to transmit the longitudinal loads between the carbody and the truck. The anchor rods shall be positioned to minimize longitudinal vibration to the carbody. Two bolster anchor rods and brackets shall be provided on each truck, one on each side of the truck, connecting the carbody to the bolster.

The rods shall extend horizontally from brackets attached to the side sills to brackets attached to the ends of the truck bolster. Elastomeric pads shall be installed between the radius rod assembly and anchor brackets to permit relative movement.

The attachment of the anchor bracket to the carbody shall be by mechanical fasteners, designed and constructed to permit interchangeability among cars, and arranged to permit removal of the bracket from outside of the carbody without interference from the car structure.

Each of the rods shall, as a minimum, withstand a longitudinal load equal to two times the weight of the complete truck, including brakes, and other apparatus mounted thereon, without exceeding the yield strength of the materials used.

Both radius rods together must also support the load that can occur if the maximum main reservoir pressure is applied to the brake cylinders assuming perfect wheel/rail adhesion. Perfect wheel/rail adhesion is defined as that condition where the wheels continue to roll (sufficient adhesion to prevent the wheels from sliding) with the brakes applied at maximum main reservoir pressure. This may be more or less than coefficient of friction of 1.0.

The anchor rod bracket or bracket mounting bolts shall be frangible. Any horizontal load which develops the ultimate load carrying capacity of the anchor rod bracket shall not develop a stress greater than yield, 80% of ultimate strength or the critical buckling stress in the side sill or other car structure. The longitudinal load shall be applied in either direction in the horizontal plane of any part of the anchor rod bracket below the side sill. A specially designed anchor rod bracket bolt, which breaks at a predetermined load, shall be permitted subject to the approval of the Customer.

Each of the brackets, by which the bolster anchor rods are attached to the truck, the truck bolster and/or the carbody, and the members to which these brackets are attached, shall, as a minimum, withstand a longitudinal load equal to three times the weight of the complete truck assembly without exceeding the yield strength of the material used.

4.7 Doorways and Passageways

4.7.1 Doorways

All doorways shall be in accordance with 49CFR Section 38.93. All cars shall include four sets of side entry doorways (two per side) and two end-frame doorways (one at each end). Location and dimensions of these doorways shall be in accordance with Amtrak Drawing D 035-00245.

4.7.2 Side Entrance Area

Four lower level side entrance doorways, in accordance with ADA standards, shall be provided. A minimum 52 in. wide clear passage shall be provided through all side entrance area doorways.

Floor height at the side entrance doors shall be 18 in. ATOR under AW0 conditions.

4.7.3 Carbody End Doorways

Each car shall include carbody end doorways. These doorways shall provide access between two coupled bi-level cars through the diaphragm passageway. The carbody end doorways shall be at the same height above top of rail as the upper level floor, 104.5 in. at AW0. Diaphragms and associated components shall be installed to be compatible with the existing fleet of bi-level equipment as specified under all operational conditions identified by Amtrak Specification 963.

4.7.4 Passageways

All passageways shall be in accordance with 49CFR Section 38.93. The passageways shall have a minimum width of 32 in.

4.7.5 Threshold and Door Track

A threshold shall be designed to guide the bottom edge of the side entrance doors and carbody end doors during door operation and mate with the door bottom edge when the door is in the closed position, so as to exclude water and drafts from the vestibule. The threshold and door track shall be provided with adequate drainage to prevent the buildup of water and debris in the track. The door track shall extend the full length of the door travel.

4.8 Diaphragm

A non-metallic modular, maintainable diaphragm shall be provided at each end of each car. Diaphragms shall provide a safe, stable, weatherproof passageway between two coupled multi-level cars, and shall exclude water ingress and drafts under all normal operating conditions. Diaphragm size, arrangement and installation shall be compatible with existing equipment as specified and shall be subject to approval by the Customer during design review.

Easily replaceable wear plates shall be provided on diaphragm faceplates. A minimum clear horizontal opening of 32 in. through the diaphragm parallel to the end door panel shall be provided when the car is at rest on level tangent track.

Hinged stainless steel walkway plates, equipped with a safety tread surface, shall be provided at each end of the car to provide a continuous flat and level walkway between coupled cars.

The construction of the walkway plates, buffer and side stems shall be such that there shall be no metal to metal contact between moving parts, in order to prevent noise, minimize wear between all parts, and require no lubrication.

The walkway plates, buffer and side stems shall be so designed to permit coupled cars to negotiate minimum radius curves and crossovers, without any binding of the mechanism.

Retractable curtains with restraining devices shall be provided on either side in the diaphragm passage. The curtains shall be directly interchangeable, without adapters, with existing curtains on bi-level equipment as specified, and shall include "automatic retraction or break away" feature and diaphragm size, arrangement and installation shall be compatible with other bi-level equipment as required.

A safety gate/bar(s) shall be provided to prevent passage through the body end door opening when the door is open and the car is at the end of the train. It shall be used to form a transverse barrier between collision posts. It shall be secured to one post on a pivot pin and shall latch securely in both the horizontal and stored (vertical down) positions.

4.9 F-End Pilot

A pilot which meets the requirements of 49CFR Section 229.123 shall be provided at the F-end of the cab/baggage car. See Chapter 16 for details.

4.10 Safety Appliances

4.10.1 Exterior

Railroad safety appliances shall be in accordance with 49CFR Part 238 and/or 49CFR Part 231. The Contractor shall be responsible for obtaining from the FRA a determination of compliance with all applicable FRA safety appliance regulations. All car types should have the same safety appliances.

Handrails shall be provided on the exterior of the carbody on each side of each entrance doors to assist passengers when boarding or alighting from the car. Design and assembly of handholds and handrails shall be submitted to the Customer for review and approval at the design review.

Sill steps shall be provided near each end on each side of the car.

Two handholds, mounted either vertically or horizontally shall be provided above each sill step. The handholds shall be located at an optimum location to assist the crew during car moving operations. Location of the handholds shall be subject to Customer approval.

End handholds shall be provided near each side on each end of the car.

Suitable warning signs shall be provided where appropriate.

All safety appliances shall be within the specified clearance envelope.

The Contractor shall arrange for an FRA sample car inspection of the safety appliance applications and shall provide the Customer with a copy of the FRA “no exceptions taken” letter prior to release of the first car of each type.

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4.10.2 Interior Passenger Grab Handles

Passenger grab handles shall be provided as follows:

- At the side of the entrance area to allow crew to stand safely in the open doorway; and
- In the end passageway adjacent to the end door, on both sides of the passageway and between the end door and the diaphragm.

4.11 Mobility Aid Accessibility

4.11.1 Wheelchair Lift

Each car shall be equipped with two permanently mounted powered wheelchair lifts, one for each side of the car located adjacent to the B-end side doors. The wheelchair lifts shall meet all requirements of ADA.

The wheelchair lift design shall ensure reliable operation under the following conditions:

- Uneven station platform edge;
- Uneven station platform: slope in both lateral and longitudinal directions;
- Car lean from up to and including 7 in. of superelevation (toward and away from the platform);
- Platform height ranging from 8 in. inches below top of rail to 18 in. ATOR, in addition to effects of superelevation, both toward and away from platform;
- Operation in all types of weather conditions as specified.

The wheelchair lifts shall be designed for safe and reliable operation, and shall be free of sharp corners or edges, pinch points, heavy components that may drop suddenly, or other unsafe designs. The lifts shall require the use of an Amtrak standard coach key to deploy, and shall be unpowered when not activated with the coach key. The wheelchair lift shall be easy to operable manually in case of hydraulic, pneumatic or electrical failure.

The wheelchair lifts shall be electrically or hydraulically powered, and shall stow out of the way when not in use. If powered hydraulically, the hydraulic lines shall be leak-proof and located for ease of access and maintenance. The hydraulic fluid reservoir shall be located to facilitate checking the fluid level and replenishing as necessary. The lift shall not require any kind of preparation or priming to operate after an extended period of disuse. A means of purging the hydraulic system of trapped air shall be provided.

The wheelchair shall not require maintenance or adjustment more frequently than annually.

The wheelchair lift controls shall provide safety interlocks as follows:

- The lift shall be interlocked with the car air brakes so that deployment of the lift when less than 30 psi brake cylinder pressure is present on the car, a magnet valve will vent the brake pipe. Deployment of the lift with 30 psi or greater brake cylinder pressure will not result in brake pipe venting. A means of closing the brake pipe in the event of a magnet valve failure shall be provided.
- The lifts shall be interlocked with the adjacent side doors so that the side doors will not attempt to close if the lift is not fully stowed. This will provide a traction inhibit function through the door closed summary circuit.
- An interlock bypass shall be provided that will allow a train to continue in operation in the event of a wheelchair lift failure that affects the ability to release the air brakes or close the doors. Utilizing the bypass feature shall isolate the lift and prevent its use. The bypass device shall be sealable with an Amtrak seal to deter misuse.

The Contractor shall provide a specification for the wheelchair lift as proposed for Customer approval during the design review for the wheelchair lift. The wheelchair lift specification shall include, as a minimum, the following information regarding the wheelchair lift and associated components:

- Design, construction and material specifications
- Electrical and hydraulic schematics
- Operation
- Interlocks
- Reliability assessment
- Maintainability
- Troubleshooting
- ADA compliance certification
- Safety/failure modes analysis
- Proven service history
- Testing program

A mockup of the wheelchair lift unit and installation shall be built to verify the function of the design, and shall be submitted for approval at the design review.

4.12 Underfloor Equipment, Equipment Rooms and Access Doors

4.12.1 General

Equipment box structures, mounting brackets, hinges, lids, covers, access doors, vents and interior panels shall be designed to withstand the loadings received in the intended railroad service. All equipment boxes and mounting supports shall meet the requirements of APTA Standard SS-C&S-034-99.

Brackets and other means of support for the equipment shall be designed and installed to facilitate access for maintenance and servicing and for removal and re-application. Fasteners

shall be conveniently accessible. Equipment boxes shall be of polyurethane painted LAHT steel, fiberglass-reinforced polyester plastic or stainless steel.

There shall be no undercar equipment other than piping, conduit, electrical boxes, safety appliances and wiring, and accessories associated therewith, unless otherwise specified by this Specification or as approved by the Customer.

In no case shall the strength of a fastener or the shearing of the fastener through the base material be the limit of the carrying capacity of a member. Fasteners are not always torqued correctly and sometimes the nut shakes loose. Analysis of all the attachments considering loose bolts should be considered. The analysis of the connection shall include considerations for fastener shear, pull out, and fastener tension.

All equipment boxes, which are required to be watertight, shall be given a water test. Junction boxes are required to be watertight. For the purposes of this test, adjustable cover latches shall be adjusted to compress the cover seals no more than 50% of the compressible height of the seal for covers so equipped.

Undercar equipment with a direct line of sight to a wheel for any possible truck orientation shall be protected from water splash and flying rock ballast or other missiles thrown by the wheel. If separately mounted solid metal shields are used to provide such protection, they shall not hinder the flow of air to a degree that might cause heat damage to wiring or apparatus.

No apparatus over 25 lbs shall be supported by bolts in tension. The Contractor may submit to the Customer, for specific approval, an alternative apparatus support design utilizing bolts in tension provided that such design includes an adequate stand-by support arrangement. The design of the standby support arrangements shall include the effect of the equipment dropping from its mount. Apparatus requiring removal and replacement for other than accident damage shall be supported so that both the bolts and nuts are accessible. Bolts used to mount or support underfloor equipment shall not be less than 0.625 in. in diameter and shall meet the requirements of Chapter 18. Dissimilar metals shall not be used at connections requiring disassembly for removal and replacement of equipment. Equipment supported on resilient mounts shall have safety straps or other devices that will support it in case of a failure of the resilient mounts. The design of the safety straps shall include the effect of the equipment dropping from its mounts. Under no circumstances shall equipment be supported by bolts, in holes, that are tapped into the primary structure of the end underframe.

Bolted connections shall be designed with a factor of safety of 1.5 using bolts of not less than 0.375 of an inch diameter. All bolted connections in equipment supports shall be supplied with minimum SAE Grade 5 bolts or equivalent, plated for corrosion resistance in accordance with Chapter 18.

Final dimensions and arrangement of all equipment compartment accesses shall be subject to approval by the Customer.

4.12.2 Equipment Rooms and Enclosures

Maintainability shall be the primary criterion in designing the layout of the equipment rooms. To the extent possible, the Contractor shall design the layout to enable a 95th percentile male crew member to safely navigate within the equipment room. Equipment that needs routine maintenance and inspection shall be located in physically accessible areas. Equipment room compartment walls and access doors shall be stainless steel and shall be both thermally and

acoustically insulated. Interior walls of the equipment room shall be painted white or an approved color tone to achieve maximum reflectivity. The layout and type of equipment that is to be mounted in the equipment room shall be submitted for approval at the design review.

An equipment room shall is any enclosed area which is interior to the car structure/exterior skin and encloses equipment or components to isolate the equipment or components from the passengers or crew. All equipment rooms shall be provided with hinged doors for access. Hinges shall not protrude above the surface of the door. Exterior doors shall be gasketed to be water and dust tight. Interior equipment compartment walls and doors shall be thermally and acoustically insulated.

Internal structure and sub-plates shall be provided within the equipment rooms to support the equipment, and equipment shall be bolted to the substructure. No equipment shall be bolted directly to the walls.

Equipment rooms shall be designed and arranged to provide a safe working environment that is well-lit and free of sharp corners or edges, pinch points or other hazards to maintenance personnel.

The battery box shall be constructed of stainless steel and shall be properly vented to prevent accumulation of gasses. The vents shall be covered with screens and deflectors to preclude entry of dirt and water. Large drain holes with deflectors shall be installed in the bottom.

Stainless steel enclosures shall be provided for all undercar and roof mounted equipment without violating the clearance envelope requirements. Hinged access doors shall be designed to provide adequate access for servicing of apparatus contained therein. Enclosures shall be water- and dust-tight under all normal railroad operating and environmental conditions.

Enclosures shall be supported on horizontal flanges of side, center or body sills, where possible. The enclosure shall inhibit vibration and meet the strength requirements defined herein. Supports for equipment boxes and apparatus shall be low alloy high tensile steel or stainless steel. Where possible, supports for heavy apparatus shall rest on the horizontal flanges of side sills, roof rails, or body sills. Attachment of these supports to structural members shall be by mechanical fasteners, not by welding, and shall be subject to the approval of the Customer.

4.12.3 Equipment Room Doors and Hardware

Equipment room access doors and hardware shall be of T304 stainless steel construction. Access door shall form a positive seal to keep the enclosure water- and dust-tight under all normal railroad operating and environmental conditions. Top-hinged doors with gas strut for underfloor equipment shall be used. Hardware shall be of stainless steel and not require special tools. To the extent possible, captive hardware shall be used. The mechanism to secure the door closed shall be simple and require minimal maintenance.

Hinged doors shall be provided for access to the equipment rooms, HVAC units and the battery compartment. Hinged access panels shall be provided for access to the air intake for the HVAC condensers and to permit installation and removal of HVAC units. Fixed access panels shall be removable to provide openings large enough to permit installation and removal of equipment room components. Louvers, where used, shall be removable as an integrated assembly. The equipment compartment access panels and doors shall be constructed so as to harmonize structurally and aesthetically with the car sides. When closed, the access panels shall be held fast with structural bolts to comprise an effective structural segment. The equipment room

doors shall swing outward and have appropriate latching, operable from inside and outside. The access doors shall have a positive seal when closed; effected on the doors by a dog type handle and be lockable with a standard Amtrak coach key. Access panel and door construction shall be stainless steel, to coincide with the carbody. The panels shall be of a rigidity and strength comparable to the adjacent car side areas. All joints and edges shall be watertight. Doors and panels shall be vibration free.

Battery Compartment Doors:

- Hinge shall be secured to the carbody and access door with stainless steel bolts – 0.25 in. – 20 UNC or larger
- Secured with a standard coach key
- Self-latching mechanism shall prevent unexpected closure and hold the door open at an angle of no less than 110° from closed
- Labeled per Amtrak Specification 696

Fresh Air Intake Door:

- Hinge shall be secured to the carbody and access door with stainless steel bolts – 0.25 in. – 20 UNC or larger
- Secured with a standard coach key
- Self-latching mechanism shall prevent unexpected closure and hold the door open at an angle of no less than 110° from closed
- Fresh air damper shall be mounted on the inside of the door
- Provides access to HVAC unit air filters

HVAC Unit:

- Door opening shall enable unobstructed removal of the HVAC unit
- Hinge shall be secured to the carbody and access door with stainless steel bolts – 0.25 in. – 20 UNC or larger
- Secured with captive bolts
- Access door shall incorporate stainless steel screens
- Mechanism shall hold the door open at an angle of no less than 110° from closed

Equipment access panels shall be provided only on one side of each equipment room to permit removal and replacement of all components. In addition, it shall be possible to perform such service functions as battery removal, watering and flushing, from the exterior of the car. Although one side access door for each equipment area is preferred, other configurations that address human factors and are practicable may be submitted for review and approval by the Customer. The access panel configuration shall be submitted for review and approval.

The car side equipment room access panels and doors shall be constructed so as to harmonize structurally and esthetically with the car sides. The equipment access panels shall be removable. When closed, they shall be held fast with structural bolts so as to comprise an effective structural segment of the side. The side access doors shall swing outward and have appropriate latching, operable from both sides.

When closed, the access doors shall have a positive seal, which is effected by a wedge latch or similar device. A lock operable by the standard Amtrak key shall be provided.

Side access panels and doors shall have a finish of stainless steel.

Side access panel and door construction shall be of stainless steel to match with the carbody. The panels shall be of a rigidity and strength comparable to the adjacent car side areas. All joints and edges shall be thoroughly sealed and drain holes provided to permit the drainage of entrapped moisture. Doors shall not rattle or vibrate during operation.

The openings with close-off panels shall be reinforced by additional side frame structure surrounding the opening. The panel to close off the opening is to be structural and bolted to the basic side frame structure with stainless steel structural bolts so as to become an integral load bearing component of the side frame. The entire installation shall be watertight.

Covers on the exterior of the car shall fit tightly and be gasketed to prevent the entrance of water (including both driving rain and high pressure car wash spray), dust and snow. Seals on covers shall be of a material that shall insure water tightness, remain resilient and remain intact for a period of at least 10 years. Only one common type of gasket shall be used on all covers, of a hollow closed tube or similar design, using a positive mechanical means of attachment. Flat foam strips or glue-on attachments shall not be permitted. The design shall allow for ease of gasket replacement, without use of adhesives.

The access panel and cover/door seal shall be hollow neoprene rubber bulb type permitting at least 0.25 in. compression using the latches and edge design proposed for each door. The edge of the access panel and cover/door shall not deflect (bow) more than 0.0625 in. between latches when the latches compress the seal 0.25 in. No permanent deformation of the door shall be possible with any combination of latch settings. The seal shall be mounted on a lip on the box and the cover shall seal against it. Foam seals shall not be allowed.

The seal shall be a clamp-on type that fits over a lip on the box and be mechanically clamped to it as are trunk lid seals on automobiles. This type of installation shall provide easy replacement of damaged seals and secure attachment until replacement is required. Adhesive bonding of seals to the box or cover shall not be permitted. Samples shall be submitted to the Customer for approval.

All access covers shall be provided with quick release, spring-loaded latches which operate with a toggle type action. The latches and keepers shall be arranged so that they do not protrude beyond the bottom of the box or cover in the latched position. The latches shall be adjustable to compensate for seal relaxation. The latch and all its components shall be fabricated from an austenitic stainless steel and shall be Nielsen/Sessions #265-30 series mounted to a Nielsen/Sessions dished (recessed) mounting.

A spring-loaded safety catch shall be provided at the center of each undercar box cover. The safety catch shall be designed to engage and retain the cover at all operating speeds without the cover latches engaged.

4.12.4 Ladders

Each equipment room shall be equipped with a T304 stainless steel ladder that is permanently and securely stowed inside the equipment room. Nylon strap at a convenient height shall be attached to the ladder for deployment from outside the car. Pivot mechanism with a high coefficient of static friction shall prevent the stowed ladder from tipping over and inadvertently

deployment. When stowed, the ladder shall rest against a rubber bumper that acts as a vibration damper and motion retardant. When deployed, a rubber bumper installed on the side of the carbody shall cushion the ladder in its fully deployed position. Stainless steel anti-skid steps and tread plates shall provide a safe and secure foot hold for the crew during ingress and egress. The height of the first step, when deployed, shall be no greater than 15 in. ATOR. Ladder frame, pivot mechanism, step and tread plate shall be designed to withstand a static load of 400 lbs at the center of the each step without permanent deformation. The ladder shall meet the requirements outlined in APTA Standard SS-C&S-006-98.

4.12.5 Floor and Roof Penetrations

The Contractor shall ensure that all floor and roof penetrations shall be sealed to inhibit pressure differential, and provide for a watertight and dust tight carbody. Floor penetrations shall be sealed with an appropriate material to prevent flame propagation from underfloor flame sources; and shall last the life of the rail car.

4.12.6 Equipment Boxes

The interior of all electrical equipment boxes and terminal boxes shall be primed and shall be given one coat of white insulating coating. A single coat of insulating varnish, enamel, white (or approved color) or epoxy powder coating may also be used. Insulating coatings are not required on fiberglass surfaces.

Boxes required to be accessible from the side of the car shall be as flush as possible with the side of the car consistent with the car clearance diagram and shall be provided with top hinged access covers on the outboard side and, if required, the inboard side. Outboard covers shall raise a minimum of 90 degrees for quick examination of the interior without removing the covers. Inboard covers shall open to the maximum extent possible, but in no case less than 60 degrees. All hinged covers shall also be readily removable without more than 12 in. swing out and without the use of tools. Openings provided upon removal of covers shall be of sufficient size to permit removal and replacement of any component in the box and easy access to equipment in the box for inspection and maintenance. All covers shall have a "hold open" feature built into the hinge configuration. The "hold open" feature shall in no way interfere with or impede the easy removal or replacement of the cover.

Conduit shall be connected to equipment groups, using watertight connectors as manufactured by Universal, Erickson, or approved equal. Entrance of conduit into the top or bottom of equipment boxes shall not be permitted.

4.13 Windows

Frame and glazing rubber of side passenger windows and side door windows shall be designed to securely retain the glazing material under all operating conditions on specified track configurations.

Glazing assembly (frame, rubber and glazing material) shall not leak during carbody water tests. The glazing material shall show no physical damage or degradation of optical qualities when exposed to the environment encountered in rail passenger service.

Construction shall be a double-glazed side window with the exterior light to be tinted laminated safety glass, and the inner light to be untinted.

All glazing assemblies shall meet all applicable requirements of 49CFR Part 223. They shall meet any applicable APTA requirements.

Glazing assemblies (frame, rubber and glazing material) shall be watertight over the entire operating environment. The sash itself shall be free of condensation, watertight and dust tight. The glazing material shall show no physical damage or degradation of optical qualities when exposed to the environment encountered in rail passenger service.

Material selection for glazing rubber and all other materials in all locations must take into account the possible interaction between the material as well as the environment.

4.13.1 Glazing Materials

Glazing material shall conform to the requirements specified in Chapter 18.

Material shall be integrally tinted with no appreciable variation in color over the entire area of each glazing and between panel of like color designation and thickness. Color measurements shall be taken with a spectrometer.

A permanent protective veneer shall be applied to the exterior surface of all glazing material. This protective covering shall significantly improve the abrasive resistant qualities of the glazing to abrasive materials, natural atmospheric acids, strong cleaning chemicals and cleaning brushes encountered during normal operating and cleaning conditions

Markings are to be in accordance with current ANSI Standard Z26.1 and 49CFR Part 223. Location of these markings must be visible for identification after installation.

4.13.2 Side Windows

Side windows shall conform to the requirements specified in Chapter 18.

An approved sealant shall be used as the primary vapor sealant on both sides of the desiccant spacer. The edges of the unit shall be sealed with a polyurethane sealant along the entire perimeter, filling all voids. Aluminum tape shall be applied to the perimeter of the glazing assembly.

The window frames shall be extruded aluminum 6063-T5 alloy. The carbody side of the window opening shall be reinforced to keep the opening flat.

Retention of glazing material in the frame shall be by means of a rubber extrusion. A "pound-in" strip shall secure the glazing from the inside of the car. A "zip strip" on the outside section of the rubber shall allow installation and/or removal of the main rubber extrusion from the carbody frame.

The window opening in the carbody shall be reinforced to keep the opening flat. A leak proof seal shall be provided.

4.13.2.1 Emergency Side Windows

A two part "Emergency" handle shall be provided at designated "Emergency" windows for removal of the window from inside of the car. The design of the glazing rubber shall also allow removal of the glazing from the outside of the car by emergency responders as described below.

4.13.2.2 Rescue Access Windows

All side windows shall be rescue access windows, and shall be capable of being removed from the outside of the car by prying and pulling a “zip-strip”. Rescue access windows shall provide a means of rescue access by emergency personnel such as, police, fire department, etc. Emergency side windows on each side of the car on each level shall be designated as an emergency and rescue access – dual-function window.

Identification and removal instructions shall be provided in accordance with 49CFR Part 223, 49CFR Section 238.114, APTA Standard SS-PS-002-98 and ASTM Standard D 4956-07 for Type I material sheeting.

4.14 Insulation

4.14.1 Acoustical Insulation

To reduce movement, structurally-borne sound and noise generated by the vibration of the roof, floor and side sheets, panels, air conditioning ducts and other metal surfaces, in particular the doors, damping material shall be applied to the inner side of these surfaces (exterior of the HVAC ducts). The thickness of the damping material shall be such that it shall provide ten percent of critical damping for the treated surface. The damping material shall have a vibration decay rate of not less than 35 decibels per second (dB/sec) as measured by the Geiger-Hamme Thick Plate Test Method. The damping material shall have a hydrodynamically smooth finish, and shall be receptive to painting. It shall be resistant to dilute acids, alkalis, greases, gasoline, aliphatic oils and vermin. It shall be unaffected by sunlight or ozone, and shall not become brittle with age.

This material shall be applied to the interior of the complete structural carshell including the roof, sides, underfloor, ends and webs of all posts, carlines, floor beams and other structural elements. The sound dampener shall be compatible with the material used at the affected locations in the car structure.

Application of this damping compound and the surfaces to which it shall be applied shall be in accordance with recommendations of the manufacturer of the compound, and as follows:

- Prior to application, the Contractor shall ensure that surface temperature of the base material meets the supplier’s recommended temperature settings. Ambient temperature shall not be used to qualify a base material for application of damping material.
- The inner surface of the carbody structural shell, except for the end underframe welds, shall be coated with sound deadening compound. The inside surfaces or structural members shall be sprayed to the extent possible. The compound shall be applied wet to the supplier’s recommended thickness.
- Structural members under the floor of the carbody shall not be coated.
- The outside surfaces of the main air duct, the vertical underfloor equipment ventilation duct, and all ventilation cross ducts shall be coated with sound deadening compound. The compound shall be applied wet to the supplier’s recommended thickness.
- Duct splitters (if used) shall not be coated.

- The underside of the main air duct, top/bottom of floor beams, inside door pockets and floors of equipment rooms shall not be coated.

4.14.2 Thermal Insulation

The floor, roof, sides and ends of the cars shall be insulated. The heat transfer through the carbody, using only the carbody's own floor heaters, shall not exceed 1200 Btu/Hr/ F under the environmental conditions specified in Amtrak specification 963 while carbody is stationary. Contractor to supply thermal analysis of completed car for approval at the design review.

As much as practicable insulation shall have an acoustic barrier and shall not settle in long service under vibrating conditions.

The roof insulation shall be retained by insulation pins of the same metal as the car structure attached to the carlines. Side and end wall insulation shall be retained by insulation pins. On the inside of the end and side powered door pockets the insulation shall be retained by stainless steel sheets.

Side wall insulation located near heater assemblies shall be metal-backed with metal side facing the heater.

A vapor barrier shall be provided between all interior linings and the carbody insulation.

Thermal breaks shall be provided between the main conditioned air supply duct and roof structural members, between interior finish panels and any metal primary or secondary structural members which are thermally grounded to the outside surface of the carbody skin and at any other location where it is necessary to interrupt an all-metal path between interior of the carbody and outside of the carbody skin.

4.15 Exterior Finish

Generally the stainless steel car exterior will not be painted, however some painting shall be required for aesthetic as well as branding purposes. Refer to the Customer exterior graphics requirements, as specified in Chapter 23 for details.

Painting of the car serves two primary purposes: 1) to protect the metal from corrosion and 2) to contribute to the overall aesthetic quality of the vehicle. Paint coatings should also assist in the overall maintenance of the vehicle by providing easy to clean surfaces. The vehicle must be fully and properly coated to achieve its service life with regular maintenance intervals.

Soon after fabrication, all carbon steel portions of the carbody shall be prepared for painting and immediately thereafter painted with the first coat of primer, utilizing the paint supplier's written procedures with trained technicians.

The surface preparation and graphics applications shall ensure that the car can operate at least eight years between major exterior finish repairs or replacement.

All exterior surface treatment plans and specifications shall be submitted to the Customer for review and approval.

4.15.1 Painting-Exterior

The carbody exterior shall be painted in accordance with the Customer instructions as specified in Chapter 18 and Chapter 23.

Care in painting application shall ensure freedom from runs, sags, orange peel and other unsightly paint deficiencies, utilizing the paint supplier's written procedures with trained technicians.

4.15.2 Post Painting

Allow the car to remain inside for a minimum of 8 hours unless outside temperatures are above 60°F, utilizing the paint suppliers written procedures with trained technicians.

4.16 Graphics and Labels

4.16.1 Exterior Graphics

All exterior graphics, lettering and signage, including vehicle numbers and reporting marks, shall be applied to the vehicle in accordance with Customer specifications as identified in Chapter 23.

4.16.2 Labels

Exterior equipment shall be labeled in accordance with Amtrak Specification 696.

4.17 Automatic Equipment Identification (AEI) Tags

Each car shall be equipped with an Automatic Equipment Identification (AEI) transponder tag on each side, located in conformance with Universal Machine Language Equipment Register (UMLER) dimensional and securement requirements and programmed with the reporting marks of the owner, road number of the vehicle and all other technical data required by UMLER.

The Contractor is responsible for ensuring the following:

- Tags are properly installed in accordance with UMLER requirements;
- Tags are properly programmed with all data required by UMLER; and
- The UMLER system is updated with the data for each vehicle as required for shipment.

4.18 Summary of Load Cases for Structural Design Requirements

The following load conditions must meet the requirements as stated in this Specification, as well as those identified in CFR and APTA:

- Fatigue
- Side structure load
- Floor load
- Roof load
- Jack pad loads
- Jacking loads
- Lifting loads
- Anchor rod loads
- Anchor rod bracket loads

Where there is a conflict between this Specification, Federal requirements and APTA standards the Federal requirements shall prevail, then the APTA standards and then this Specification.

4.19 Stress Analyses

No later than 270 days after NTP and prior to carbody and truck testing, the Contractor shall prepare and submit, for review and approval during design review, stress analyses of the carbody and truck structure and equipment supports for any element of equipment weighing over 150 lbs in accordance with APTA Standard SS-C&S-034-99, Section 7.0. Stress analyses for supports for safety related items weighing less than 150 lbs shall be included in the analysis. For non-safety related items, stress analysis may be requested for review at the discretion of the Customer.

The Contractor shall use the stress analysis as an engineering tool to aid in the design of the lightest weight car and truck in compliance with the requirements of the Specification. Structural tests shall be conducted in accordance with the requirements of Chapter 19 to confirm the accuracy of the analyses as required.

The approved stress analyses, including crashworthiness analysis, shall be a prerequisite for approval of the structural test procedures and structural drawings required by this Specification and shall be used as an aid in determining strain gauge locations during the tests.

The stress analyses shall indicate the calculated and allowable stresses and margins of safety for all elements, for all specified load conditions. The stress analyses shall, as a minimum, include Finite Element Analyses (FEA) using recognized computer programs, supplemented as necessary by manual or computer calculations of stresses at joints.

The initial stress analyses shall require assumptions as to configurations, weights, and the method of manufacture. All of which may require re-evaluation and change as the designs are developed. As changes are made to the original assumptions, the stress analyses shall be

revised and submitted for review. The final submitted and approved stress analyses shall be for the car and truck in the as-built configuration.

All stress analysis reports shall conform to the requirements specified herein.

The meanings described in the following section shall apply in performing the analyses.

Permanent Deformation — A member shall be considered as having developed permanent deformation if any one of the following conditions is met:

- The minimum yield strength as published by ASTM for the specified material and grade is exceeded. For materials or grades not covered by an ASTM standard, the minimum yield strength as guaranteed by the Manufacturer is exceeded. For materials without a specific yield point, the 0.2 percent offset method shall be used to determine yield strength.
- The material has buckled or deformed and does not return to its original shape or position after the load is released.

Ultimate Load Carrying Capacity — The ultimate load carrying capacity of a member is the maximum load that the member can support before it separates at its ultimate strength or completely fails as a column.

Margin of Safety (MS):

$$MS = (\text{Allowable Stress} / \text{Calculated Stress}) - 1$$

The calculated stress shall include the applicable load factors. MS shall be a minimum value but a positive number.

Load Factor — Load factor is a number by which the actual or specified load is multiplied in computing the calculated stress. The load factor shall include all applicable safety factors.

4.19.1 Stress Analyses and Test Plan

A Carbody and Truck Stress Analysis and Test Plan shall be submitted for approval no later than 120 days after NTP. The Plan shall address the requirements of Section 6.0 of APTA Standard SS-C&S-034-99, Rev. 2 regarding a CEM and Survivability Plan. It shall be discussed during the first design review meeting. The Plan shall be a working document and updated as the design develops. When the plan for the analyses and testing is revised, it shall be updated and resubmitted no more frequently than monthly. Each revision shall include revision level indications.

The Stress Analyses and Tests Plan shall include an outline of the procedure the car builder shall use to analyze and test the design of the carbody and truck. It shall also include the following:

- A listing of all load conditions to be used during analysis and test, including load magnitudes and points of application, with Specification references.
- A description of the analysis to be used for each load condition.
- Acceptance criteria for each load condition.

- Diagrams displaying loads applied externally to the carbody and truck and points of support for each load case for each analysis.
- Diagrams displaying loads applied externally to the carbody and truck and points of support for each load case for each test.
- A table of material properties showing the engineering properties of each grade and temper of each material used in the car and truck structures. This table shall include the material designation, yield strength, ultimate strength and elongation, Young's modulus for tension, compression, shear elastic moduli, and CEM material as required. For all material properties, an acceptable source for those properties shall be cited. In each case, minimum-guaranteed values from the specifications for the corresponding grade and heat treatment of the material shall be used. Materials, grades, and tempers not used in the carbody construction shall not be included in the tables. The table shall list the properties of the fasteners and the welds. For implicit and explicit (Large Deflection) non-linear load cases, input shall include modeling of non-linear material properties in accordance with the online help for the FEA code used or equivalent source. The non-linear material properties shall be derived from conservative values of basic mechanical material properties (Young's modulus, yield and ultimate stress strain) as appropriate to the model.
- A description of all the major assumptions used in the stress analyses.
- A description of how analyses results shall be correlated with test results.
- A list of all connections deemed "potentially critical," e.g. all corner and collision post connections, all connections of the end underframe to the carbody and the underframe.
- A list of all structural tests to be conducted on carbody and truck along with acceptance criteria.
- Diagrams displaying all boundary conditions including symmetry and asymmetry boundary conditions.
- An introduction page referencing all the related Stress Analysis documents to be submitted.

The Stress Analyses and Tests Plan shall be approved prior to submittal of the Stress Analysis Report required by this specification. The Plan shall be made a volume of the Stress Analysis Report. The Plan shall follow the general requirements of the report as identified herein.

4.19.2 Finite Element Model Report

The Contractor shall submit Preliminary and Final reports outlining the FEA work. Solid elements shall be used for major structural areas of the truck frame and bolster.

The element mesh, all assumptions, loads, boundary conditions summed totals of reactions forces and moments, area properties and material properties, and units used shall be included as part of the preliminary submittal and again as part of the complete report. A key to all symbols and colors shall be included. Boundary reaction forces of the carbody and truck at AWO shall be included. Each load condition submittal thereafter shall also include diagrams of areas of mesh refinement.

The FEM Report shall include a structural diagram (layout) of the carbody (including sheathing) and truck showing the locations of all members and shapes, and indicating the material and dimensions of each in accordance with APTA Standard SS-C&S-034-99, Rev. 2, Section 7.2. Methods of joining shall be completely defined. As a minimum, the following

views shall be included on the carbody structural sketch: side elevation, top view of the roof and the underframe, and typical cross-sections of the carbody at a window, side doors, and full-height side-frame posts. For the truck, the following views shall be included in the structural sketch: side elevation, top and bottom views and typical cross sections at key changes of geometry and weld types. Cross-sections of the structural members with shape, dimensions, material and thickness shall be shown.

The FEM Report shall include a list of drawings, with revision levels, used to develop the model. As drawings are revised, the model shall be updated to reflect the changes, or there shall be documentation to indicate that the drawing changes do not affect the FEA results to be included with the next FEM submittal.

4.19.3 Carbody and Truck Stress Analyses

The stress analysis shall show the calculated and allowable stresses and Margins of Safety for all elements, for all specified load conditions.

The stress analysis shall include calculations of stresses in joints, joint elements, and other important elements. It shall include FEA results, connection, buckling, natural frequency, and fatigue analyses.

In computing the shear strength of a beam, only that portion of the beam, which is in line with the force vector, shall be considered as resisting the force. If the force is skewed to the web of the beam, the force vector shall be divided into components, one in line with the web and the other in line with the flange. The shear resistance shall then be computed separately for each component. There shall be a table showing geometric properties, such as area and section moduli.

4.19.3.1 Finite Element Analysis

As part of the stress analysis, a linear-static finite element analysis (FEA) of the complete carbody and truck shall be performed. The FEA shall be a recognized computer program. The purpose of the carbody and truck FEA, along with other supporting analyses, calculations, shall be to show that the design meets the requirements of the Specification.

The submittal input and output shall have each page numbered and columns of data shall be clearly labeled on each page using terms, symbols, abbreviations, and units defined in the analysis report.

At the discretion of the Customer, Finite Element Models (FEM) and results shall be reviewed during the conferences conducted within three weeks after each submittal.

Color plots shall be prepared showing the following:

- Deflections in all three axes
- Von Mises or other approved combination stresses
- Maximum and minimum principal stresses
- Direction of maximum and minimum principal stresses
- Meshing accuracy index
- Maximum shear stress

All plots shall show the maximum and minimum values and all values which are greater than 80% of the specified maximum value. Each drawing or plot shall include a triad showing the direction of the global axes. Plots at high magnification shall be keyed to a plot showing the structure to an extent sufficient to orient the high-magnification plots.

The report shall include all reaction forces, summed totals of reaction forces and moments, and a table to show static equilibrium for each load case.

Upon completion and approval of the final design, the FE model and analysis report shall be updated to represent the final configuration of the structure.

4.19.3.2 Connections

The Report shall include analyses of all critical connections of major structural elements under all specified load conditions.

Critical connections which cannot be adequately analyzed shall be prototyped and tested to demonstrate compliance with the requirements of the design and the Specification.

The Report shall include analyses of all critical and highly loaded connections, showing that the joint is stronger than the weakest member being joined.

The FEA shall be supplemented as necessary by manual or computer calculations of stresses at joints.

4.19.3.3 Buckling

The inelastic buckling strength of structural members subjected to any combination of compression and shear shall be calculated. The variation in the stainless steel compression modulus with stress shall be considered in calculating compressive stability of stainless steel members.

The buckling values shall be used as the basis for the allowable stress values for the specified load cases. Any member in any of the elastic static analyses with a calculated compressive stress equal to, or greater than, 35% of its material's yield strength shall be included.

4.19.3.4 Natural Frequency

The natural frequency of the carbody under AW0 and AW3 load, and supported at the bolsters, shall be calculated. The natural frequency of the carbody under AW3 load, and rigidly supported at the bolsters, shall be no less than 2.5 times the natural frequency of the car's secondary suspension system.

4.19.3.5 Fatigue

An analysis of fatigue life of the car and truck shall be included in the stress analysis report as required herein and in Chapter 5. It shall include a tabulation of the Contractor's selection of allowable fatigue stresses, with data sources and assumed fatigue stress ranges, for structural members which are critical in fatigue.

The minimum allowable fatigue stress range for the carbody is computed by multiplying the static stress at the AW3 load by the dynamic factor. The dynamic factor shall be determined by the Contractor but shall not be less than $\pm 20\%$. The allowable fatigue stress range shall be based on a calculated car shell lifetime of 10 million cycles. This stress range must be within the design fatigue stress range obtained from one of the following sources as approved by the Customer:

- For carbon and low alloy steel members, the stress range shall be obtained from AWS Standard D1.1.
- For aluminum members, the stress range shall be obtained from Aluminum Association Aluminum Design Manual, *Specifications and Guidelines for Aluminum Structures*, 2000 Edition, Section 4.8.
- For spot welded structures, the Contractor shall conduct a sufficient number of fatigue tests to determine the fatigue properties of the welded structure. The Contractor shall consider the effect of multiple spot welds and different spot weld arrays when planning the test program.
- The Contractor shall conduct fatigue tests to determine allowable fatigue stresses for materials or joint designs not covered by the above requirements.

The fatigue stress range and acceptance criterion for the trucks is detailed in Chapter 5 and Chapter 19.

The fatigue analysis section of the stress analysis report shall include table(s) showing the minimum static and fatigue strengths of single and multiple spot welds. Values shall be given for each material, temper, weld size and thickness combination used in the carbody. The source of the data shall be provided.

4.19.3.6 Manual Analysis

A manual analysis may be conducted to closely examine details of the carbody and truck (weld connections, welded and/or bolted joints and fatigue conditions) that are not readily handled by the FEA in accordance with APTA Standard SS-C&S-034-99, Rev. 2, Section 7.3. Load cases that the Contractor prefers to analyze by manual methods shall be listed in the Carbody and Truck Stress Analyses and Tests Plan as required herein. The manual analysis format shall consist of a title, sketch of item to be analyzed with dimensions and applied forces, drawing reference, material properties, allowable stress, detailed stress analysis and conclusions.

The following are examples of stress calculations for which manual analysis may be used:

- An analysis of the critical connections of the major structural elements and the critical loading conditions
- An analysis of the strength of the connections of the trucks to the carbody including calculated vertical and horizontal connection load limits
- An analysis of the truck equalizer beams
- An analysis of the axles
- An analysis of the coil springs
- An analysis of primary and secondary suspension
- An analysis of equipment hangers

4.19.4 Validation of Stress Analyses

Validation of the FEM shall be accomplished by comparing the carbody and truck structural test results for each test required by Chapter 19 with the corresponding stress analysis results. This information shall be tabulated and submitted with the carbody and truck structural test reports for each test.

In the test procedure for each test to be used for validation, there shall be a pre-selected list of strain gauges to be used for the comparison, which shall not be less than half of the total number of strain gauges used during the test. This table shall include gauge number, element number, location, stress analysis strain value in the direction of the gauge, direction of gauge on carbody and truck, a column for the strain gauge value, and a column for notes.

The test report shall include tables that compare stresses calculated from the test strain gauge readings with analytical stresses from the FEA and shall include the test stress value, the analytical stress value, the percent difference between the two values, and a space for annotation. The report shall include a graph plotted in MS Excel comparing the stresses calculated from test strain gauge readings with analytical stresses from FEA.

The percent difference between the two values shall be within 20% for 75% of the compared values of the test results and analytical results.

If the analyses results do not agree with the test results within the above-specified tolerance, the Contractor shall revise the stress analyses, update the FEM, and re-run all FEA. All manual analyses using data from the FEA shall be recalculated using the corrected values. This process shall be repeated until agreement of results is within the specified tolerance. The stress analysis report shall be revised and re-submitted. All results from re-analysis shall meet specification requirements. The design shall be corrected if such requirements are not met.

For any of the remaining 25% of the compared values, if the analytical values disagree with the test value by more than 20% and the test value is equal to or greater than 35% of the yield strength of the material, a detailed explanation of the reasons for the excessive variance shall be included in the carbody and truck test report. This explanation may include supporting manual calculations.

Approval of the carbody and truck test report shall depend, in part, on the adequacy of the analyses of excessive variance between analytical and test stress values.

4.19.5 Stress Analysis Report

The Stress Analysis Report shall be prepared and submitted for review and approval not later than 60 calendar days prior to commencing manufacture of any carbody and truck structural parts. The Contractor shall submit the required Stress Analysis report in compliance with the format and content specified herein. If a cited reference is not readily available to the Customer, the Contractor shall provide the reference or copies of the pertinent pages. All references shall be in English. If an English reference cannot be found, an English translation shall be provided, and both the original and the translation shall be included in the report.

The report shall demonstrate that all structural members satisfy the requirements of this Specification on compliance with each design load and condition and of good practice in the rail transit industry. The report shall be organized and in sufficient detail so that the Customer can readily follow the theory and its application to the car. The Contractor shall

certify that the analysis and calculations have been reviewed and checked before the report is submitted to the Customer.

A summary of the results of calculations of stresses in all structural framing members and shear panels shall also be included. The locations where calculated stress levels equal or exceed 80% of the allowable stress criteria shall be shown in a separate table along with the design and operating conditions (loads) which precipitate them.

The report shall include detailed calculations of stresses with Margins of Safety (MS) in all structural framing members and sheathing. There shall be a summary table listing the Margin of Safety of all major members and any other member where the Margin of Safety is less than 0.20 together with the affected joints under all specified loads. The table shall include:

- The identity of the member
- Its location
- The load condition
- The Margin of Safety
- The page on which the analysis can be found
- The material of that member
- The allowable stress of the members.

In addition to the body of the analysis, the stress analysis report shall include, at a minimum, the following:

- A Table of Contents
- The algebraic statement of all formulas and equations before the related calculations are performed, along with the definitions of all terms and the values and units to be applied to these terms. In addition, the pages that show the development and interpretation of the formulas or data shall be included
- Units with all quantities
- References for all formulas, calculation procedures, buckle coefficients, material strengths, fatigue strengths and other physical and mechanical properties where these items appear in the stress analysis
- Each page, including all stress analysis sheets, shall be numbered, dated, and initialed by the author, or analyst and checker, and in the event of a revision, the revision letter, date and initials of the analyst and checker
- Particular reference to, but not limited to, the following:
 - Side sill
 - Body sills (if used)
 - End sill
 - Anti-climber
 - Draft sills
 - Coupler supports
 - Side frame rails
 - Side frame posts

- Transverse and longitudinal sections at doorways
- Body bolster
- Floor and floor beams
- Collision posts
- Corner posts
- Structural shelf
- Roof structure
- Equipment supports
- Connections between structural elements
- Truck frame
- Truck bolster
- Truck equalizer beam
- Axle
- Bolster anchor rod and bracket
- Pilot
- Truck and attachment.
- If tests are conducted to provide the necessary data, the entire test report shall be submitted. This report shall show the test procedure, raw data as well as reduced data, and summary, with detailed discussion of the results
- A table listing and defining all symbols and abbreviations used in any analysis shall be included
- A table providing the physical properties of each material (grade and temper) used for the carbody and truck. This table shall include yield strength, ultimate strength, elongation, and tension, compression, and shear moduli. Minimum-acceptable values shall be used and shall be selected from the ASTM (or equal) material specification
- A tabulation of the Contractor's selection of allowable fatigue stresses for the carbody and truck material and each type of weld joint and assumed applied fatigue stress ranges for members and weld joints which are either highly or critically loaded

4.20 Crash Energy Management (CEM) Design

The carbody shall be designed with Crash Energy Management (CEM) following the guidelines in APTA Standard SS-C&S-34-99, Section 6 Crash Energy Management (CEM). Scenario analysis as described in APTA Standard SS-C&S-034-99 shall not be required.

A CEM and Collision Survivability Plan shall be submitted to the Customer for review and approval in accordance with APTA Standard SS-C&S-034-99, Section 6.2. **CDRL**

4.20.1 Protected Operator Cab Space

In addition to APTA SS-C&S-034-99, the cab shall be designed with a protected operator cab space for the Engineer's and Assistant's cab control compartment.

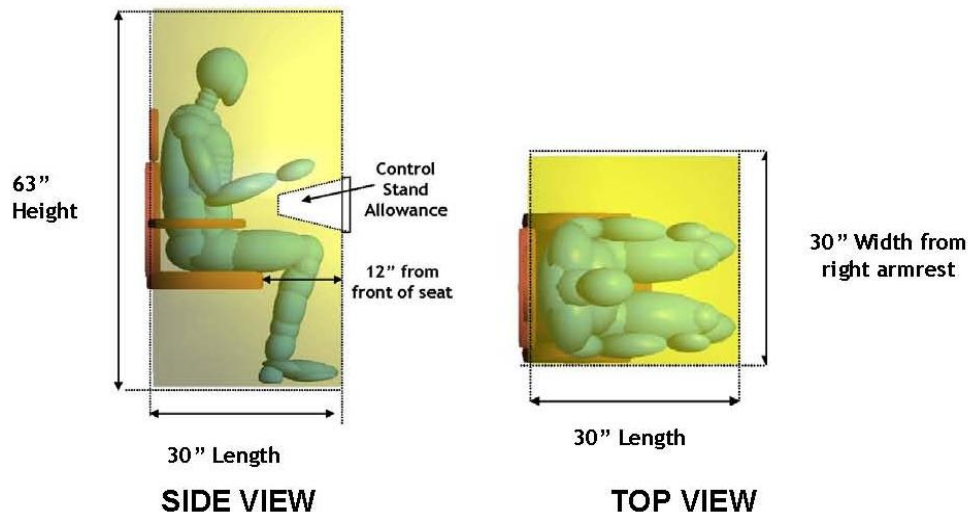


Figure 4-1: Operator Seat Clearance Zone

For the Cab Car Interaction Evaluation required by this Specification, at the point when the design energy absorption has been reached, each seat in the operator compartment shall have a survivable space where there is no intrusion, and there shall be a clear exit path for the cab occupants. The clear exit path shall be free of debris, obstructions, deformed panels or hazards, and the cab door shall function as an exit path without hindrance.

The protected operator cab space shall be maintained at a minimum of 30 in. in length, 30 in. in width, and 63 in. in height. The outboard plane of the protected operator cab space shall be 12 in. from the front surface of the operator seat adjusted to its median fore and aft position. The outboard side of the protected operator cab space shall be at the lateral extremity of the seat defined by the side arm rest adjacent to the side wall of the carbody. The cab console may extend into the protected operator cab space as necessary for satisfactory ergonomics, but shall remain upright and at the same distance from the mounting of the operator seat to the floor throughout crushing.

The deformation of the structure shall not cause any vehicle equipment or parts (e.g. console, window screens, etc.) to encroach into the designated survival spaces. The structure immediately outboard the Operator's survival space shall be designed in a manner that does not create sharp-edged fracture surfaces, crippled structural members with sharp bends and similar injurious features.

The front windscreen shall be supported by the structure of the Operator's cab in a manner that resists the windscreen as a whole, whether or not damaged, moving into the Operator's survival space. Operation of the cab end CEM system to exhaustion shall not result in any condition that interferes with ready egress from the cab. The seat attachment shall meet the requirement of APTA Standard SS-C&S-011-99.

4.20.2 Sequence of Operation of CEM Functions

The sequence of operation of the CEM functions shall be as follows for the condition of a cab car colliding with a locomotive. Approved equal functions and sequences will be considered subject to demonstration of satisfactory performance resulting from the application of the design, analysis, and testing requirements of this Specification.

- Coupling mechanisms of cab car and locomotive contact,
- Coupling mechanism initiates energy absorption,
- Structure(s) involved in principal load path engage,
- Crush elements initiate, and
- Crush zone operates to extent necessary to absorb required energy.

The sequence at coupled-car interfaces is the same except that the initial condition is with couplers mated.

The coupling mechanisms shall meet the requirements in Chapter 6.

4.20.3 Cab Car Interaction Evaluation

The cab end shall be analyzed to show that during a collision with the standard FRA collision-simulation locomotive, the geometry of which can be found on the Volpe website listed in Chapter 2. The ends of the vehicles shall engage and the sequence of operation of the CEM function as stated in Sequence of Operation of CEM Function (above), and all requirements within this Chapter shall be met, including the protected operator's space, energy absorption of the cab end and the acceptance criteria. (See Cab End Crush Zone, Non-cab Crush Zone, Analysis of Pass Volume Strength).

In addition, compliance with the requirements of this chapter at a coupled interface of a cab end with a non-cab end, and with another cab end shall be demonstrated by test and analysis as required by the Plan and this specification.

4.20.4 Cab End Crush Zone

Requirements for energy absorption at each cab end is as follows:

- Not less than 2,000,000 ft-lbf including coupling mechanism energy absorption
- Length of carbody deformed by crushing shall not exceed 24 in.
- For crush zone, best-fit straight line approximation of crush load vs. crush distance data has zero or positive slope
- Trigger, frangible, and fuse elements shall be designed to not interfere with operation of the crush zone

Contractor shall submit the force-crush characteristic curves for the actual car design to the Customer for review and approval.

4.20.5 Non-cab End Crush Zone

Requirements for energy absorption at each non-cab end is as follows:

- Not less than 1,500,000 ft-lbf, including coupling mechanism energy absorption
- Length of carbody deformed by crushing shall not exceed 24 in.
- For coupler and crush zone, best-fit straight line approximation of crush load vs. crush distance data has zero or positive slope
- Trigger, frangible, and fuse elements shall be designed to not interfere with operation of the crush zone

Contractor shall submit the force-crush characteristic curves for the actual car design to the Engineer for review and approval.

4.20.6 Analysis of Passenger Volume Strength

For the length carbody structure occupied by passengers, stresses shall not exceed yield under the action of loads applied by the crush zone to exhaustion.

Highly localized areas of stress exceeding yield ("hotspots") may be permitted provided:

- Plastic analysis of the model shows the affected areas to be small with plastic strain not exceeding 1%;
- With removal of the simulated load there is no permanent set in the overall dimension of the occupant volume; and
- The function of the structure is not compromised.

4.20.7 CEM System Validation, Analysis, and Testing

CEM system design validation shall be provided according to separate CEM System Tests Plan and CEM System Analyses Plan that shall be integrated into the Carbody and Truck Tests and Analyses Plan. The CEM System Tests Plan shall include as a minimum the tests included in Chapter 19 and the CEM System Test Matrix shown in Chapter 19. The CEM System Analyses Plan shall include as a minimum the analyses included in Chapter 19.

Validation of the analysis models shall be by testing of crush elements and fuse elements. The validated models of these elements shall be assembled into a model of the crush zone on the end of the car. The assembled model shall be used to perform a full 3D explicit analysis of the car (flat wall for coaches, into a locomotive for cabs) to prove compliance with this specification.

Full scale whole car testing will not be required. Also, elements previously validated may be used as-is without re-test.

* End of Chapter 4 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 5

Trucks

Table of Contents

5.0	Trucks	5-2
5.1	Overview	5-2
5.2	General Requirements.....	5-2
5.3	Ride Quality and Performance	5-3
5.4	Truck Design	5-3
5.4.1	Truck Frame and Bolster.....	5-3
5.4.2	Bolster Anchor	5-4
5.4.3	Suspension	5-4
5.4.4	Stops.....	5-5
5.4.5	Hand Brake Linkage.....	5-5
5.4.6	Adjustments	5-6
5.5	Wheel and Axle Assembly.....	5-6
5.5.1	Axles	5-6
5.5.2	Wheels	5-6
5.5.3	Brake Discs.....	5-6
5.5.4	Journal Bearings.....	5-6
5.5.5	Journal Bearing Housings	5-6
5.6	Shock Absorbers and Shock Mounts	5-7
5.7	Electrical Wiring.....	5-7
5.7.1	Speed Sensor.....	5-7
5.7.2	Grounding.....	5-7
5.8	Painting	5-7

5.0 Trucks

5.1 Overview

Each car shall be equipped with two four-wheel trucks. Trucks shall be designed for operation at all speeds up to 125 mph. Truck frames may be either cast or fabricated. The trucks shall incorporate braking via tread and disc brakes. Truck design shall be proven for safe and reliable operation on all FRA Classes of track up to and including Class 7.

5.2 General Requirements

The truck assembly shall be a four wheel, roller bearing truck designed for operations specified in Chapter 1 (Track Geometry). A comfortable ride shall be provided at all permissible speeds under normal operating conditions. Truck designs must have a proven service history in North American intercity or commuter rail service, or must be demonstrated as being compliant with all Specification requirements through finite element analysis, truck dynamic behavior through computer simulation (validated as defined by the Customer) and instrumented testing at an approved test track facility. The truck dynamic characteristics shall be suitable for a bi-level car and must demonstrate appropriate response for all speeds, curves, spirals, switches and turnouts, and for all typical track perturbations found within defined safety limits of FRA track geometry standards and as described in this Specification. The truck design must meet this level of suitable performance for up to 5 inches of cant deficiency. Overall curving performance shall be demonstrated to be at least as good as the existing *Surfliner* type rail car at maximum design speeds over a range of curvatures.

Truck wheelbase shall be 8 ft 6 in. Truck centers shall be spaced 59 ft 6 in. apart, equal distance from the car's lateral center line. Trucks shall be designed to operate under the environmental and operating conditions identified in Amtrak Specification 963, including track configurations. All truck-mounted equipment shall conform to the clearance requirements of Amtrak Bi-level Standard Clearance Drawing B-066-00050, Rev. A. Trucks shall be interchangeable from one end of the car to the other, and all trucks and bolsters shall be directly interchangeable between all car types addressed in this Specification.

The truck shall be equipped with the brake equipment specified in Chapter 7. The disc brake arrangement shall be inboard mounted. Brake equipment shall provide braking rates as identified in Chapter 7.

The truck shall be locked to the carbody with a safety mechanism consistent with 49CFR Part 238 requirements.

Provisions shall be made for use of a wheel truing machine, for reprofiling wheels while mounted on a car; without requiring any degree of truck disassembly. Access to the ends of the axle, for wheel truing, shall be available without the removal of any additional parts, including roller bearing end caps (with the exception of cover plates, plugs or axle tachometer generators.)

All truck assembly parts shall be designed to withstand maximum stresses as called out in APTA Recommended Practice RP-M-009-98. See Chapter 19 for stress analysis requirements.

Truck components shall be designed to have sufficient clearance but no less than 1.0 in. to prevent unintended contact of truck-to-truck or truck-to-carbody components under all loading and track conditions including worn wheels and failed springs.

5.3 Ride Quality and Performance

Ride quality for all proposed truck designs shall be demonstrated analytically and through actual track testing (at an approved test facility) per the requirements of Chapter 19. Truck designs with proven service history on North American intercity or commuter railroads may be validated analytically, if the validation methodology is approved by the Customer. Some or all portions of the required design validation tests may be waived at the sole discretion of the Customer if design adequacy can be proven by submittal of existing engineering analysis and demonstration of successful service history of the truck design.

A comfortable ride shall be provided at all permissible operating speeds for each FRA track class, up to the vehicle rated speed. A comfortable ride is defined as weighted root mean square (rms) acceleration less than 0.032g and a crest factor less than 9. Weighted rms acceleration and crest factors shall be calculated according to ISO 2631.

5.4 Truck Design

5.4.1 Truck Frame and Bolster

Truck frame and truck bolster shall be of cast or fabricated steel construction. They shall be heat stress-relieved after all primary welding is completed. Critical areas of all welds and castings shall be magnetic-particle inspected per ASTM E709-01, radio-graphically inspected per ASTM E94-04 or ultrasonically inspected per AWS D.1.1.

Rotational range of motion shall be limited by stop blocks with replaceable wear surfaces mounted to the center sill. The truck shall not contact any other part of the carbody or suspension throughout its range of motion.

All wearing parts or surfaces shall be provided with renewable liners or bushings. Truck frame pedestals, if used, shall be lined with low-friction polycarbonate components to minimize wear. Truck design shall permit replacement of pedestal liners without requiring the removal of the wheelset.

This truck design shall provide sufficient restraints to prevent hunting of the truck at all speeds up to 125 mph, with worn wheels and other components at their condemning wear limits, in accordance with 49CFR Section 213.333, 49CFR Section 238.227 and APTA Recommended Practice RP-M-009-98.

The design of the trucks shall be analyzed and validated in conformance with the requirements stated in Chapter 19, to verify that the truck design meets all safety, ride quality, durability and maintainability requirements.

A centering bearing or pivot shall be located between the truck bolster and the truck frame at its center.

5.4.2 Bolster Anchor

Longitudinal forces shall be transmitted between the truck and the carbody through bolster anchors. The bolster anchors shall be designed to accommodate longitudinal, swiveling and vertical forces encountered during operation on all classes and conditions of track identified in Amtrak Specification 963. See Chapter 4 for other requirements for the bolster anchor and related mounting points.

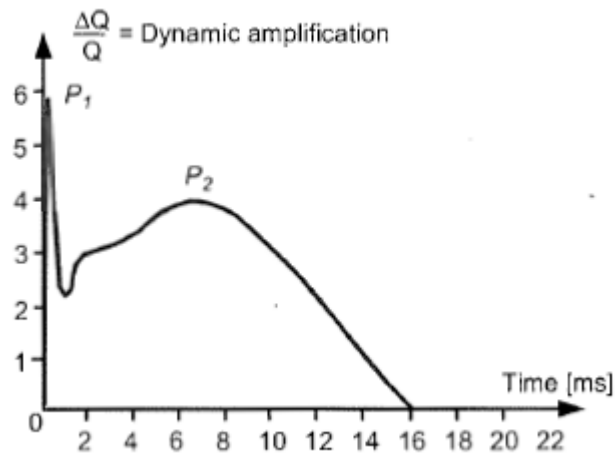
5.4.3 Suspension

Primary and secondary suspension arrangements must be of proven arrangement for application on a bi-level car.

Primary suspension shall be designed for a minimum functional service life of eight years. Deflections in primary suspension due to asymmetric forces from tread brakes shall not result in an unacceptable level of influence on wheelset angle of attack. The car body secondary suspension shall be provided by coil springs located at each end of the bolster.

At the Customer's request, air springs or other alternative secondary suspension arrangements may be proposed in lieu of steel coil springs. Alternative arrangements must meet all criteria set for this Specification for acceptance. Lateral and vertical motion of the bolster shall be damped by hydraulic shock absorbers and/or air orifices (if air suspension is used). Longitudinal and swiveling motion of the bolster shall be prevented by bolster anchors between the carbody and bolster.

Vertical P_2 forces shall not exceed 68,000 lbs with a 1° dip angle using the Esveld equation.



Esveld Equation:

$$P_2 = P_0 + 2\alpha v \sqrt{\frac{m_u}{m_u + m_{T2}}} \left[1 - \frac{c_T \pi}{\sqrt{k_{T2}(m_u + m_{T2})}} \right] \sqrt{k_{T2} m_u}$$

The parameters in the P_2 force calculation are:

- P_0 is the nominal static vertical wheel load (pounds)
- 2α is the total dip angle at a joint, weld dip or other rail discontinuity (radians)
- v is the speed (inches/sec)
- m_u is the unsprung mass of the wheelset (pounds-sec²/inch)
- m_{T2} is the equivalent track mass (pounds-sec²/inch)
- C_T is the equivalent track damping (pounds-sec/inch)
- K_{T2} is the vertical track stiffness (pounds/inch)

The assumed values of selected parameters are:

- $2\alpha = 0.017$ rad, (1 degree) with half of this (α) on either side of the dip.
- $m_{T2} = 1.1335$ pounds-sec²/inch, for nominally stiff concrete tie track
- $C_T = 671$ pounds-sec/inch, from literature for nominal track conditions
- $K_{T2} = 330,000$ pounds/inch, for nominally stiff concrete tie track which corresponds to a track modulus of 4000 pounds/in/in (assuming a track deflection of 0.10 inches under a wheel load of 33,000 pounds)

A safe ride shall be provided in the event of a broken spring, inoperative damper or collapsed or over-inflated air spring (if used).

A minimum of 0.75 in. of vertical free travel shall be provided for the range of normal load conditions. Free travel is defined as the change in vertical displacement between the axle center and a carbody reference point as measured under static load conditions with an empty car (AWO) and a fully loaded car (AW3). Sound and vibration deadening inserts shall be provided for all spring seats.

Springs and chevrons, if used, shall be designed for ease of replacement and maintenance. Chevrons shall be secured to the truck frame when axle assemblies are removed. Chevrons shall be color-coded for spring rate and shall be installed in matching pairs on each axle assembly of the truck.

Coil springs, if used, shall be thoroughly shot-peened after grinding and then coated in accordance with a Customer-approved paint type.

Unless otherwise noted, all coil springs shall meet the latest revision of AAR Standard M-114.

5.4.4 Stops

Rubber stops limiting vertical and lateral motion shall be designed with a progressive compression rate and shall not exceed 90% of their design compression under any condition that can be developed in the truck. Lateral stops shall limit the motion of the car body to 1.5 in. in either direction. Stops that limit truck over-rotation shall be equipped with a replaceable liner to prevent metal-to-metal contact.

5.4.5 Hand Brake Linkage

Truck-mounted hand brake linkage shall be provided on the B-end truck per the hand brake requirements contained in Chapter 7. All trucks shall be equipped with necessary attachment points for hand brake linkage as specified in Chapter 7.

5.4.6 Adjustments

Provisions shall be made for adjusting the carbody height up to 0.75 in. in either direction from nominal (1.5 in. total adjustment range), in increments of 0.25 in., to compensate for wheel wear or other variations. Suspension design shall permit adjustments to be made without disconnecting the truck from the carbody. Air spring leveling valve adjustment shall not be used for adjusting carbody height.

5.5 Wheel and Axle Assembly

The wheel and axle assembly shall consist of an axle, two wheels, two outboard journal bearings, two inboard brake discs, 104-tooth speed sensor gear at each journal and associated materials. This wheel and axle assembly shall be fully interchangeable in form, fit and function with Amtrak standard wheel assembly for bi-level cars. Mounting graphs and inspection records shall be included in each vehicle history book for all components.

5.5.1 Axles

The axle shall be of solid, forged, Grade "F", carbon steel furnished to AAR Standard M-101. It shall have dimensions as specified for a Class F axle according to APTA Recommended Practice RP-M-001-98 and Amtrak Drawing D-08-2269 for a four wheel (per truck) configuration.

5.5.2 Wheels

The wheels shall be 36 in. diameter (nominal) Class B, multiple-wear type, conforming to AAR Standard M-107-84 and APTA Standard SS-M-012-99, and shall have a 1 in 40 tapered tread.

5.5.3 Brake Discs

Brake discs shall be of self-ventilated "mono-block" construction, 28 in. diameter as specified in Chapter 7.

5.5.4 Journal Bearings

The journal bearings shall be fully enclosed, grease lubricated, Timken Type "G" roller bearings configured for No Field Lubrication (NFL), AAR Class "G" 6.5 in. by 12 in., with HDL seals (or equivalent). The service life of the journal bearing shall be at least 1 million miles under AW3 loading.

5.5.5 Journal Bearing Housings

Removable journal bearing housings (journal boxes) shall be provided. Pressing shall not be required to remove the journal box from the bearing. Journal boxes shall be common for all locations, or may be common for all right-hand sides and left-hand sides, respectively.

Each journal box shall be drilled and tapped in four locations, two locations to the left and two to the right of top-dead-center, to accommodate up to two speed sensors, and a hot bearing detector, per Amtrak Drawing D-00-7075.

5.6 Shock Absorbers and Shock Mounts

Lateral and vertical motion of the trucks and suspension shall be damped through the use of shock absorbers and/or air orifices (if air suspension is used). Shock absorbers, if used, shall be of a hydraulic type terminating in elastomeric bushed connections to eliminate metal to metal contact. All shock absorbers shall be accessible for replacement without requiring the removal of the trucks from the carbody.

Shock mounting brackets on the trucks and carbody shall be designed to last the life of the carbody without wearing, deforming, loosening or otherwise requiring repair.

Durability of the shock absorbers, shock mounting brackets and bushings shall be demonstrated analytically and through accelerated life cycle testing simulating actual shock absorber functional service life. Test plan for the shock absorbers and shock mounts shall be submitted to the Customer for approval as part of the Contractor's proof of design testing (see Chapter 19).

The shock absorbers shall be appropriately rated for a service life of no less than five years.

5.7 Electrical Wiring

5.7.1 Speed Sensor

A speed sensor cable shall be provided on each truck to provide a signal from the 104-tooth gear located on each axle to the wheelslip control system (see Chapter 7). The speed sensor cables shall be attached to the truck frame using coated steel clamps that provide secure attachment while not abrading or pinching the cable. Each clamp shall secure no more than one cable. Clamps shall be securely fastened to the truck frame. Appropriate slack shall be incorporated into the cable length to allow free movement of trucks and truck components while providing adequate securement for the cable. Cables shall be routed to prevent damage from pinching, stretching or catching on adjacent equipment.

5.7.2 Grounding

An electrical ground path using highly flexible cables or straps shall be provided from each journal bearing to the car body. Grounding paths shall be run from each journal box to the truck frame, from the truck frame to the truck bolster and from the truck bolster to the car body. Grounding cables or straps shall not restrict the movement of truck components, and shall remain slack under all operating conditions.

5.8 Painting

The truck manufacturer shall apply at least one coat of a metal primer on all exposed surfaces of the trucks immediately after final assembly cleaning, repairs, and inspection.

Final coat of paint will be applied in accordance with exterior graphics requirements in Chapter 23.

* End of Chapter 5 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 6

Couplers and Draft Gear

Table of Contents

6.0	Couplers and Draft Gear.....	6-2
6.1	Overview	6-2
6.2	General Requirements.....	6-2
6.3	Performance Requirements	6-2
6.4	Coupler, Yoke and Radial Connector	6-3
6.5	Draft Gear.....	6-3
6.6	Coupler Carrier	6-3
6.7	Uncoupling Mechanism.....	6-3
6.8	Mounting Arrangement	6-3
6.9	Crash Energy Management	6-4

6.0 Couplers and Draft Gear

6.1 Overview

Each car shall be equipped on both ends with an energy absorbing coupler with associated draft gear, coupler carrier, uncoupling mechanism and centering device. The couplers shall be designed to be physically compatible with, couple to, and operate with standard Type H Tightlock couplers and components conforming to MCSCM drawings and APTA standards. The coupler head and knuckle shall conform to the Type H Tightlock pattern as per corresponding MCSCM drawings and specifications. The coupler and draft gear assembly shall be compliant with the requirements of APTA Recommended Practice RP-M-003-98. Push back couplers with energy absorption shall be used as a component of an integrated crash energy management system.

6.2 General Requirements

Couplers, draft gear and associated components shall conform to the strength requirements specified in all applicable APTA and AAR standards and recommended practices. Coupler carriers shall be capable of withstanding the vertical forces identified in 49CFR Section 238.207. All components shall be designed to operate properly under the operational and environmental conditions defined in Amtrak specification 963. It shall be possible to remove or install a coupler and draft gear assembly without requiring lifting of the carbody or removal of the truck.

6.3 Performance Requirements

Couplers and associated apparatus shall be designed to meet buff and draft strength requirements as specified by AAR. The strength of the knuckle and head shall be equal to or greater than the strength of an MCSCM/APTA Type H tightlock knuckle and head. Under normal operating conditions, couplers and associated apparatus, including coupler carrier, shall be capable of withstanding for any horizontal position of the coupler, a vertical load of 100,000 lbs applied in either direction to the coupler as near to the pulling face as practical without deformation to coupler carrier, supporting car body structure and intervening connections.

Each car shall be capable of operating satisfactorily while coupled to any other car or locomotive used in passenger service under the operational and environmental conditions defined in Amtrak specification 963. Coupler swing shall be such that a car shall be able to negotiate a 250-foot radius (23 degree) curve while coupled to other cars and/or locomotives as specified without damage to trucks, draft gear, carbody, diaphragms, air hoses or car-to-car connections.

The centering mechanism shall maintain the coupler on the vehicle center line when in the uncoupled condition.

Car-to-car and coupler-to-carbody air connections shall be designed in conformance with APTA Recommended Practice RP-M-001-97. See Chapter 7 for details regarding car-to-car air connections.

6.4 Coupler, Yoke and Radial Connector

Couplers shall use Type H –MCSCM/APTA standard Tightlock heads & knuckles. Material for couplers and yokes must be AAR Standard M-201 grade C or E high tensile steel. Couplers shall comply with the requirements of APTA Recommended Practice RP-M-003-98.

6.5 Draft Gear

Draft gear elements shall consist of twin-cushion WM-6-DP draft gear packs with standard 24.625 in. pockets.

6.6 Coupler Carrier

The coupler carrier shall be designed to adequately and consistently support the coupler through its full range of vertical and horizontal movement, and shall maintain the coupler at a nominal 34.5 in. Above Top of Rail (ATOR) height (as measured at the center of the coupler) when uncoupled. The coupler carrier shall be designed to accommodate the complete push-back motion of the coupler without interference with the energy absorption function. During coupler pushback, contact between the coupler head and the coupler carrier will not result in unintentional activation of the coupler uncoupling mechanism and therefore cause car separation.

A means shall be provided to allow removal and replacement of wear plates, carrier springs and carrier stops. The top surface of the coupler carrier shall be equipped with a replaceable nylon (or other low friction material) wear plate - the coupler shall not rest on a metal surface.

The coupler carrier shall provide for adjustment of coupler height of 1 in. in either vertical direction from the nominal 34.5 in. ATOR coupler height standard. The coupler carrier shall comply with the vertical force requirements specified in 49CFR Sections 238.205 and 238.207.

6.7 Uncoupling Mechanism

All uncoupling levers and hardware shall meet the safety requirements of 49CFR Part 238. An uncoupling mechanism shall be installed at each end of each car, in conformance with section 5.10 of APTA Standard SS-M-016-06. Minimum clearance of 2 in. shall be maintained between uncoupling mechanism and all other components on the end of the car (including jumper cables, receptacles and carbody structural elements such as collision posts) when car is either coupled or uncoupled. The uncoupling levers shall seat firmly when locked in place and will not rattle or vibrate.

The uncoupling mechanism shall be designed to accommodate the complete push-back motion of the coupler without unintentional activation of the coupler lock mechanism and therefore car separation.

6.8 Mounting Arrangement

The proposed mounting arrangement of the coupler assemblies (cab and non-cab ends) will be submitted for customer approval during design review.

6.9 Crash Energy Management

Both ends of all cars shall be equipped with push-back, energy absorbing coupler assemblies. A higher capacity coupler shall be provided on the cab-end of the cab car.

The push-back energy absorbing coupler assemblies shall meet the requirements shown in Table 6-1, Push-Back, Energy Absorbing Coupler Requirements.

Table 6-1: Push-Back, Energy Absorbing Coupler Requirements

Application	Minimum Initiation Load, Pounds	Minimum Energy Absorption, Ft-lbs	Minimum Push-Back Stroke, Inches
All, except cab-end of Cab Car	600,000	200,000 @ 4 in.	9
Cab-end of Cab Car	600,000	700,000 @ 14 in.	20

The slope of the force during push back shall be greater than or equal to zero.

The coupling system must be capable of transferring a 150,000 pounds draft load at any time during the push back sequence to ensure that cars remain coupled during and after an impact.

Indicators shall be provided that shall be visible from outside the car to indicate full or partial activation of the energy absorption unit and the need for its replacement. The activation of the energy absorption unit shall be readily apparent when performing periodic inspections.

* End of Chapter 6 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 7

Brakes

Table of Contents

7.0	Brakes	7-2
7.1	Overview	7-2
7.2	General Requirements	7-2
7.3	Performance	7-2
7.4	Design Review	7-3
7.5	Car Body Components	7-4
7.5.1	Piping and Fittings	7-4
7.5.2	Angle and Cut-out Cocks	7-5
7.5.3	Hoses and Couplings	7-5
7.5.4	Emergency (Conductor) Brake, Application and Vent Valves	7-5
7.5.5	Air Reservoirs	7-6
7.5.6	Control Manifold and Valves	7-6
7.5.7	P-2-A Application Valve	7-7
7.5.8	Auxiliary Air Equipment	7-7
7.6	Truck Components	7-7
7.6.1	Disc Brake Actuator	7-7
7.6.2	Brake Discs	7-8
7.6.3	Tread Brake Units	7-8
7.7	Wheelslide Control System	7-9
7.7.1	Control Unit	7-9
7.7.2	Dump Valves	7-11
7.7.3	Speed Sensors and Wiring	7-12
7.8	Brake Indication Devices	7-12
7.8.1	Pneumatic Indicators	7-12
7.8.2	Pressure Switches and Brake Status Lights	7-12
7.9	Handbrake	7-13
7.9.1	Handbrake or Spring Brake Units	7-13
7.9.2	Handbrake Linkage	7-13

7.0 Brakes

7.1 Overview

This chapter describes the design and functionality of the pneumatic and mechanical braking systems that shall be provided on each passenger rail car. The braking systems shall include a conventional pneumatic system for service and emergency brake applications for all cars in the train, control equipment to be installed on the cab/baggage car to provide braking control for the train brakes and a pneumatic parking brake for the cab/baggage car, a wheel slide control system and a mechanical hand brake.

7.2 General Requirements

A conventional pneumatic brake system shall be provided on all cars unless specified otherwise by the Customer.

All air brake equipment shall be completely compatible with 26C/26L air brake equipment, currently in use in intercity rail passenger service. The air brake system shall be capable of running in conventional service in graduated release or direct release mode.

Nominal air pressures in the air brake system shall be:

Main Reservoir:	140 psig
Brake Pipe:	110 psig
Brake Cylinder:	100 psig maximum

All cars shall be equipped with provision for an electrically controlled pneumatic (ECP) brake system. This provision shall consist of a discrete conduit and wiring per AAR Standard S-4200, and particularly AAR Standard S-4210, for redundant implementation of ECP cable-based system in this Specification. The installation shall include a terminal box at each end of the car (for installation of the inter-car jumper cables), a terminal box at the brake manifold, conduit connecting them, as well as, armored cable wiring. The Contractor shall provide appropriate clearance on brake manifolds and adjacent structure to permit installation, servicing and removal of ECP modules. The Contractor shall provide a wiring diagram showing connections of brake controls with the two car end junction boxes to implement ECP braking.

7.3 Performance

The system shall be designed for operation at all speeds up to 125 mph in train consists of up to 24 cars with any combination of intercity rail passenger locomotives and bi-level cars as specified.

The air brake system shall be designed for operation and maintenance in conformance with all applicable Amtrak air brake rules.

Braking performance shall be in conformance with the braking performance curve as identified in Amtrak Standard S-603.

A train consisting of five bi-level cars built to this specification (in any combination of car types) and one F59 locomotive (or equivalent) shall have a minimum full service braking rate of 1.35 miles per hour per second (mphps) at 125 mph increasing to and maintaining an average of 2.00 mphps at speeds of 70 mph or less. The instantaneous full service deceleration rate shall not exceed 2.75 mphps nor be less than 1.25 mphps. The emergency brake rate shall not be less than 2.50 mphps at speeds below 70 mph. The cars shall be loaded to AW2 condition. The Contractor shall verify that the brakes are fully functional under all operating and environmental conditions found in Amtrak Specification 963. Locomotive dynamic braking shall not be used to determine compliance with specified brake rates.

The maximum jerk rate (the change in the rate of deceleration) during initial service brake application shall be limited to 1.5 miles per hour per second per second (mphpsps) under all normal conditions. There shall be no jerk limit for emergency brake applications.

The Contractor shall determine the brake system delay/dead time, build-up time, response time and equivalent deceleration rates for all speeds from maximum speed to full stop. This information shall be provided to the Customer during the brake system design review. The Contractor shall use *Mass Transit Brake System- Performance Requirements* per DIN EN Standard 13452-1 as the method to measure dead time response time and deceleration rate where applicable.

7.4 Design Review

Preliminary design review shall address the following subjects, describing operator actions and indications and also providing detailed technical design and performance analysis for the following subjects:

Concept:

- Concept and operation of friction brake system
- Thermal capacity of brake system
- Calculations showing that the system's performance requirements will be met
- Graduated release setting of control valve
- Direct release setting of control valve
- Graduated release mode of automatic brake valve operation
- Direct release mode of automatic brake valve operation
- Lead/trail (cut-in/cut-out of automatic brake valve)
- Feed valve setting
- Safety control interface [cab signal, overspeed, alerter, Positive Train Control (PTC)]
- Foretell pending restriction – positive and accurate interlock with suppression
- Penalty application
- Recovery from penalty
- Compliance with Amtrak daily and periodic test requirements

- Power knockdown: brakes and traction
- Penalty
- Emergency
- Wheel slide control
- Parking brake interface with brake system, both before and after parking brake application/release, penalty application and automatic brake application

Operating:

- Push-pull operation with locomotive in either leading or trailing position
- Stopping on a grade
- Starting on a grade
- Penalty brake application
- Engineer-initiated emergency brake application
- Conductor- or passenger-initiated emergency brake application
- Train separation (break-in-two)
- Operation of short trains (three cars or less)
- Operation of long trains [six to 24 cars including the locomotive(s)]
- Dead engine movement (with and without Main Reservoir (MR) to cab car)

Design and performance analysis will be evaluated during design review, First Article Inspection (FAI) and proof of design testing.

7.5 Car Body Components

7.5.1 Piping and Fittings

The inside diameter of the trainline MR pipe shall be 1.00 in. Iron Pipe Size (IPS). The Brake Pipe (BP) shall be 1.25 in. IPS. All pipes and fittings in both lines shall be extra-heavy steel pipe in accordance with ASTM Standard A-53.

Brake pipe trainline must pass AAR Standard S-471.

Piping practices shall conform to AAR Standard S-400.

AAR type branch pipe tees shall be provided and shall be orientated at a 45 degree slope upwards or higher to prevent moisture from being drawn into the branch pipes. The trainline MR branch pipe shall be routed to the main reservoir tanks before being routed to the brake manifold. As much as possible, piping shall be routed to avoid traps and avoid draining moisture toward brake valves.

Unless the main reservoir pipe is not routed below the lower level of the car, the low point of the MR pipe shall be equipped with a heated drain valve, to rid the pipe of moisture buildup; moisture drain shall be in response to either brake release cycle or timed cycle. The air supply system shall conform to APTA Standard SS-M-011-99 for compressed air quality for passenger locomotive and car equipment.

7.5.2 Angle and Cut-out Cocks

Locking, ball type, cut-out cocks shall be provided in the MR Pipe and the BP at each end of the car. The MR pipe cutout cock shall be vented toward the hose end, oriented below horizontal.

A locking vented ball-type cut-out cock shall be provided in the brake cylinder line to each truck for venting brake cylinder pressure. The cutout cock shall be a 3-way type, vented down stream. The vent port of the cut-out cock shall be tapped for 0.25 in. National Pipe Thread (NPT).

All cut-out cock handles, except end of car BP angle cocks, shall be arranged so that the handles are parallel to the air pipe in the closed position. Closed "end of car" BP cut-out angle cock handle shall be perpendicular to the air pipe.

All valves and cocks shall be identified including the cut-in and cut-out positions. A "flow bar" cast or stamped into cock handles shall be acceptable for cut-in/cut-out position labeling. All air brake angle cocks and cutout cocks are to be clearly labeled using engraved and color-coded stainless steel, aluminum or plastic tags.

7.5.3 Hoses and Couplings

All connecting hoses, except BP trainline hoses, shall be AAR Standard M-618 double wire braid reinforced hose. Brake Pipe trainline hoses shall be AAR Standard M-601 braided hose. All hose material, when installed on the car, shall be less than one year old from date of manufacture. Trainline hose connections shall be in accordance with APTA Standard SS-M-001. MR and BP hoses shall be supported near the glad hand end from the coupler using rubber suspenders. Trainline hose locations shall be in conformance with APTA Recommended Practice RP-M-001-97.

Two dummy couplings, one "F" type and one "E&L" non-insert vented type, shall be provided at each end of the car. The dummy coupling shall be secured to the car with chains in a manner which will prevent the trainline hoses at the ends of the car from dragging when the couplings are connected to the hoses.

7.5.4 Emergency (Conductor) Brake, Application and Vent Valves

Manually operated conductor's valves, Wabtec B-3-B emergency brake valve p/n 88566 shall be provided as follows:

- On both ends of the car in the upper level, just inside the body end door, right side of the door facing outward (except the F-end of cab/baggage cars).
- On the upper level F-end of the cab/baggage car, on the passenger side of the bulkhead separating the cab from the passenger area, to the right of the door when facing the cab area.
- In the lower level B-end side entrance vestibule, on the electric locker wall.

These emergency brake valves, when used in conjunction with a Wabtec E-3 brake valve p/n 505405 shall cause an emergency brake application when activated.

The valves shall be located in a conspicuous location for ease of operation. The operating handles shall be red and shall be clearly labeled, in accordance with Amtrak Specification 697.

A Wabtec emergency brake valve p/n 535026 shall be located in the cab on the Assistant's console.

Vent valves shall be provided along the BP in accordance with air brake system design requirements.

Ready access shall be provided to all valves to facilitate inspection, replacement and maintenance.

The valves shall meet the requirements of APTA Standard SS-M-007-98.

7.5.5 Air Reservoirs

Reservoirs of sufficient capacity for a minimum of three full-service brake applications without recharging shall be provided. ASME-certified main and auxiliary (brake cylinder) supply reservoirs shall be drilled as described in FRA 49CFR Part 229 to eliminate the need for hammer and hydro-static testing. When installed, they shall be sloped toward one end, where a manual purge valve with locking handle shall be provided to drain accumulated moisture. Main reservoirs and air supply reservoirs used for water raising shall be coated internally with a suitable paint to prevent corrosion. All reservoirs shall comply with the ASME Boiler and Pressure Vessel Code as applicable.

7.5.6 Control Manifold and Valves

The control valve shall be a Wabco 26C service portion and pipe bracket (Wabtec p/n 587904). Control valves shall use stainless steel springs and spool valves where appropriate. The control valve shall include the control reservoir charging cable.

The air brake control valve and cab control manifolds shall be located inside the carbody, above the level of brake pipe. Branches will leave the brake pipe at a 45-degree slope upwards or higher, and shall utilize an AAR "branch pipe tee". The Air Brake Control Valve manifold shall include test fittings for main reservoir, brake pipe, brake cylinder and #16 air pipes. In addition, the relay valve exhaust and #10 air pipe exhaust shall have a threaded exhaust outlet to permit mounting a gauge.

Full-face gaskets or o-ring gaskets shall be used for valve portion interface sealing. All stud mounted components shall be designed to allow installation or removal with standard socket wrenches.

Electronic modules, pneumatic modules, cutouts, test points and electrical connections shall be front-plate mounted on the manifold. Front-plate mounting is not required if the manifold is oriented so that access is provided to both sides. All power, input and output connections, external to the manifold, shall be provided with multiple pin connectors or a screw-type terminal block. Individual spade-type or threaded connectors are not permitted. Ring terminals shall be used if connected to a screw-type terminal block.

All valves on the manifold, as well as the manifold itself, shall be easily removable for servicing. All valves shall be individually replaceable with the manifold installed on the car without removing any additional valves or components.

Valves shall be acoustically isolated from the car interior areas to minimize exposure of passengers and crew to noise generated by the air brake components. Exhausted air shall be piped to the underside of the car. All valves that have an exhaust port shall be equipped with a wasp excluder.

Brake cylinder pressure shall be supplied and maintained by a relay valve with a nominal 1:1 ratio.

All devices shall be clearly and permanently labeled on the manifold body, including cut-in and cut-out positions of all valves and cocks. Etching or silk screen printing during the machining process is acceptable for labeling manifold items. Stamped aluminum tags may be used on valve handles.

7.5.7 P-2-A Application Valve

A Wabco P-2-A application valve portion and pipe bracket (Wabtec p/n 561925) shall be used to initiate a full service brake application when actuated by the alerter, overspeed or PTC.

7.5.8 Auxiliary Air Equipment

MR air will be used for air-operated auxiliary devices. BP air shall not be used. Auxiliary functions shall be isolated from air brake functions and shall be disabled when MR pressure falls below 80 psig. Auxiliary valves shall regulate air pressure for MR-supplied functions such as water raising and toilets. Air for the horn and bell on the cab/baggage car shall be supplied from the first main reservoir.

The water raising air valves shall be mounted above the water level of the water storage tank to prevent backflow of water into the air system during normal operation or when the air system is depressurized. The valves shall be readily accessible for maintenance and replacement.

7.6 Truck Components

The car shall be equipped with a combination disc and tread brake equipment. The actuators for both the disc brakes and the tread brakes shall operate at the same air pressure from the same air source. Brake effort contributions from disc and tread brakes shall be specified to avoid wheel thermal cracking and brake disc damage. Under all circumstances the brake rates defined in this chapter and in this Specification shall be achieved.

The truck-mounted components as specified have been identified for the purposes of interchangeability with other intercity bi-level cars. The Contractor may propose alternate components for Customer approval if the components as specified cannot achieve the specified braking rates, or if superior braking performance can be achieved through the use of other brake system components.

7.6.1 Disc Brake Actuator

An air actuated caliper mounted on the truck frame shall be used in conjunction with each disc to develop braking effort. Automatic slack adjusters shall maintain a 0.03 in. to 0.06 in. clearance between the pad and the disc when brakes are released.

The disc brake system shall use Wabtec composition disc pads p/n V2601 (right) and p/n V2602 (left), or if the Customer requests a different pad that is compliant with Amtrak Specification 80-276. Performance of brake disc friction material shall be suitable for the speeds, route brake duty cycle and overall train braking performance and shall not induce temperatures that may result in long or short term thermal damage as to disc friction ring as defined by brake disc manufacturer.

Pad holders and disc pads shall be equipped with a locking device. The slack adjuster shall have sufficient capacity to maintain nominal shoe clearance and piston travel through the full range of new to worn discs and brake pads.

The disc brake actuators shall be Wabtec p/n 694954-0001 (left) and p/n 694954-0002 (right). The disc actuator shall be capable of handling pressure up to 140 psig without damaging the actuator, disc, brake rigging or any other system or component on the vehicle.

7.6.2 Brake Discs

Two self-ventilated 28 in. maximum, 27.5 in. nominal diameter ductile iron "monoblock" brake discs shall be provided per axle. Brake discs must meet all Amtrak requirements for design, heat dissipation, resonant frequency and mechanical stability. The fatigue life of the connection between the hub and friction ring must take into account cyclic loading from thermal and shock environments encountered in normal service. The strains resulting from shock loading is a function disc response in the form of "bending out plane" vibrational mode from the shock environment developed at the wheel/rail interaction at normal revenue speeds. The natural resonance frequency of the disc, for this bending mode, shall not be less than 350 hz. The fatigue life of the connection between the hub and spoke, taken at the highest stress point for combined strains from thermal and shock load, shall be equal or greater than the projected service life of the friction ring or 1,000,000 miles, whichever is greater.

7.6.3 Tread Brake Units

A truck mounted air actuated tread brake unit, with integral single acting slack adjuster, Wabtec p/n 693187-1313 (left) or p/n 693187-1424 (right), shall be applied at each wheel. The tread brake unit shall operate in conjunction with the adjacent disc brake caliper from the same air source.

Composition brake shoes 2 in. thick and of a size and type in general use by Amtrak shall be provided, Wabtec p/n V-185. Performance of brake shoe friction material shall be suitable for the speeds, route brake duty cycle and overall train braking performance and shall not induce temperatures at the wheel tread that may result in long or short term thermal damage, as defined in 49CFR Part 238. A brake key shall secure the brake shoe to the brake heads, and shall not require the use of specific tools for installation or removal.

The design of the tread brake shall accommodate a new wheel with a diameter 0.625 in. greater than nominal wheel diameter.

The slack adjuster shall have sufficient capacity to maintain nominal shoe clearance and piston travel through the full range of new to worn wheels and brake shoes, and shall provide sufficient clearance to install a 2.0 in. brake shoe against a new wheel.

One tread brake unit on each axle of the B-end truck shall be equipped with hand brake linkage [Wabtec p/n 693188-1313 (left) and p/n 693188-1424 (right)]. Tread brake units shall

be provided with spring applied parking brakes, integral to the tread brake unit which is compatible with APTA Standard SS-M-006-98, if specified by Customer.

7.7 Wheelslide Control System

The wheel slide control system shall modulate the application of the pneumatic brakes to prevent sliding of the wheels through the use of a microprocessor design. The system for each car shall include:

- System unit/controller with pre-wired connector plugs
- Modulation type dump valves (two per car)
- Molded T-harness cable, or equivalent protected cable type (two per car)
- Speed sensors (one per axle)
- Download any diagnostic software for a Portable Test Unit (PTU) (test unit itself is not required)
- Adapter cable to connect a PTU to the wheelslide control unit

The system shall continuously measure the speed of each axle and take corrective action should a sliding wheel be detected. The wheel slide system shall operate under all braking conditions and shall not permit the jerk limit to be exceeded on reapplication of brakes following a slide correction. The system shall be designed to prevent permanent thermal damage to the wheel tread as evidenced by spalling, under all adhesion conditions.

The wheelslide system components, including controller and dump valves shall be equipped with an identification plate or tag which includes:

- Vendor
- Vendor part number
- Date of manufacture
- Serial number
- Car type

7.7.1 Control Unit

The control unit shall be mounted in the electric locker.

The wheelslide control equipment is subject to the following conditions:

- The wheel slip function shall be automatically self-calibrating to continuously adjust for the difference in wheel circumference from nominal new wheel to fully worn wheel rim thickness.
- The system software shall be designed to account for the rotational inertia properties of the wheel set assembly.
- Wheel slide corrections shall not occur at normal deceleration rates on dry, level tangent track. System logic and criteria for detection and correction of wheel slip and instantaneous deceleration rate shall be submitted for review and approval.

- The system software/control electronics shall possess features to prevent inappropriate wheel slip correction function from transient signals arising from one damaged or missing gear tooth. This requirement includes provisions for intelligent interpretation of transient changes in signal amplitude at all speeds due to axle gear run-out, vibration of sensor mounting bracket or sensor/gear clearance settings.
- Wheel slide protection shall be retained on all remaining axles should the control unit fail to receive one or more axle speed signals. It is recognized the system performance for the axle with the defective sensor is compromised under these conditions.
- A safety timing function shall be provided to cancel wheel slide corrections exceeding a specified duration to be determined based on final system design. Protection shall be locked out on the affected truck until car is at zero speed.
- The system shall utilize software that is at the current revision at the time of installation.

7.7.1.1 Auxiliary Functions

The system shall supply two auxiliary zero speed signals, provided for door control, as described in Chapter 8, as follows:

- A zero-speed switching device shall close below 3 mph, and shall open above 3 mph.
- A 20 mph speed switching device shall close below 20 mph and shall open above 20 mph.
- Logic shall be fail-safe, such that zero-speed and 20 mph relay drop out in the event of any component failure or loss of power. Speed signal logic shall meet the requirements of EN 50126 SIL 2. The speed signal shall incorporate separate relays that break both the positive and negative components of the zero and 20 mph signals. Both the normally open and normally closed contacts shall be made external to the unit. Contact rating shall be 0.25A @ 80VDC. Contacts shall be high reliability to reduce the probability of welding.

7.7.1.2 Diagnostics

The wheelslide control unit shall include integral diagnostic indications (at a minimum) of the following system states with the vehicle moving:

- Open, shorted or grounded speed sensor circuit
- Open, shorted or grounded dump valve circuit
- Electronics fault identified at card level
- Power loss/low supply voltage during car deceleration
- Software logic fatal error or program lockup
- Time out of safety timer
- Weak/missing speed sensor signal

When the car is stationary with adequate power and air, it shall be possible to conduct a self-test that shall verify the following functions in addition to those above:

- Ability of magnet valves to release and apply brake cylinder pressure
- Ability to test magnet valve time-out

- Ability to exercise zero-speed relays

7.7.1.3 Faults

Faults detected shall be retained in the fault memory and displayed on the front of the controller using a numerical display that indicates proper system operation, or a fault code. The readout shall:

- Be able to identify defects down to printed circuit board, individual speed sensor or magnet valve level.
- Include transient faults detected while the car is in motion.
- Provide sufficient information to enable maintenance personnel to determine if the unit is working properly, and if not, whether the system can be repaired while on the car or must be removed for repairs.

A permanent label shall be fixed to or near the controller that identifies the numerical codes for faults represented by numerical display. It shall also provide instructions for initiation of self test program and the clearing of faults from memory. The chart shall be positioned so that it can be easily referenced in seated or standing position (as appropriate) while reading the display or manipulating button.

7.7.1.4 Circuit Boards

All circuit boards shall be identified with:

- Vendor name
- Vendor part number
- Date of manufacture
- Revision level
- Serial number

7.7.1.5 Test Equipment and Software

The Contractor shall provide five electronic copies of wheelslide system diagnostic software to be used on a PTU. Operating instructions for this software shall be included in the vehicle maintenance manuals.

The Contractor shall provide 10 cables to connect a PTU to the wheelslide control unit to allow on-car troubleshooting.

7.7.2 Dump Valves

When a slide condition is detected by the controller, it shall be relieved on a per truck basis, by controlled reduction of brake cylinder pressure by an electro-pneumatic modulating type dump valve. Braking shall be reapplied after correction is made at a rate designed to take maximum advantage of prevailing adhesion but shall not exceed the jerk rate. Air consumption shall be minimized during slide correction. The dump valve porting and internal capacity shall be optimized for car dead and displacement brake cylinder volumes. All valve and relay coils, except anti-skid valves, shall be suppressed with passive electronic devices. The manufacturer

must provide a pre-wired mating plug connector for each dump valve. The wire pigtail must be molded construction and sealed at the plug.

7.7.3 Speed Sensors and Wiring

Axle speed shall be determined from a passive magnetic speed sensor mounted on a journal bearing adapter and a 104-tooth gear mounted on the end of the axle. The sensor shall detect speeds of 2.5 mph or more. Nominal sensor gap shall be 0.020 in. to 0.035 in. The speed sensors shall connect to the wheelslide control unit through a T-harness, or equivalent protected cable system. The T-harness or equivalent protected cable system shall connect to the carbody wiring through a MIL standard circular connector, mounted to an electrical box on the carbody. Terminal and junction boxes shall not be mounted on the trucks.

The speed sensor cables and T-harness, or equivalent protected cable system, shall be attached to the truck frame using coated clamps that provide secure attachment while not abrading or pinching the cable. Each clamp shall secure no more than one cable. Clamps shall be attached to the truck frame using fasteners and lock washers in tapped holes. There shall be sufficient slack in the speed sensor wiring to allow the bearing adapter to move to the bottom of the pedestal opening without stressing the cable (such as when the truck is lifted with axles installed). Cables and harnesses shall be accessible for replacement while the car is in service.

7.8 Brake Indication Devices

7.8.1 Pneumatic Indicators

Pneumatically operated indicators, one on each side of the carbody at each truck, shall be connected to the brake cylinder air supply line between the brake cylinder cut-out cock and the brake cylinder. These indicators shall provide a positive visual status of the brake system to crewmembers, with the plunger extended away from the carbody when the brakes are applied, and retracted under the carbody when the brakes are released. The indicators shall be readily visible from station platforms as well as track level, and from both ends of each side of the car.

7.8.2 Pressure Switches and Brake Status Lights

A pressure switch shall be provided for each truck, monitoring the brake cylinder pressure downstream of the truck cutout cock. A test fitting shall be provided in each brake cylinder line to the trucks, downstream from cutout cock and dump valve. In addition, a test fitting shall be provided for each pressure switch to check calibration. These pressure switches operate the brake applied/released indicator lights, as well as provide a signal to the engineer's console in the locomotive or cab/baggage car (via pins 19 and 20 of the 27-point communication trainline) to display brake system status (applied or released). Trainline function is as follows:

- Brake released: continuity when brake cylinder pressure on both trucks is less than one-half of a minimum service application, and handbrake is released.
- Brake applied: continuity when brake cylinder pressure on both trucks is applied at one-half of a minimum service application or greater or handbrake is applied.

The exterior of each car shall be equipped with two 3-lamp indicator assemblies, as specified in Chapter 11. Indicators shall display the following aspects:

- Green: All brakes released and handbrake released
- Yellow: Brakes applied and handbrake released
- Flashing Yellow: Handbrake applied (with air brakes applied or released)

A weatherproof micro-switch shall be provided to indicate handbrake status to the car's exterior brake status lights, and to the locomotive and cab/baggage car via pin 20 of the 27-point communication trainline. The switch shall be weatherproof to prevent damage from environmental conditions.

7.9 Handbrake

7.9.1 Handbrake or Spring Brake Units

A handbrake with lever-type handle shall be provided at the B-end of each car accessible from the passageway between collision posts. Spring-applied parking brakes may be provided in lieu of a handbrake if requested by the Customer. The handbrake or spring brakes shall be compliant with APTA Standard SS-M-006-98.

7.9.2 Handbrake Linkage

The handbrake linkage shall connect the handbrake operator to one tread brake actuator on each axle on the B-end truck. All handbrake linkage, chain or cable guides, lever pivots and carriers shall be adequately designed to prevent wear or binding throughout the life of the vehicle, including due to corrosion, abrasion or close clearances. The handbrake system shall not rattle during car motion, and shall not inhibit proper operation of the brake cylinder slack adjusters. A return spring shall ensure that adequate slack is in the handbrake linkage when released, so that the tread brakes do not drag on the wheels when the handbrake is released. This section applies only if handbrakes are utilized.

* End of Chapter 7 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 8 **Door Systems**

Table of Contents

8.0	Door Systems	8-3
8.1	Overview	8-3
8.2	General Requirements.....	8-3
8.2.1	Design Objectives	8-3
8.2.2	Design Requirements.....	8-3
8.3	Powered Side Entrance Doors	8-4
8.3.1	Side Door Controls and Operation	8-5
8.3.2	Side Door Operator and Linkage.....	8-6
8.3.3	Door Panel Construction	8-7
8.3.4	Door Windows	8-8
8.3.5	Obstruction Detection	8-8
8.3.6	Overhead Door Track.....	8-8
8.3.7	Bottom Door Guides and Thresholds	8-9
8.3.8	Weather Seal	8-9
8.3.9	Door Leaf Wiring.....	8-9
8.3.10	Emergency Releases	8-9
8.3.11	Door Control Panel	8-10
8.3.12	Door Control Panel-Local.....	8-10
8.3.13	Conductor's Single-Leaf Momentary Control Switch.....	8-11
8.3.14	Exterior Crew Key Switches	8-11
8.3.15	Door Cutout and Mechanical Lock.....	8-11
8.3.16	Door Status Indicators and Alarms.....	8-12
8.3.17	Design Safety Validation.....	8-13
8.3.18	Tests	8-13
8.3.19	Door Pocket.....	8-13
8.3.20	Door Markings.....	8-14
8.4	Powered Body End Frame Doors	8-14
8.4.1	Body End Door Controls and Operation.....	8-14
8.4.2	End Door Operator and Linkage	8-15
8.4.3	End Door Panel Construction	8-16
8.4.4	Push and Kick Plates.....	8-16
8.4.5	Obstruction Detection	8-16
8.4.6	Overhead Door Track.....	8-17
8.4.7	Bottom Door Guides and Thresholds	8-17
8.4.8	Weather Seal	8-17
8.4.9	Door Leaf Wiring.....	8-18
8.4.10	Inside and Outside Door Control Switches.....	8-18
8.4.11	Positive Mechanical Door Lock.....	8-18
8.4.12	Tests	8-18
8.4.13	Door Pocket.....	8-18
8.4.14	Door Markings.....	8-19

<i>Table of Contents</i>	<i>8-2</i>
8.5 F-End Frame Door	8-19
8.5.1 Door Panel.....	8-19

8.0 Door Systems

8.1 Overview

Each car shall be equipped with four sets of electrically controlled, power operated side entrance doors located on the lower level that can be operated either from a local door control panel or via trainline OPEN or CLOSE commands from another location of the train. The side doors in the A-end vestibule of the café/lounge car shall be controlled only from a local door control panel. The F-end side doors on the cab/baggage cars will be controlled from a local door control panel, or from a trainline command, as selected by the crew by use of a trainline/local or local only selector switch. The side door system shall have a safety interlock that prevents the locomotive from developing traction effort if any side door is not fully closed and latched, or mechanically locked and isolated.

Each car shall also be equipped with two body end pocket doors located on the upper level (except cab/baggage cars which shall have a manually operated hinged door on the upper level at the F-end).

8.2 General Requirements

8.2.1 Design Objectives

Door systems have a demonstrated history of complexity and inconsistent performance that can affect the operation of passenger service and hinder maintenance and repairs. In order to maximize safety, system functionality and equipment availability, while minimizing the potential for degraded service or system performance, the side and end door systems shall be specified, designed and manufactured with an emphasis on addressing the following areas of concern:

- Unsafe conditions for passengers or crewmembers;
- Train delays from malfunctioning side door equipment;
- Poor system reliability in adverse operational and environmental conditions;
- Accumulation of dust and dirt that affects system performance and cause failures;
- System complexity that increases the time and effort required for troubleshooting and repairs; and
- Requirement for frequent adjustment and component replacement.

The door system shall be designed with great attention to details so that it is safe, very reliable, requires little maintenance, is easy to service, has support parts available and will have a long service life.

8.2.2 Design Requirements

The door system shall meet the requirements of Amtrak Specification 965 and APTA Standard SS-M-18-10, unless specified otherwise. The side door system shall be designed and constructed so that no single point malfunction of door system components shall create an unsafe condition. Door system failures shall be detectable through the following means:

- Failure to complete the door closed summary circuit and therefore prevent the locomotive from developing traction power (when a door panel is not fully closed and latched, or mechanically locked in the closed position and isolated electronically);
- Use of indicator lights that signal when a door is not confirmed closed and latched; and

- An indicator that signals when a door has been locked manually and isolated electrically.

All controls, locks and latches identified in this section shall use the standard Amtrak coach key (coach key), per Amtrak Drawing B-144 (J.L. Howard Part No. 2555).

When closed, the doors shall provide a weatherproof seal under all car operating conditions. Neither drafts, nor air noises shall be detectable from the closed door over the full range of operating speeds of the vehicle, on all specified classes of track. The doors shall operate as specified over the entire range of all operational, climatic and track climatic conditions identified in Amtrak Specification 963. None of the electrical components, such as limit switches, shall be directly exposed to the weather, even with the door open. Climatic and environmental conditions, such as dust, snow or heat, shall not be a cause of door system failures.

Door control relays and associated panels shall meet Amtrak Specification 528.

The door equipment mounting and internal fasteners shall be such that once adjustments are made and locked, they will not need to be disturbed until equipment overhaul or replacement. Fasteners shall be standard U.S. hardware. Jam nuts, lock washers, nylock nuts or equivalent fasteners shall be used to secure door equipment. Deformed nuts and fastening aids, such as Loctite or equivalent products, shall not be permitted, unless specifically approved by the Customer.

All door mechanisms, including but not limited to tracks, operators, wiring to door panels, stops, limit switches and controls shall be accessible by opening hinged access panels on the inside of the car. No special tools will be required to open such panels, nor will any equipment have to be disconnected or removed to gain access. Access shall be provided from inside the car to all points necessary for inspection, service, installation or removal. All door system equipment shall be installed in such a manner so as to be readily accessible to maintenance personnel with minimal effort. Adjustments shall be readily available from the exposed side of the door operator.

All door equipment of like function and the same hand shall be interchangeable without requiring modification. To this end, all component mounting holes for all door hardware shall be jig-drilled by the manufacturer. Likewise, mounting holes on the car shall also be jig-drilled. Door operators, door tracks and thresholds shall have their mounting positions controlled through suitable jigs/fixtures so as to ensure the correct physical relationship between carbody, door track, door pocket and operator.

All door operators, tracks, hangers, linkages, brackets, obstruction sensing and electrical fittings shall be manufactured or supplied by one subcontractor.

A Portable Test Unit connection and software will be provided to aid in troubleshooting and provide system diagnostics.

8.3 Powered Side Entrance Doors

Trainline-controlled, power operated bi-parting stainless steel side entrance plug or pocket doors (with fixed windows) shall be installed at the quarter points on each side of the car. Door control panels shall be installed on both sides of the B-end entrance of all cars, and in addition, a door control panel-local shall be installed in the A/F-end entrance of the café/lounge and cab/baggage car types. Refer to Figure 8-1.

Cars will be equipped with a wheelchair lift that will have an interlock with the side door system; refer to Chapter 4 for details.

The clear door opening shall be a minimum of 52 in. in width and a minimum of 76 in. in height.

Major door system components: door panels, door operator and door control panels shall include vendor identification, which includes (but is not limited to) the following information:

- Vendor name
- Vendor part number
- Serial number
- Customer part number (if applicable)
- Date of manufacture
- Revision level

8.3.1 Side Door Controls and Operation

The side door controls shall include the following features:

- Trainline control at 74 Volts Direct Current (VDC) via 27 point communication trainline cable, in compliance with Amtrak Drawing A-63-7676-1.
- Relay-based logic and discrete trainlines for the issuing of control commands to the doors. Discrete trainlines shall also be used to monitor the door closed and locked status of all doors in the train, and for providing the required indications to the train crew.
- The door control system shall incorporate logic that shall meet the requirements of EN 50126 SIL 3 so that no unsafe condition will be created through normal operation of the door system, or due to a failure of door system equipment or components.
- Door control panels shall be located adjacent to side doors 3 and 5 in the B-end lower level vestibule of all cars.
- A door control panel-local shall be located adjacent to door 7 in the A/F-end lower level vestibule on cab/baggage and café/lounge cars.
- Each door leaf shall be provided with a position sensor to detect that the door is fully closed and that it is mechanically latched.
- The zero-speed protection from wheel slide control unit on each car including all of the following:
 - Door control panel system deactivation if not at zero-speed.
 - Removal of power from door open function of door operator if not at zero speed.
 - Door CLOSE command automatically issued in both directions on left and right door close trainlines when car motion is detected.
- Zero-speed signal supplied by the wheelslide control unit shall be required in order to issue an OPEN command to the side doors. Conversely, the absence of a zero speed signal shall prohibit the issuance of an OPEN command to the side doors.
- Obstruction detection on each door leaf meeting the requirements of APTA Standard SS-M-18-10.
- Weatherproof crew key switch outside doors 3 and 6, adjacent to the B-end vestibule of all cars, as well as outside doors 2 and 7, adjacent to the A/F-end of the café/lounge and cab/baggage cars, which allows crew to open or close a single door (both panels) to enter or exit the car.
- Manual emergency release for each door leaf from inside the car, with frangible cover.
- Exterior emergency release for each door leaf, fully enclosed behind a weatherproof cover.
- Mechanical lock which can be engaged manually with a coach key from inside the car which allows the on-board crew to secure the door leaf closed and isolate the door operator electrically.

- Door control system which can tolerate two separate grounds anywhere in the train in the door circuits and not have an unintended door opening.
- Control system design shall be fault tolerant to prevent unintended door openings.
- Yellow Light Emitting Diode (LED) door status indicator above each door panel, which shall be illuminated when that door panel is open, extinguished when that panel is closed and latched and flashing when the panel is mechanically locked.
- A red exterior LED-type door open indication shall be provided (see Chapter 11).
- A blue ADA exterior LED indicator, located on each side of the car adjacent to each door opening (excluding the service entrance doors at the A-end of the café/lounge and the F-end baggage area access doors on the cab/baggage cars) that flashes at 1 Hertz (Hz) while the doors at that opening are open, and that flash at 2 Hz when a CLOSE command has been given to that door opening (see Chapter 11).
- Audible signal, on or near the door header at each side door opening that pulses at the same rate as the blue ADA indicator light. Tone and volume of audible signal to be submitted to the Customer for approval during design review.
- Traction interlock with the door closed indication so that traction cannot be applied unless the doors are closed and latched, or mechanically closed and locked and electrically isolated. (There is no interlock between the door closed summary circuit and the brake system.)
- Interlock with the car-borne wheelchair lifts at doors 3/4 and 5/6 that prevent the doors from closing when the wheelchair lift is deployed at that door opening.

8.3.2 Side Door Operator and Linkage

The side doors shall employ electric, electro-pneumatic or linear-induction operators, one per door leaf. Doors shall be operated from the nominal 74VDC car battery system, but shall operate normally over the full voltage range from normal Head End Power (HEP) to load drop (from 58-86VDC) without damage and without affecting the reliability and serviceable life of the operator. The Contractor shall provide an engineering analysis to verify door operators will reliably operate over this voltage range without damage to components.

The operator shall include an over-center or equivalent locking mechanism so that a door which is closed will remain closed and latched upon loss of electrical or pneumatic power, regardless of car vibration.

The operator and linkage for each panel shall be arranged so the maximum force required to manually move a door panel shall not exceed 30 pounds of force (lbf) at mid-point of travel.

The drive mechanism shall be designed to minimize torque applied to door panels during operation. The door operator shall decelerate the door leaves at each extremity, to preclude slamming or rebound, and bring them to rest gently at the extremity of door leaf travel. The door motion shall be smooth and free of shock and impact. Damping shall be provided at the ends of travel of the door panel in both the opening and closing directions.

Operator design shall be such that a mechanical or electrical failure shall not result in subsequent damage to other equipment.

All limit switches and proximity sensors used in the operator shall be hermetically sealed and shall be easily replaceable. All limit switches and proximity sensors shall be precision units that are positively and precisely located so they may be replaced without the need for mechanism adjustment.

Door leaf travel shall be easily adjustable, with provisions, to set open and close positions.

Door opening and closing times shall be independently adjustable and shall be initially set at:

Opening	3 (\pm 0.5) seconds
Closing	3 (\pm 0.5) seconds

These values shall be independently adjustable by the Portable Test Unit.

With reduced voltage the door opening/closing times shall be a maximum of 6 seconds. Contractor to supply the method of adjusting times and a demonstration of compliance along with an analysis of operation in reduced power scenario, down to the specified minimum voltage.

The doors shall open or close successfully with no greater than a 60 lbf applied perpendicular to the interior door surface at a height of 56 in. above the floor, throughout the entire opening cycle, and through the closing cycle until 5 in. before the fully closed position.

Stall protection will be provided to prevent operator or control damage or degradation should a leaf be immobilized. When the problem is corrected, the operator will not require a manual reset to return to operation.

If the door operator uses a lead screw drive system, the screw shall not require lubrication more frequently than every 2 years. The door motion shall be smooth and free of shock and impact. Damping shall be provided at the ends of travel of the door panel in both the opening and closing directions.

The operator shall be capable of holding the door, without oscillation, in either an open or closed position with the car on all configurations of track as specified in Amtrak Specification 963.

The door operators shall include a local cutout switch which allows the on-board crew to deactivate and isolate a door operator by locking the door with a mechanical mortise lock.

The door operator shall be designed so that it requires adjustments no more frequently than once per year. The door motor and operator assembly shall be suitable for operation without component replacement between heavy overhaul periods of at least eight years. All door operator motors shall be interchangeable from one door position to another, or between all doors of the same hand (right-hand and left-hand). The door motor shall be suitably protected from the surrounding environment and be of a sealed design.

8.3.3 Door Panel Construction

Side entrance doors shall be constructed of stainless steel and have a honeycomb core. Doors shall be of an adequate thickness for the intended service, which means they shall be resistant to damage from impacts with roadside debris such as rocks, as well as resist being bent from misuse, attempted operation with the door stuck, or a mechanical malfunction. In addition, the door leaf shall sustain when supported at both ends, a concentrated load of 250 lbs applied over 4 in.², 90° to the plane of the panel at the center of the front face without deflecting more than 0.25 in., nor shall the panel take a permanent set.

All door panel joints and edges shall be sealed against moisture. Stainless steel reinforcements shall be provided at attachment points. Structure used to secure the door leaf to the door hanger shall last the life of the car, without fatigue cracks or similar failure, even if the door operator malfunctions and slams the door leaf repeatedly. Epoxy used in door panel construction shall be waterproof.

All internal door leaf wiring and sensitive edge tubing shall be run through internally routed conduit.

The exterior surface of the door panel shall match that of the exterior of the car body.

The sensitive edge and door mounted weather seals shall be part of the door panel assembly.

Door panels shall be insulated against thermal and sound transmission.

Door panels shall be welded in accordance with all applicable AWS requirements.

8.3.4 Door Windows

Each door panel shall have window openings formed to accept FRA Part 223 compliant glazing. The door window frame shall be an integral part of the door structure and shall be capable of retaining the window in the door opening when subjected to the impact applicable to the window location described in 49CFR Part 223. The window and its glazing shall not extend beyond the outer surface of the door.

Side door windows shall be tinted to match side window specification.

All door windows shall be retained in the door frame by use of a rubber extrusion and zip strip combination which will allow installation/removal of the glazing from inside of the door.

8.3.5 Obstruction Detection

Each door leaf shall be equipped with an obstruction detection system. Should the door close against an obstruction, the obstruction detection system shall immediately initiate the door opening cycle. The force required to activate the system shall not exceed 20 lbf. The sensitivity of the obstruction detection system shall conform to APTA Standard SS-M-18-10. The design of the obstruction detection system shall not allow the door to oscillate if no obstruction is present.

The design of the obstruction detection system shall be subject to Customer approval during design review. The Contractor shall provide a detailed assessment of the obstruction detection system as proposed, including theory of system operation, proven service history, reliability and maintainability, compliance with applicable regulations and standards, and safety analysis.

8.3.6 Overhead Door Track

Door leaves shall be suspended from an overhead door track. The track and door hanger assembly shall have minimum service life of 25 years. The load bearing surface of the door track shall be convex, so as to be self-cleaning from buildup of dust. The door track shall employ rollers with sealed, permanently lubricated bearings or other roller design that does not require lubrication. The overhead door track and rollers shall not be affected by environmental conditions, including the accumulation of dust. The door hanger and door track shall be able to resist, without damage or permanent deformation, a force of 200 lbf applied perpendicularly at the center of the door panel, both in inward and outward directions.

The rollers shall be secured to the hanger assembly with a mechanism, both to adjust for level as well as control vertical free-play between the hanger assembly and door track. Door leaf adjustment shall allow the space between the nosing seal to be made constant from the top to the bottom of the leaf. The amount of track-to-roller free-play shall prevent the trailing edge roller from lifting on the track if the door leaf strikes an obstruction down low while closing. Adjustment of free-play clearances shall be easily done using standard tools.

The track itself and mounting to carbody (not the door-to-hanger connection) shall be adjustable to accommodate both carbody and door leaf tolerances, including both height and plumb.

Sliding plug doors with linear bearings may be used, provided that the linear bearings are of a service proven design and do not require lubrication more frequently than annually.

The door track/hanger shall not require lubrication over its life.

8.3.7 Bottom Door Guides and Thresholds

A door guide with corresponding threshold shall be provided at the bottom of the door. Adjustable wear strips, if provided, shall be easily replaceable without removing or readjusting the door panel. The bottom guide arrangement shall be designed not to collect dirt and debris and to ensure a low friction operation with no binding or rattling. The thresholds shall be compliant with ADA requirements. The door guide/threshold shall form part of the door weather seal and shall incorporate drain holes to carry off water to the underside of the car. The threshold and drain and their sealing to the carbody shall ensure that water or other fluids do not seep underneath and cause deterioration of flooring, its substructure or insulation. Easy access shall be provided to the door guide/threshold for cleaning and maintenance. The guide shall be adjustable to accommodate both carbody and door leaf tolerances. Any part of the door guide system subject to wear shall be easily replaceable without removing the door panels. The bottom guide shall require adjustments no more frequently than every 460 days.

The threshold shall incorporate a freeze protection heater in accordance with Chapter 10.

8.3.8 Weather Seal

The leading edge of the door panel shall interlock with the adjacent door panel to form a weatherproof seal. The door opening, including the interior and exterior sides and top, shall be equipped with a flexible weather seal. The rear edge of the leaf shall be equipped with a batten that positively engages the door seal when the door is fully closed, including the radius at the top of the door opening. This combination shall create a dust and weatherproof seal. The seal shall be attached to the door frame with sufficient clearance so as to prevent chafing against the leaf as it moves, yet ensure every door leaf seals on every car, despite the combination of all manufacturing tolerances. The top of the opening shall also be equipped with a weather seal. The interface between the bottom of the door and the threshold shall form a weather seal. Seal design shall also limit the entrance of dust and snow into the door pocket when the door is open. Adjustments to keep the seal system weather tight shall not be required more often than annually. The weather stripping shall be easily replaceable and maintain a hardness index of 60 to 70 durometer (if rubber) at -30°F. The entire door seal arrangement shall be demonstrated to provide an effective door seal under all operating conditions.

8.3.9 Door Leaf Wiring

Wiring and air tubing within the door leaf shall be configured to allow individual door elements (sensitive edge, mechanical lock, etc) to be easily replaced.

Wiring or air tubing connecting the door leaf to the carbody shall be designed to avoid snagging, abrasion or other damage regardless of car/door motion. The door leaf wiring shall be a sealed design and suitably protected from the surrounding environment. The door panel shall be grounded per APTA Standard SS-E-005-98. Cable and/or air tubing carried with the operator linkage to the door leaf shall be secured, so that any motion imparted to the cable by car motion will not result in cable snagging, abrasion or other damage. Access shall be provided to easily replace and terminate the cable.

8.3.10 Emergency Releases

Manual interior and exterior emergency releases shall be provided to allow each side door panel to be opened manually in emergency situations. The emergency release handle shall be red and be simple for individuals to understand and operate. Activating the emergency release handle shall: remove power from the door motor, release the door mechanical lock (if locked) and disengage the door over-center locking mechanism and separate the door panels by at least one inch so that the door leaf may be manually opened. Using the emergency release, the force to disengage the door operator and to move the door leaf shall not exceed 30 lbf external per APTA Standard SS-C&S-012-02.

The exterior emergency release handle shall be located on the car side, near the door it releases, behind a weatherproof cover. At least one release shall be provided for each door opening that permits the opening of both door leaves. The cover shall allow access in an emergency and be able to be sealed and locked for securing car when not occupied. Operating instructions shall be provided on or near the cover.

An interior emergency release handle shall be located adjacent to each door leaf, behind an easily replaceable, transparent frangible weatherproof cover. One release mechanism may be used for a pair of bi-parting doors provided that the one release allows both door leaves to be opened. To allow crew access to the release emergency release without breaking the frangible material, such as when the car has no power, the cover frame shall be hinged and equipped with a coach key release. Opening the frame will also allow the frangible material to be easily replaced. The inside handle, once actuated, shall remain in the actuated position. Operating instructions for the emergency door release mechanism shall be installed near the emergency release, per the location and illumination requirements of 49CFR Part 238.

It shall be possible for emergency personnel to manually open the side doors from outside the car with the car resting on its side, by using only tools normally carried by such personnel. This shall be demonstrated with an exterior door and frame assembly in the horizontal position, using actual production components. It shall be assumed that no damage exists to the door, door frame or operating mechanism.

If a cable system is employed between the external release handle and door operator, it shall be run within a conduit to allow it to be replaced easily, without major car disassembly.

Appropriate labels shall be provided with operating instructions at convenient locations, consistent with APTA Standard SS-PS-002-98.

8.3.11 Door Control Panel

A door control panel shall be provided on both sides of each car to provide train crew control of all side doors on its respective side of the train. The panel shall be located in accordance with Figure 8-1. The panel shall be activated with a coach key, with the key removable only in the OFF position. Indicator lights on the panel shall employ socket-mounted LED technology.

The design, function and operation of the door control panels shall be in accordance with Amtrak Specification 965.

8.3.12 Door Control Panel-Local

The cab/baggage and café/lounge car types shall be equipped with a door control panel-local in the A/F-end lower level service vestibule to allow control of the A/F-end side doors.

The design, function and operation of the door control panel-local shall be in accordance with Amtrak Specification 965.

The side doors in the lower-level service vestibule of the café/lounge and cab/baggage cars shall be subject to the same redundant zero speed protection logic as identified above, and shall be incorporated into the trainline door close summary circuit.

In addition, the cab/baggage car shall be equipped with a trainline/local coach key switch panel which allows the crew to select whether the baggage area doors open in response to trainline OPEN commands, or only on a local basis (as may be used when baggage is checked). Positions shall be labeled TRAINLINE/LOCAL (9 o'clock position) and LOCAL ONLY (6 o'clock position). The coach key is removable from either position. With the switch in the LOCAL ONLY position, the connection from the door open trainline is interrupted, so that the baggage area doors only open upon an OPEN command from the door control panel-local or the crew access switch adjacent to those doors, and shall not open in response to a trainline OPEN command from another door control panel. When in the TRAINLINE/LOCAL position, the side doors at this

location shall open either upon a trainline OPEN command from another door control panel, or from the adjacent door control panel-local or exterior crew access switch. In either position, the doors will close upon a CLOSE command from the door control panel-local, or from a trainline CLOSE command.

Both panel types shall be weatherproof so no damage will occur nor the system be disabled by a door being left open and the station getting wet, such as in going through a carwash. The switches themselves shall be weatherproof.

8.3.13 Conductor's Single-Leaf Momentary Control Switch

The door leaf adjacent to each door control panel shall be equipped with a momentary crew switch located in the hand hold adjacent to that door leaf, to permit that door leaf to be opened by the crew as the train is arriving or departing at a station. This conductor's single-leaf momentary control switch shall operate when all the following conditions are met:

- It shall be activated only when the adjacent door control panel is keyed on;
- It shall be activated only when car speed is below 20 mph, as measured by the wheel slide control unit; and
- It shall fully open the adjacent door leaf when the momentary switch is closed and held closed by the crewmember. Releasing the momentary switch shall close the door leaf.

When the above conditions are met, pressing the momentary conductor's door switch, located in the interior grab handle adjacent to the door control panel, will result in the adjacent door leaf opening. Should any condition no longer exist, the door leaf will close. The switch itself shall be weatherproof. Opening the door leaf with the momentary control switch shall not break the door closed summary circuit as long as the adjacent door control panel is keyed on.

A plug door design, if used, will have to fit within the specified static and dynamic clearance diagram when one leaf is open.

8.3.14 Exterior Crew Key Switches

A weather proof coach key switch, complete with seal over key opening and detent latch, shall be provided adjacent to doors 3 and 6 on each side of all cars which allows crew to open or close the adjacent door leaves to enter or exit the car. The cab/baggage and café/lounge car types shall also be equipped with an additional crew key switch on each side of the car on the A/F-end of the car, adjacent to doors 2 and 7, which allows crew to open or close the adjacent door to enter or exit the car. See Figure 8-1.

The switch shall be three-position, spring return to center, with key capture in open and closed positions. Rotating the key to the left shall open the doors, and to the right shall close the doors.

The crew key switch shall be arranged so that when the key is removed, the door shall remain in the last position commanded. Trainline commands shall take precedence over local commands. If a door is opened with the local crew key switch, it shall be possible to close it by trainline control. Switches within the assembly shall be weatherproof.

8.3.15 Door Cutout and Mechanical Lock

A positive mechanical lock function shall be provided for each passenger side door leaf, or pair of side door leaves if door operation uses synchronized door panels, to deactivate power from that door operator and to secure the leaf in the fully closed position. This lock shall be operated from inside the car only, by a coach key, and shall engage the door leaf directly. When closed and locked in this manner, the door latched sensing switch shall be bypassed. The door latched sensor shall only be bypassed when the door leaf is fully closed and the mechanical lock fully engaged.

The emergency release function shall still be available for a locked out door, but if the release is used, the door panel locked sensing function shall be reactivated. If the emergency release has been activated while the mechanical lock was in the locked out position, the design of the keeper shall allow the lock bolt to re-engage automatically when the door leaf is again closed (so as to not ram the edge of the keeper with the bolt).

Engagement of the lock bolt shall be sufficient to provide positive panel locking under all conditions. It shall not be possible to withdraw the key unless the lock bolt is fully engaged or fully unlocked.

8.3.16 Door Status Indicators and Alarms

Audible and visual warnings that comply with the requirements of 49CFR Parts 37 and 38 shall be provided at each doorway and shall be activated prior to door closing. Activation of the warnings shall precede the initiation of door closing by approximately 3 seconds. The warnings shall alert passengers inside and outside the car on the side of the car at which the doors are open.

8.3.16.1 Exterior Door Open Indicators

A red exterior LED type door open indication shall be provided on each side of the car at each entrance doorway (4 per car) (see Chapter 11). Both lights adjacent to an individual vestibule (one on each side of the car) shall be extinguished when all doors at that entrance vestibule (both sides of car) are closed and locked. The indicators shall be bright enough to be visible in bright direct sunlight, and shall be visible to crewmembers in vestibules and in the operating cabs of locomotives and cab/baggage cars when looking down the side of the train from either direction.

8.3.16.2 Exterior ADA Indicators

A blue ADA LED indicator shall be provided outside each side entrance door as follows (see Chapter 11):

- Coach car: all door openings (4 per car)
- Cab/baggage and café/lounge cars: B-end door openings only (2 per car)

The ADA indicators shall be triggered via the door controls to provide a flashing indication at 1 Hz while the doors at that location are open, and shall flash at 2 Hz from the time that a CLOSE command is issued to those doors until the doors are closed and locked (see Chapter 11).

8.3.16.3 Interior ADA Door Closing Indicators and Alarms

Red LED interior door closing warning lights shall be provided in the door header at each side entrance door.

These lights shall be triggered via the door controls to provide a flashing indication, upon initiation of the door “close” command, and continue to flash until the door begins to close. This is to warn hearing impaired passengers that the doors are about to close. The flashing rate of the indicator shall be approximately 2.0 Hz.

Interior door closing warning audio alarm shall be provided in the door header at each side entrance door as follows:

- Coach: all door openings (4 per car)
- Cab/baggage and café/lounge: B-end door openings only (2 per car)

These audio alarms shall be triggered via the door controls to provide a pulsing audio, upon initiation of the door CLOSE command, and continue to sound until the door begins to close, to

warn passengers that the doors are about to close. Sound level shall be 88 +/-2 decibels (dB) at 5 ft 6 in. above the center of the door threshold, with a frequency of 3000 Hz.

An interior door closing interlock with Public Address (PA) system to initiate “doors closing” message shall be provided. See Chapter 12.

When the door closed trainline is activated, a 3 second warning of the above visual and audio devices will be given at each entrance area before the doors begin to close.

8.3.16.4 Interior Door Status Indicators

Each door leaf shall be equipped with a yellow LED indicator light mounted in the ceiling panel over each door leaf. This indicator shall display the status of the door leaf:

- On continuously: Door leaf is open, or is not confirmed closed and latched.
- Flashing (1 Hz): Door leaf is locked manually with the mortise lock and isolated from the door control circuit and the door closed summary circuit.
- Off: Door panel is confirmed closed and latched, but not locked with the mortise lock.

8.3.17 Design Safety Validation

The Contractor shall conduct a hazard analysis and a Failure Mode and Effects Criticality Analysis (FMECA) for hardware and a Fault Tree Analysis (FTA) for the entire side door system as necessary to demonstrate that the safety requirements of the system are met under all operating conditions. This analysis shall be performed for an individual car of each type and for a train consisting of cars from the same build lot. This shall include: logic, interlocks, mechanical mechanisms, indicators, bypasses, cutouts and controls. The analysis shall be presented to the Customer for approval during design review.

8.3.18 Tests

The doors and their operating equipment shall be tested and adjusted on all cars to assure smooth functioning, attainment of the required speed of operation, and proper functioning of all associated controls, signals and interlocks.

The obstruction detection features shall be checked for proper operation and adjusted, if necessary prior to the start of the cycling test. This feature shall operate properly, without the need for adjustment, at the end of the cycling tests.

See Chapter 19 for the door system testing requirements.

8.3.19 Door Pocket

If pocket doors are provided, the door pocket will accommodate the door leaf while the door is open. Since the bottom of the door pocket is a wet area, it shall be lined with corrosion resistant material to prevent deterioration of car structure and flooring. This pan shall be designed to drain water out of the pocket area through a tube to the underside of the car. It shall be designed to ensure that water does not seep underneath and cause deterioration of flooring, its substructure or insulation. The drain shall be easily accessible for cleaning, and shall be equipped with a backflow preventer to keep dust and moisture from blowing into the pocket.

8.3.20 Door Markings

Door positions (# 1 - 8) shall be numbered in accordance with Figure 8-1. In addition, they shall be labeled for emergency egress in accordance with APTA Standard SS-PS-002-98, Rev. 2.

Signage shall be installed on each door leaf that describes the procedure for opening the doors in the event of an emergency. This signage shall conform to the requirements of APTA Standard SS-PS-002-98 and 49CFR Part 238.

Signage shall also be provided above each door leaf or pair of door leaves, adjacent to the yellow door status LED indicator, that states that the door leaf is inoperative or out of service when the yellow light is flashing.

A sign shall be installed on the exterior of the A-end vestibule doors on the café/lounge car that states NO PASSENGER ENTRANCE.

The proposed artwork, material, color, size, location and adhesive for these signs shall be submitted for Customer approval during the design review.

8.4 Powered Body End Frame Doors

Electrically operated, stainless steel, single leaf body end frame doors, with fixed windows, shall be provided at each end of the car except the cab end of the cab/baggage car. A minimum 32 in. "clear passage" shall be provided through the doorway when the door is fully opened. Refer to Figure 8-2.

Major door system components: door panel, door hanger assembly and door operator shall include a stainless steel vendor nameplate, which includes the following information:

- Vendor name
- Vendor part number
- Serial number
- Date of manufacture
- Revision level

8.4.1 Body End Door Controls and Operation

Body end door controls shall include the following features:

- Push and kick plates labeled PRESS (hand and foot height) on both sides of the door for activation. Plates on the exterior side of door to be weatherproof.
- Timed opening sequence in which the door responds to the push plate and remains open for 15 seconds (over a range \pm 5 seconds) before closing.
- Detent which will hold the door closed upon loss of power.
- Hold-open feature, so that door will not oscillate during the open interval when the car leans toward the door closing direction.
- Mechanical sensitive edge (air bladder type).
- 3-position switch inside and outside the door with red switch guard.
- Removable emergency egress panel in the door leaf, in accordance with 49CFR Section 238.235 (e).

8.4.2 End Door Operator and Linkage

The end door operator and controls shall operate from nominal 74VDC car battery system, but operate normally over the entire voltage range of charging down to load shed without damage and without affecting the reliability and serviceable life of the operator.

The drive mechanism shall be designed to minimize torque applied to the door panel during operation. The door operator shall preclude slamming or rebound, and bring it to rest gently at the extremity of door leaf travel. The door motion shall be smooth and free of shock and impact. Damping shall be provided at the ends of travel of the door panel in both the opening and closing directions. In the opening direction damping shall preclude the door leaf from contacting the mechanical door stop.

Operator design shall be such that a mechanical or electrical failure shall not result in subsequent damage to other equipment. For example, if the operator linkage to the leaf comes loose, it shall not be possible for the operator to damage itself from over-travel of the mechanism. The door operator and drive motor shall be protected from damage created by in-service conditions.

All limit switches and proximity sensors used in the operator shall be hermetically sealed and easily replaceable. All limit switches and proximity sensors shall be precision units that are positively and precisely located so they may be replaced without the need for mechanism adjustment.

Door leaf travel shall be easily adjustable through a single adjustment point to set open and close positions.

Door opening and closing times shall be independently adjustable and shall be initially set with DC bus voltage with HEP on, at:

Opening	2.5 (\pm 0.5) seconds
Closing	3.0 (\pm 0.5) seconds

The door shall open or close successfully with no more than a 60 lbf applied perpendicular to the interior door surface at a height of 56 in., throughout the entire opening and closing cycle.

Stall protection will be provided to prevent operator or control damage or degradation should a leaf be immobilized. When the problem is corrected, the operator will return to full functionality without a manual reset. Thermal cutouts shall not be used for motor protection. The door motion shall be smooth and free of shock and impact. Damping shall be provided at the ends of travel of the door panel in both the opening and closing directions.

The operator shall be capable of holding the door, without oscillation, in either an open or closed position with the car in service. Also, the operator shall include an over-center mechanism so that a door will remain in the open or closed position upon loss of power. The operator and linkage for the doors shall be arranged so the maximum force required to manually move a door panel with power removed shall not exceed 20 lbs.

Door motor control and timing function shall be incorporated on the operator unit.

The door operator shall require adjustments no more frequently than every 460 days. The door motor and operator assembly shall be suitable for operation without component replacement between heavy overhaul periods of at least eight years. All door operator motors shall be interchangeable from one door position to another. The door motor shall be a sealed design and suitably protected from the surrounding environment.

8.4.3 End Door Panel Construction

Body end doors shall be constructed of stainless steel and have a honeycomb core. In addition, the door leaf shall sustain, when supported at both ends, a concentrated load of 250 lbs applied over 4 in.², 90° to the plane of the panel at the center of the front face without deflecting more than 0.25 in. nor shall the panel take a permanent set.

All door panel joints and edges shall be sealed against moisture. Stainless steel reinforcements shall be provided at attachment points. Structure used to secure the door leaf to the door hanger shall ensure it lasts the life of the car, without fatigue cracks or similar failure, even if the door operator malfunctions and slams the door leaf repeatedly.

The lower portion of the door shall be equipped with an emergency egress knock-out panel, in accordance with 49CFR Section 238.235 (e). The panel shall be clearly labeled and simple to use. The panel and the method of securing it shall not extend beyond the face of the door leaf on either side. The panel shall meet the required release forces, but be securely attached to the main body of the door leaf so as to not vibrate, squeak, whistle or leak water. The panel shall only be removable without tools from the inside. It shall be possible to easily non-destructively test the knock-out function and then reinstall the panel without damage or marring of either part.

A hand-hold recess shall be provided on both sides of the door panel to allow manual opening of the door from the inside and outside, with the operator deactivated.

Cutouts shall be provided on the inside and outside panels for the two push and kick plates and associated wiring. All internal door leaf wiring and sensitive edge tubing shall be run through internally routed conduit.

Each door panel shall have window openings formed to accept FRA Part 223 Type I compliant glazing. The door window frame shall be an integral part of the door structure and shall be capable of retaining the window in the door opening when subjected to the impact applicable to the window location described in 49CFR Part 223. The glazing and its mounting system shall not extend beyond the outer surface of the door.

Door panels shall be fully insulated against thermal and sound transmission and grounded per APTA Standard SS-E-005-98. Door panels shall not rattle or vibrate.

8.4.4 Push and Kick Plates

The right hand side of the door leaf (as viewed from inside of the passenger seating area of the car) shall be equipped with a pair of push and kick plates, operable from both sides of the panel, for door activation. Plates shall be embossed and labeled in white text PRESS, and shall be weatherproof both within themselves and also to the exterior face of the door panel. The push plates shall be recessed and be flush with the surface of the door. They shall not interfere with the operation of the door as it travels in and out of the pocket. The internal micro-switch shall be a weatherproof design.

The Contractor may propose alternative designs to control the opening of the end doors, to be reviewed and approved by the Customer as part of the door system design review.

8.4.5 Obstruction Detection

Each door shall be equipped with an obstruction detection system. Should the door close against an obstruction, the obstruction detection system shall immediately initiate the door opening cycle. The force required to activate the system shall not exceed 20 lbf. The sensitivity of the obstruction detection system shall conform to APTA Standard SS-M-18-10. The design of the obstruction detection system shall not allow the door to oscillate if no obstruction is present.

The design of the obstruction detection system shall be subject to Customer approval during design review. The Contractor shall provide a detailed assessment of the obstruction detection system as proposed, including theory of system operation, proven service history, reliability and maintainability, compliance with applicable regulations and standards, and safety analysis.

8.4.6 Overhead Door Track

Door leaves shall be suspended from an overhead door track. The track and door hanger assembly shall have minimum service life of 25 years. The track shall be convex with the curve on top, so as to be self-cleaning from buildup of dust. The door track shall employ concave rollers, with sealed, permanently lubricated bearings. The overhead door track and rollers shall not be affected by environmental conditions, including the accumulation of dust. The door hanger and track shall be able to resist without damage or permanent deformation a force of 200-lbf applied perpendicular at the center of the door panel both in either the inward or outward directions.

The rollers shall be secured to the hanger assembly with a mechanism, both to adjust for level as well as control vertical free-play between the hanger assembly and door track. Door leaf adjustment shall allow the space between the nosing seal to be made constant from the top to the bottom of the leaf. The amount of track-to-roller free-play shall prevent the trailing edge roller from lifting on the track if the door leaf strikes an obstruction down low while closing. Adjustment of free-play clearances shall be easily done using standard tools.

The track itself and mounting to carbody (not the door-to-hanger connection) shall be adjustable to accommodate both carbody and door leaf tolerances, including both height and plumb.

The door track and hanger shall not require lubrication over its life.

8.4.7 Bottom Door Guides and Thresholds

A door guide with corresponding threshold shall be provided at the bottom of the door. Wear strips, if provided, shall be easily replaceable without removing or readjusting the door panel. The bottom guide arrangement shall ensure operation with no binding or rattling. The door guide/threshold shall form part of the door weather seal and shall incorporate drain holes to carry off water to the underside the car. The threshold and drain and their sealing to the carbody shall ensure water or other fluids do not enter the equipment room, nor do they seep underneath and cause deterioration of flooring, its substructure or insulation. Easy access shall be provided to the door guide/threshold for cleaning and maintenance. The guide shall be adjustable to accommodate both carbody and door leaf tolerances. The bottom guide shall not require adjustments more often than every 460 days.

8.4.8 Weather Seal

The leading edge of the door panel shall interlock with the door frame to form a weatherproof seal. The interior and exterior of the door opening, including any curves at the top, shall be equipped with a flexible weather seal. The rear edge of the leaf shall be equipped with a batten that positively engages the door seal when the door is fully closed, including any radius at the top of the door opening. This combination shall affect a dust- and weatherproof seal. The seal shall be attached to the door frame with sufficient clearance so as to prevent chafing against the leaf as it moves, yet ensure every door leaf seals on every car, despite the combination of all manufacturing tolerances. The interface between the bottom of the door and the threshold shall form a weatherproof seal. When door is manually locked a seal shall prevent air infiltration. Seal design shall also limit the entrance of dust and snow into the door pocket when the door is open. The entire door seal arrangement shall be demonstrated during the design review process to provide an effective door seal under all operating conditions and is

subject to Customer approval.

8.4.9 Door Leaf Wiring

Wiring and air tubing within the door leaf shall be configured to allow individual door elements (push plates, sensitive edge, mechanical lock, etc) to be easily replaced.

Wiring connecting the door leaf to the carbody shall be designed to avoid snagging, abrasion or other damage regardless of car/door motion. The door leaf wiring shall be a sealed design and suitably protected from the surrounding environment. The door panel shall be grounded per APTA Standard SS-E-005-98. Cable carried with the operator linkage to the door leaf shall be secured, so that any motion imparted to the cable by car motion will not result in cable snagging, abrasion or other damage. Access shall be provided to easily replace and terminate the cable.

8.4.10 Inside and Outside Door Control Switches

Each end door shall be equipped with a three-position door cutout switch on the inside and outside of the door opening. The switches shall be located on the right side of the door opening, when inside the car facing outward. The switches shall be clearly distinguished from the emergency fan switches, located nearby. The switch shall have three positions, with two positions maintained (MANUAL and NORMAL), and the third position shall be momentary contact (OPEN). The switch and plate shall be keyed so switch cannot be mounted backwards. A red switch guard shall be provided, which closes fully only when the switch is in NORMAL position. The switch plate will be labeled from the bottom upward, OPEN, NORMAL and MANUAL.

This switch allows a door to be deactivated when in MANUAL mode. It also allows a five minute open duration when placed in the momentary OPEN position, after which the door operation goes back to normal. Timeout can be cancelled by moving the switch briefly to MANUAL, then back to NORMAL. The switch can also be used to allow the door to be opened manually in an emergency. See Figure 8-2 for switch location.

8.4.11 Positive Mechanical Door Lock

A positive mechanical door lock, operable with a coach key from either side of the door, shall be provided to positively secure the door panels in the closed position at the ends of the train. The lock shall incorporate a weatherproof switch which deactivates the push plates and door operator when the door is locked. The key opening shall be equipped with a self-closing dust flap; the lock itself shall be sealed against dust.

The door system shall be designed so that no damage shall result to any system components should the door be activated when it is locked or otherwise prevented from operating, and so that no open command is issued to the door operator when the door panel is locked.

8.4.12 Tests

The doors and their operating equipment shall be tested and adjusted on all cars to assure smooth functioning, attainment of the required speed of operation, and proper functioning of all associated controls, signals and interlocks.

See Chapter 19 for door system testing requirements.

8.4.13 Door Pocket

The door pocket will accommodate the door leaf while the door is open. Since the bottom of the door pocket is a wet area, it shall be lined with corrosion resistant material to prevent deterioration of car structure and flooring. This pan shall be designed to drain water out of the pocket area through a tube to the underside of the car. It shall be designed to ensure that

water does not seep underneath and cause deterioration of flooring, its substructure or insulation, nor does not it freeze in the drain. The drain shall be easily accessible for cleaning, and shall be equipped with a backflow preventer to keep dust and moisture from blowing into the pocket.

8.4.14 Door Markings

The doors shall be labeled for emergency egress in accordance with APTA Standard SS-PS-002-98. It shall also include the car number in 2 in. tall digits near the top center of the door on both inside and outside. Artwork to be provided for Customer approval at the design review.

8.5 F-End Frame Door

8.5.1 Door Panel

A manually operated, hinged collision post door shall be provided at the F-end of the cab/baggage car between the collision posts. The door shall be constructed from stainless steel with a stainless steel honeycomb core and shall be equipped with an FRA Type 1 windshield. The door shall be compliant with the requirements of 49CFR 238.209, and shall be of an adequate thickness for the intended service, which means it shall be resistant to minor wayside impact damage, as well as resist being bent from misuse. In addition, the door shall sustain, when supported at both ends, a concentrated load of 200 lbs applied over 4 in.², 90° to the plane of the panel at the center of the front face without deflecting more than 0.25 in. nor shall the panel take a permanent set. The door shall be recessed from the front surface of the vehicle, so as to shield it from possible impacts. The door shall be designed to swing 100° into the car. See Chapter 16 for additional requirements.

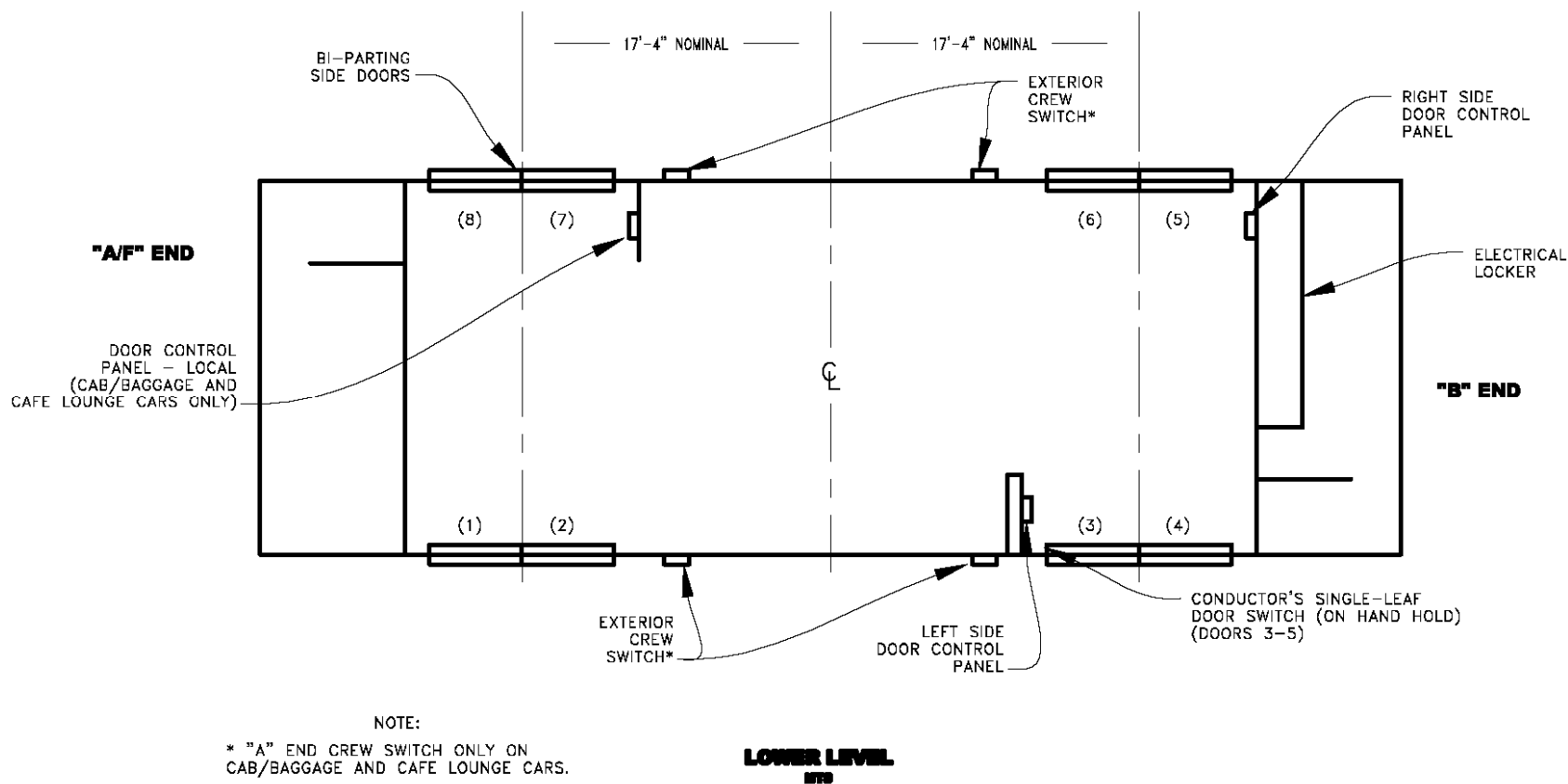


Figure 8-1: Door Location of Door Equipment – Lower Level

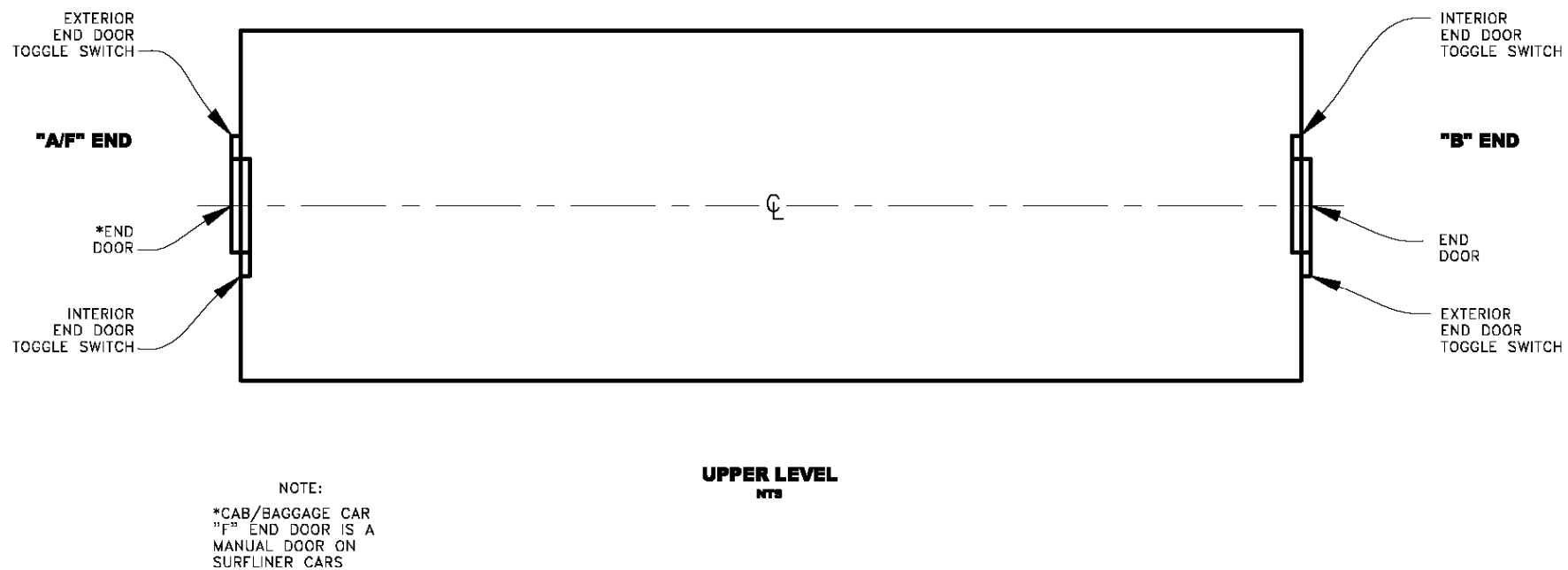


Figure 8-2: Door Location of Door Equipment – Upper Level

* End of Chapter 8 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 9

Interior

Table of Contents

9.0	Interior	9-3
9.1	Overview	9-3
9.2	General Requirements.....	9-3
9.3	Basic Features of All Car Types	9-4
9.3.1	Coach Car	9-5
9.3.1.1	Basic Car – Upper Level	9-5
9.3.1.2	Basic Car – Lower Level.....	9-5
9.3.1.3	A-end Vestibule.....	9-6
9.3.1.4	B-end Vestibule	9-6
9.3.2	Cab/Baggage Car	9-7
9.3.3	Business Class Car	9-7
9.3.4	Americans with Disabilities Act (ADA).....	9-8
9.4	Interior Structure	9-8
9.4.1	Stairways	9-8
9.4.2	Bulkheads	9-9
9.4.3	Side Walls	9-9
9.4.3.1	Window Masks	9-9
9.4.3.2	Sidewall Heat	9-9
9.4.4	Diffusers and Grilles.....	9-10
9.4.5	120V Outlet Strip	9-10
9.4.6	Central Ceilings.....	9-10
9.4.7	Drinking Water Stations	9-11
9.4.8	Electrical Locker.....	9-11
9.4.9	Recycling and Trash Receptacles	9-12
9.4.10	Enclosed Overhead Luggage Bins	9-12
9.4.11	Luggage Racks/Towers.....	9-14
9.4.12	Vestibule Luggage Racks	9-14
9.4.13	Baggage Room.....	9-14
9.5	Toilet Rooms	9-15
9.5.1	Accessible Toilet Room (ATR)	9-15
9.5.2	Unisex Toilet Room (UTR)	9-16
9.5.3	Toilet Room Pan and Flooring.....	9-17
9.6	Interior Décor.....	9-17
9.6.1	Floor Covering.....	9-18
9.6.1.1	Carpeting.....	9-18
9.6.1.2	Skid Resistant Flooring.....	9-18
9.6.2	Seats and Tracks.....	9-19
9.6.2.1	Seats.....	9-19
9.6.2.2	Seat Tracks.....	9-19

Table of Contents	9-2
9.6.2.3 Workstation Tables	9-19
9.6.3 Curtains.....	9-20
9.7 Signage and Labels	9-20
9.8 Doors and Latches	9-21
9.9 Noise and Vibration.....	9-21
9.9.1 Interior Noise Levels (Passenger Areas)	9-21
9.9.2 Vibration	9-22
9.10 Mockup Requirements	9-22

9.0 Interior

9.1 Overview

This chapter defines the interior design and configuration for the upper and lower level revenue seating areas of coach, café/lounge and cab/baggage cars, including vestibules, toilet rooms, stairways and overhead luggage storage bins. All car types are bi-level with entry from station platforms through twin bi-parting doors on the lower level, and access between cars on the upper level, through single leaf sliding end doors.

All cars shall be equipped with an accessible toilet room, two lower level vestibules, stairways for access to the upper level, and seating areas with overhead luggage bins, curtains, workstation tables and convenience outlets. Cab/baggage cars shall be equipped with a lower level baggage/bicycle storage area. Coach and cab/baggage cars shall have a unisex toilet room on the upper level. Café/lounge cars shall have a revenue seating area at the B-end of the upper level, and a lounge area at the A-end of the upper level. For details regarding the lounge area, galley, elevator and food service equipment on the café/lounge car (see Chapter 14). Cab/baggage cars shall have a locomotive control cab at the F-end of the upper level (see Chapter 16).

9.2 General Requirements

This chapter shall describe the basic interior configuration of all car types in this specification, and each car type shall include all requirements for ADA accessibility and general seating arrangements that provide comfort and amenities such as electrical outlets, task lighting, and individual work trays or tables.

The interior of the car shall be designed and constructed for maximum safety, comfort, convenience and service to the passenger, and shall be fully ADA compliant. Walls, ceiling panels and window masks shall be designed and constructed to form a safe and attractive environment. Curtains shall be provided on a track located above each window. Visible fasteners shall be minimized. Windscreens shall be placed at strategic locations to dampen noise in the passenger seating areas.

The cars will have designated crash energy management crush zone of 24 in. at the end of each coach and café/lounge car, and the B-end of the cab/baggage car. Coach and café/lounge cars, and the B-end of the cab/baggage cars shall not have any passenger seating or restrooms located closer than 24 in. to the car end exterior walls. This area should be used for trash and recycling receptacles, door opening equipment, luggage towers, HVAC supply or return ducts, utility lockers and other crushable components that allow energy absorption requirements to be met in the available space.

All systems requiring maintenance shall be easily accessible and removable for cleaning and repair.

A conceptual floor plan for all car types is provided for use by the Contractor as guidance to design the general layout of the car on both levels. These conceptual interior layouts shall serve as general guideline for the development of the interior of the cars. Final interior layouts shall be reviewed and approved by the Customer during design review.

9.3 Basic Features of All Car Types

Whenever possible, common components shall be used in all car types.

Strength of all interior fittings and their attachment to the carbody shall meet APTA Standard SS-C&S-006-98 and 49CFR Section 238.233.

All car types shall include the following:

- Accessible Toilet Room (ATR) – lower level
- Wheelchair parking location – lower level
- Wheelchair storage area – lower level
- Accessible transfer seat – lower level
- Mechanical wheelchair lift – B-end lower level (one on each side). All structural and mechanical fittings and electrical connections needed for the wheelchair lift are required.
- Single and pair standard coach seating, facing seat pairs with workstation tables
- One Unisex Toilet Room (UTR) – upper level (except café/lounge car)
- 120 Volt Alternating Current (VAC) electrical outlets adjacent to each seat or seat pair on the sidewall (see Chapter 13)
- Trash receptacles and recycle bins on each level and at both ends of the cars
- Emergency tool lockers
- Electric locker
- Public Address (PA) system (See Chapter 12)
- Passenger Information System (PIS)/Onboard Train Information System (OTIS) (see Chapter 12)
- Heating, Ventilation and Air Conditioning (HVAC) system (see Chapter 10)
- Lighting system (see Chapter 11)
- Low-Level Emergency Path Markings (LLEPM)
- Emergency lighting (see Chapter 11)
- Emergency and non-emergency windows (see Chapter 4)
- Passenger information signage and service markings
- Window curtains
- Drinking water station (except café/lounge car) (see Chapter 15)
- Racks for promotional materials
- Enclosed overhead luggage bins
- Two lower level vestibules with side entry doors
- Two stairways, except the café/lounge, which shall only have a staircase at the B-end
- Two end doors/passageways

The above configuration will represent the “basic” coach car for this specification.

Refer to Figure 9-1 through Figure 9-3 for car interior conceptual drawings.

9.3.1 Coach Car

9.3.1.1 Basic Car – Upper Level

See Figure 9-1.

Upper level passenger seating will be provided in double-seat arrangements. There will be nine tables with seat facing pairs, with a maximum seating of 72 on the upper level. The seats shall have a nominal seat pitch of 41 in., unless specified otherwise by the Customer (see Chapter 23). Seats shall be located to line up with window pillars to maximize the passengers' view through the side windows and minimize obstructed views.

The stairways at both ends of the cars shall be surrounded on three (sides with floor-to-ceiling partitions, the upper portion of which is clear Lexan. These transverse walls shall be equipped with the upper level Passenger Information Signs, facing the opposite end of the car. See Chapter 12.

There will be a chilled drinking water station at the B-end of the car that is equipped with a drain and a cup dispenser. The water station shall have a push-button-style faucet with auto turn-off.

An emergency tool locker shall be accessible by a latch door mechanism. See Chapter 17.

Equipment lockers shall be provided at A-end left and B-end right corners of car to enclose respective end door operator and provide space for trash and recycle receptacles

A luggage rack shall be located at each end of the upper level of the car. The racks shall have two shelves for storing carry-on luggage, and shall have a capacity of 250 lbs per shelf.

Enclosed overhead luggage bins shall be designed to hold a standard airline sized suitcase (13.38 in. by 18 in. by 22 in.), inserted longitudinally into the bin. The luggage bin door shall be opened with a latch mechanism and will stay open with hinges and supported with gas struts. Open luggage racks with restraining devices may be specified by Customer.

A unisex toilet shall be located at the B-end of the car adjacent to the luggage rack (except the café/lounge car).

Clear Lexan windscreens 0.38 in. thick shall be located at Customer approved intervals to reduce noise levels in the passenger seating areas.

9.3.1.2 Basic Car – Lower Level

See Figure 9-1.

Lower level seating shall be provided between the side door vestibule areas, with a maximum seating capacity of 18. Lower level seating will be double- and single-seat arrangements with a nominal seat pitch of 41 in. There will be at least one workstation table located between facing double seats. Seat layout as specified by the Customer shall be provided in Chapter 23.

Twin bi-parting pocket side doors open into car-width vestibule areas, which provide access to the lower level as well as the stairways to the upper level. Hand holds shall be provided on both sides of both entrance doors on both ends on all cars.

The B-end entrance shall be designed for wheelchair accessibility to accommodate either two wheelchair lifts or a portable bridge plate, at the direction of the Customer.

Partition walls shall separate the A-end vestibule from the passenger seating area. A passageway shall permit access from the vestibule to the seating area. This passageway shall be no less than 32 in. wide. The partition walls shall be clear Lexan on the upper half.

An ATR shall be provided on the lower level at the B-end of the car and be adjacent to the wheelchair seating and storage area.

A wheelchair seating area and a wheelchair storage area shall be provided adjacent to the ATR restroom.

A chilled drinking water station shall be located in the B-end vestibule area.

An emergency tool locker shall be accessible by a latch door mechanism in the B-end vestibule. See Chapter 17.

A storage area with two luggage shelves and four bike racks shall be located at the lower level A-end of the cab/baggage and coach cars. This area shall be convertible from a luggage rack to a bike rack by raising the shelves.

9.3.1.3 A-end Vestibule

At the A-end vestibule there shall be:

- Side entrance doors
- Bicycle/luggage racks
- Stairway to upper level
- Partition windscreen
- Recycling and trash receptacles

9.3.1.4 B-end Vestibule

At the B-end vestibule there shall be:

- Side entrance doors
- Door control panels
- Electric locker
- Wheelchair lifts
- Emergency equipment locker
- ATR
- Stairway to upper level

- PA station
- System status panel
- Recycling and trash receptacles
- Chilled water drinking station

9.3.2 Cab/Baggage Car

See Figure 9-2.

The cab/baggage car shall be configured as the basic coach car with the following differences:

- The cab area of the car shall be located at the F-end (the end opposite the B-end) of the car on the upper level and shall be a full-width control cab for push/pull operations. (See Chapter 16)
- A checked baggage storage area shall be located on the lower level of the F-end of the car.

The baggage storage area shall be configured with walls and a lockable door of sufficient durability to provide security for passenger checked baggage. The room shall contain folding baggage shelves on both sides of central aisle that allows converting individual sections into bicycle racks. The door into this area shall be secured with a coach key lock mechanism.

The general seating on both levels of the car will follow the coach configuration except for the space needed for the cab control area and the baggage area.

The F-end side doors can be operated via trainline, allowing passengers to self-load bikes or luggage; or doors can be operated locally only, allowing luggage to be checked by crew. See Chapter 8.

The upper level of the F-end cab car stairwell entrance shall be equipped with a gate that latches to the inside, to deter passenger use of the stairwell when the lower level is used for checked baggage storage. This gate shall be capable of latching open when the lower level is used for bicycle loading. The gate, along with the structure supporting it and the piano hinge used to secure it to the partition, shall be robust to endure rough service by crews. The structure on the free end of the gate shall be robust to successfully sustain the impact of the gate slamming closed. A bumper shall be provided to cushion the gate at the full-open position. The gate shall use a self-latching latch to secure it when closed.

9.3.3 Business Class Car

At the discretion of the Customer, a business class car may be configured out of a coach car or a cab/baggage car that may provide some or all of the following features:

- Seat and reading light pitch greater or less than that provided in basic coach;
- Business Class module on the upper and lower levels where snacks, beverages and other provisions may be made available;
- Appropriate interior and/or exterior signage identifying the car as Business Class; and
- Other features and amenities as specified by the Customer.

9.3.4 Americans with Disabilities Act (ADA)

The lower level of all car types shall be fully compliant, at the time of manufacture, with all rules and regulations of the Americans with Disabilities Act of 1990. Review of the car's accessible features shall be conducted with the Customer as part of the mockup review. **DR**

A parking location shall be provided in the accessible section of the car which shall permit a wheelchair passenger to remain in their wheelchair while on board the car and be compliant with ADA. Wheel restraints are not required. Segway restraints will be provided at Customer request.

A storage area for unoccupied, folded wheelchairs, 48 in. long, 20 in. wide and 40 in. high, shall be provided.

9.4 Interior Structure

The coach car shall serve as the base for the interior for all car types. Interior colors, design, patterns and finishes of materials shall be developed by the Contractor as part of the conceptual design and mockup process to be approved by the Customer. **DR**

Easy access shall be provided for all items that require periodic maintenance or replacement. Tape or other material that prevents squeaking or chafing shall be used between linings and any structure to which they are attached or in which they may come into contact. Linings covering apparatus requiring maintenance or servicing shall be fastened with approved fasteners in a manner that permits ready removal and replacement by technicians, but is secure from passengers.

All interior surfaces that are of fiberglass shall have a high-gloss finish with a minimum gloss meter measurement of 82. Color shall be applied as a gel coat surface. Interior liners and partitions shall be fiberglass or equivalent using fire retardant resins.

9.4.1 Stairways

Each car, except the café/lounge car, will have two stairways, one at each end. The café/lounge car will only have one stairway located at the B-end.

Each stairway shall be equipped with handrails on both sides with a minimum clear width of 32 in. between handrails. These shall attach with positive locking machine screws directly to car structure for strength.

The stairway framing, step treads and risers shall be constructed of stainless steel. Stairway side walls shall be made of similar materials as interior wall panels throughout the car. As required, hinged access panel(s), secured closed with stainless steel fasteners, shall be provided to give access to car side door tracks/mechanisms for maintenance.

Flooring material identical to that used in the vestibules shall be used on the stair treads and upper stairway landing. All steps shall have a bright yellow nose rubber for visual demarcation of the stairway. All stair way flooring materials shall be adhered to the stairway structure using a waterproof, durable epoxy on vertical and horizontal surfaces. The flooring will be anti-skid.

The stairway shall be illuminated with stairway lighting that meets the requirements of Chapter 11.

9.4.2 Bulkheads

Bulkhead walls at the end of each passenger seating area shall be constructed of melamine-faced aluminum panels or fiberglass panels for durability and to be pleasing to the passenger. All fiberglass material shall be covered with a high gloss gel coat. All seams will be sealed, using appropriate sealing materials. Fasteners shall not protrude from the wall panels, but countersunk to be flush with the wall panels.

9.4.3 Side Walls

The sidewalls shall be designed and constructed to minimize the number of joints, with all joints being tight, and meeting manufacturer's requirements for trim, maximum gap and fit-up quality. Floor heating cover panels shall be designed and installed to withstand the temperatures and maintenance of the heating system without removal of adjacent components. The vendor shall provide recommended cleaning instructions as part of the Service and Inspection manual (see Chapter 22).

The wainscot fabric shall be a woven loop pile weave using 100% wool face yarn incorporating static control and have a synthetic backing material. An approved stain resistant chemical shall be applied to the wainscot carpet material. Wainscot fabric shall be applied to the wainscot panel using a manufacturer-approved adhesive. The wainscot carpet shall comply with the following requirements:

Pitch:	216 P. O. B.
Rows per Inch:	10.5
Pile Height:	0.14 in.
Weight:	20.0 oz/square yard
Width:	12 ft, slit to 6 ft

9.4.3.1 Window Masks

The window masks shall be either Fiberglass Reinforced Plastic (FRP) or thermoformed plastic. The window edge should incorporate openings for heating vents at the window. Sidewall heat vents may be separate powder coated aluminum (as appropriate for the mask to window interface), or integral to the window mask. The window masks must not readily collect dust/dirt, and shall be easy to clean without removal or special tools.

9.4.3.2 Sidewall Heat

Passenger seating areas as well as the café/lounge car passage at the galley shall be equipped with a heating system as specified in Chapter 10. The sidewall materials, as well as any materials attached to them, shall be of sufficient temperature rating that they do not discolor, become brittle or otherwise deteriorate for the life of the car from exposure to the heating system.

9.4.4 Diffusers and Grilles

Supply and return air diffuser grilles shall be stainless steel or extruded aluminum and integrated into the surrounding surfaces. An arrangement using adjustable regulating registers and grilles shall be provided. Regulating registers shall be hidden by these grilles and shall be removable for cleaning periodically. These grilles shall be configured to be easily removed for cleaning. Diffusers shall be designed to be easily adjusted to set car air balance without having to drop ceiling panels. It shall be possible to drop ceiling panels without having to disturb supply air diffusers.

Grilles shall be designed to minimize drafts onto passengers. Regulating registers shall be designed to eliminate rattles and noise levels associated with high velocity air supply systems.

Grilles or suitable openings (such as a gap below the door) shall be provided as necessary to provide a return path for air through enclosed spaces, such as the engineer's cab, baggage room and galley (when it is secured). The restroom doors shall have a grille at a low location to allow air to enter the room, to be exhausted from that space by the exhaust system. Grilles that are subject to impact from luggage, such as that on the electric locker, shall employ a guard for protection.

The heater grilles shall be constructed of stainless steel or extruded aluminum, formed and perforated appropriately to perform their ventilating function. Heater grille length should correspond approximately to the heater system specified in Chapter 10. Standardized and interchangeable grille pieces shall be used to the maximum extent possible. The top of the sidewall heater grilles shall be sloped toward the train interior to discourage the placements of items on top. The grille openings shall be easy to clean and not readily accumulate dirt. The grilles shall be designed to provide a smooth transition with the side wall and to prevent debris from entering the heating space and contacting the heating system. Heater grille temperatures should not exceed 125°F at nominal supply voltage.

9.4.5 120V Outlet Strip

Convenience outlets utilizing duplex 120VAC receptacles shall be located between the window mask and wainscoting. The conduit base shall be integrated into the surrounding surfaces. A duplex receptacle shall be provided for each seat, including those at tables, in all car types. Receptacles shall be located approximately 24 in. forward from the front of the seat back, 16 in. forward of the seat back for those seats located at tables. Two duplex receptacles shall be installed at each table, located such that the table or seat does not interfere with access to the outlet. A 120 VOLTS label, in accordance with Amtrak Specification 697, shall be installed on the conduit cover at each outlet location, 0.50 in. from outlet, between the outlet and the seat facing the outlet. The raceway shall be securely attached to the carbody structure so it does not work loose from repeated use. Refer to Chapter 13 for further requirements.

9.4.6 Central Ceilings

Ceiling panels shall be designed and constructed and installed to allow easy individual removal for maintenance and repair of any components included in the ceiling design, such as air ducts. Ceiling panels shall be constructed of fiberglass covered with a high gloss gel coat or other material that meets flame, smoke, toxicity and structural standards, subject to Customer approval.

Where the car ceiling panels form the bottom of the HVAC duct, they shall be hinged along one side to allow them to be easily opened for periodic duct cleaning. The panels shall be sealed against air leaks around their entire perimeter, with the seal on the carbody side of the joint. The panels shall be secured closed with captive threaded fasteners; each panel will include a passive safety catch. Ceiling panel size shall allow a single person to open/close the panels safely, unaided. Self-engaging safety catches shall be included to prevent accidental panel openings. These safety devices shall be stainless steel and be configured so as not to rattle in service.

9.4.7 Drinking Water Stations

Each car type shall be equipped with an upper and lower level drinking station at the B-end of each car. Each station will consist of:

- Chilled water cooling unit (see Chapter 15);
- Recessed chilled water dispenser with drain;
- Recessed cup dispenser for 100 - 4 oz paper cups, with durable springs to secure cups in the unit;
- An access side panel secured with quarter-turn fasteners for access to the water cooler for maintenance;
- Lower level drinking water station that shall be ADA compliant; and
- Clearly marked trash container for disposal of used cups.

9.4.8 Electrical Locker

The electrical equipment and switch locker shall be located as appropriate at the B-end of the car.

Locker walls shall be of melamine faced aluminum panel construction with substructure as appropriate to support components. Longitudinal walls facing into the vestibule shall be decorated with melamine or other factory-manufactured laminate material.

The door lock shall be a coach key style lock with interior release latch.

The electrical locker shall be positively pressurized by conditioned air as part of the HVAC system to prevent dust from entering and accumulating in the electrical locker. Air shall only be allowed to vent from the electrical locker through gaps and voids where dust may enter. There shall not be a vent or grille in the door to the electrical locker. If the return air path for the B-end lower level passes through the electric locker space, it shall do so within an air duct and not use the electric locker space as part of the return air system.

The locker shall include a metal pocket or rack to hold the car defect report book, which is approximately 8.5 in. wide by 11 in. tall by 1 in. thick. Likewise, an 8.5 in. wide by 11 in. tall metal surface shall be provided on the inside face of the door for FDA inspection form and stickers.

9.4.9 Recycling and Trash Receptacles

Recycling and trash receptacles shall be provided on both levels of each car type, on the upper level at the end passageways and at the top of each stairway, and in or adjacent to each vestibule on the lower level. They shall meet all FDA and NSF requirements for trash containers and their materials. Each set of receptacles shall include two separate openings and respective bins: one for trash, and one for recyclables (cans, bottles and newspapers). Openings for these receptacles shall be designed to encourage passengers to use the proper receptacle for disposing of trash and recyclables, through the use of distinctive opening designs and signage. The recycling and trash receptacles shall be side-by-side in a row. To the extent possible, these receptacles will be designed to accommodate the Amtrak standard trash container, per Amtrak Drawing C-96-7591. The receptacles shall be labeled with an icon for type of contents, in accordance with Amtrak Specification 697. The locker shall include appropriate brackets and/or guides to properly index the containers with the openings, and as required, to keep them upright. The containers shall be rounded to protect staff handling the containers or servicing the end door from injury.

Toilet rooms shall only contain a trash receptacle, sized to provide the maximum trash capacity and receptacle opening permissible by the toilet room design.

Recycling and trash receptacle lockers shall be of panel construction with substructure as appropriate to support components. Panel construction shall be the same as bulkheads when transverse walls serve as bulkheads. Longitudinal walls shall be of the same construction as the bulkhead walls except that there will be no wainscot carpeting.

Trash and recycling locker door panels shall have melamine or factory-applied laminate. Alternatively, panels may be constructed of honeycomb or plymetal wall materials. The door shall be secured closed with a pencil latch and shall include a knob or handle to be used to pull the door open when unlatched.

Visible hardware and fasteners shall be minimized to aid cleaning, reduce build-up of contaminants and provide for pleasing aesthetics.

Vertically-oriented recycling and trash receptacles shall include a hinged self-closing door flap, shall be a touch-free design and shall be as large as practical. These flaps shall be held closed by gravity without requiring the use of springs. Horizontally oriented recycling and trash receptacles shall have clear openings without flappers.

The inside of the trash locker shall be easy to clean and be sealed at all joints for good sanitation and to meet FDA requirements.

9.4.10 Enclosed Overhead Luggage Bins

Enclosed overhead luggage bins shall be provided above all revenue seating. The Customer may specify open luggage racks in lieu of enclosed bins and if so will provide a specification in Chapter 23. The luggage bins shall consist of modular units bolted to the sidewall and roof car structure and extend the entire length of the passenger-seating compartment. The bins shall accommodate carry-on luggage of up to 13.38 in. by 18 in. by 22 in. in size. The door opening shall provide at least 14 in. open vertical clearance. Length of bin modules shall match the window pitch so that the bin dividers are located centered on the pillar between windows. Design of the bins shall include as few obstructions as possible for manipulating luggage into and out of the bin.

The bin shall incorporate a raised lip along the longitudinal edge of the luggage support surface. The lip shall be of a sufficient height to mitigate the potential of any luggage resting on the bottom surface of the bin from sliding out of the bins when the doors are opened.

Luggage bin doors shall be robustly hinged at the top with a stainless steel piano hinge. Doors shall contain a positive latching device to secure the door in the closed position and retain luggage inside the bin in accordance with FRA securement requirements. Under no conditions shall the door latch self-disengage during train operation. The doors shall be self-opening when the door latch is released. The mounting of hinges, latches, keepers, dampers and self-opening mechanisms shall be via steel tapping plates, which are integral with the rack and door structure, so that hardware does not work loose or cracks develop in the parent material. Design of the bins shall take into account the likely rough handling by passengers in the course of normal service life, including repeated loading and unloading of luggage. The luggage bins shall be designed, manufactured and installed to prevent rattles resulting from car movement at any speed. Reliability and robustness of the luggage bin system shall be demonstrated to Customer satisfaction. A 50,000-cycle endurance test shall be conducted on the door and all associated hardware (latch, hinges, self-opening mechanism, etc.) to demonstrate reliability and freedom from wear. See Chapter 19.

The luggage bearing surface shall be durable and not require replacement or refurbishment for the life of the car. The lower edge of the rack at the aisle shall incorporate a smooth convex radius to mitigate passengers bumping their heads against the underside of the luggage bin. The luggage bin fascia shall be fiberglass faced or approved alternative. The underside of the luggage bin fascia shall integrate the upper curtain track above the side windows.

The bin structure and attachment to carbody shall have sufficient strength to support a load of 250 lbs, applied over a 10 in. by 10 in. area, midway between adjacent supports with a deflection not to exceed 0.25 in. (including rack itself and its attachment to carbody) and without fracture or permanent deformation. The load-bearing surface shall be inclined upward from the horizontal toward the center of the car at an angle of approximately three degrees. The complete and fully-loaded luggage bin and its attachment to the carbody shall be designed to resist loads, without failure or door opening, due to accelerations of 8g longitudinally 4g laterally and 4g vertically. The Contractor shall demonstrate the strength and luggage retention capability of the luggage bins during the design review.

Track-mounted reading light assemblies, as described in Chapter 11 shall be mounted on the underside of the bins, with the entire installation conducted from the bottom side of the bins. The design shall allow the light fixture units to be moved in small increments longitudinally along the luggage rack so as to allow it to be centered above each passenger seat pair, regardless of seat pitch. The luggage rack shall be equipped with a wiring chase or equivalent that provides the flexibility in wiring to achieve this.

A means to retain conductor seat checks shall be provided on the luggage rack. This may be individual parts, a continuous strip or part of the reading light assembly. The seat check holders shall hold seat checks in plain view of the conductor, looking along the length of the car. Seat check holders shall be positioned so that seat checks are not easily struck by passengers using the luggage rack edge to steady themselves. The design of the seat check holders shall be integrated into the design of the luggage bins.

9.4.11 Luggage Racks/Towers

A luggage rack/tower shall be provided at both ends of the car near the top of the stairs, upper level. It shall be of robust tubular brushed stainless steel construction and include shelves. Bumper guards shall be mechanically attached to the wall panels within the luggage rack/tower to prevent damage to walls or luggage.

The racks shall have sufficient strength to support a load of 250 lbs midway between adjacent supports with a deflection not to exceed 0.25 in. and without permanent deformation. The load-bearing surface shall be not less than 24 in. wide and shall be inclined upward from the horizontal toward the center of the car at an angle of approximately three degrees.

9.4.12 Vestibule Luggage Racks

A luggage/bike rack area shall be located on the lower level at the A-end of each car type, except for the café/lounge cars. The structural mounting points will be provided for installation of luggage racks, bike racks or luggage/bike racks, as defined by the Customer. The walls shall be constructed for durability in handling heavy luggage and various sizes of bicycles. All exposed fasteners in the luggage rack area shall be countersunk or flush mount types to preclude any damage to passenger luggage. The luggage racks shall be constructed of brushed stainless steel material in a robust tubular form. The racks can be lowered or raised depending on usage for luggage or bicycles. Airline-style quarter-turn latches shall be used to secure the racks in the up position.

Bicycle racks shall be capable of storing no less than four bicycles in an upright fashion without any bicycle component interfering with passenger circulation in the vestibule, stairway or side entry doors. Bike racks shall have the capability to lock the frame of a bicycle to the rack assembly using a standard U-shaped Cryptonite-type lock. Bike racks shall be designed to accommodate bicycles with tires up to 2.5 in. wide.

The luggage rack shall consist of two shelves that can be raised or lowered, to create three levels of luggage storage (the two shelves and the floor). Lower and upper shelves will be approximately 21 in. to 24 in., and 48 in. to 52 in. above the floor, respectively. Luggage racks shall have sufficient strength to support a load of 250 pounds midway between adjacent supports with a deflection not to exceed 0.25 in. and without permanent deformation. The load-bearing surface shall be not less than 24 in. deep and shall be inclined upward from the horizontal toward the center of the car at an angle of approximately three degrees.

9.4.13 Baggage Room

A separate area shall be provided in the F-end half of the lower level of the cab/baggage car for storing checked baggage and passenger-loaded bicycles. This storage room shall be a minimum of 19 ft long (including the F-end vestibule) from the transition bulkhead at the F-end to the interior partition wall separating the baggage room from the seating area. The baggage room shall consist of five sets (two on each longitudinal wall and one in the F-end vestibule area) of flip-up luggage shelves, similar to those used in the A-end vestibule luggage rack/bike rack on coach cars. Each set of shelves shall consist of two shelves that can flip up to access a wall-mounted bike rack. Each set of shelves on the longitudinal walls shall be approximately 66 in. long, with a structural frame between them. The shelves in the F-end vestibule shall be identical to those in the A-end vestibule of coach cars. The baggage room

shall be designed to hold a minimum of 16 bicycles. The bicycle racks used in the baggage room shall be identical to those used in the A-end vestibule of coach cars.

The baggage room shall be separated from the lower level seating area by a wall with a lockable entry door. The partition wall shall be plymetal and shall span the width and height of the car. The door shall have a grille in the lower portion for air circulation, and shall be 32 in. wide. The door lock shall be operated with a standard Amtrak coach key. This door shall be labeled NOT AN EXIT in accordance with emergency exit pathway marking requirements.

The side entry doors in the baggage room shall be operated using a Door Control Panel-Local, and shall have the capability of being controlled via a trainline command, or only from the local door control panel. The Door Control Panel-Local and Trainline/Local switch shall be located adjacent to door 7. See Chapter 8.

9.5 Toilet Rooms

9.5.1 Accessible Toilet Room (ATR)

The Accessible Toilet Room (ATR) must be compliant with all applicable ADA requirements, and shall have the following features:

- The restroom shell shall be constructed primarily of FRP or thermoformed plastic with a high gloss gel coat finish on surfaces exposed to the public.
- Trash bins shall be sized to use Amtrak standard 30 gal trash liners and have a large bin opening.
- There shall be two toilet paper roll dispensers that shall accommodate at least two full rolls each.
- A polished stainless steel mirror with a minimum 20 in. by 30 in. viewing area shall be mounted above the sink. The mirror shall be removable to allow access to the equipment behind the wall for maintenance.
- A water-resistant, LED light fixture shall be mounted over the toilet vanity mirror.
- A motion-activated hand dryer/blower.
- A sliding pocket door with lock shall be provided. The lock shall be operable from the outside with a standard Amtrak coach key. A TOILET ROOM OCCUPIED indicator shall be provided on the outside of the toilet room, and a DOOR IS LOCKED WHEN LIT indicator shall be provided on the inside of the toilet room, activated when the door is locked (see Chapter 11). A decal shall provide door lock operation instructions.
- All controls, switches and amenities shall be readily accessible and operable by passengers with disabilities.
- Minimum ATR dimensions shown by 49CFR38 Subtitle A, Figure 4 *Intercity Rail Car (with accessible restroom)* shall be met or exceeded.
- A toilet stand with shroud assembly (see Chapter 15) shall be located in the toilet room.
- An automatic electronic flush mechanism shall be incorporated into the toilet. A back-up manual flush button shall be obvious and convenient to the user. Toilet shroud shall be constructed of stainless steel, brushed finish. The toilet seat and cover shall be constructed of reinforced fiberglass.

- A sink with a faucet to automatically blend hot and cold water shall be located convenient to the toilet. The sink shall have a one-gallon capacity and a permanently mounted strainer. The faucet shall be motion activated. Water temperature shall meet the specifications contained in Chapter 15.
- Sink and sink base shall be constructed of brushed finish stainless steel.
- A 120VAC Ground Fault Circuit Interrupter (GFCI) duplex receptacle shall be located near the sink.
- A Celeste foam soap dispenser base shall be mounted on the countertop in compliance with ADA regulations.
- A coat hook, toilet seat cover dispenser and baby changing table (that can support 75 lbs) with child belt shall be provided.
- An Amtrak standard facial tissue dispenser shall be provided.
- The fittings in toilet rooms shall meet the attachment strength requirements defined in 49CFR Section 238.233.

9.5.2 Unisex Toilet Room (UTR)

The Unisex Toilet Room (UTR) shall have the following features:

- The restroom shell shall be constructed primarily of FRP or thermoformed plastic with a high gloss gel coat finish on surfaces exposed to the public.
- 30 gal capacity trash bins with large bin opening.
- There shall be one toilet paper roll dispenser that shall accommodate two full rolls.
- A polished stainless steel mirror with a minimum 20 in. by 30 in. viewing area shall be mounted above the sink. The mirror shall be removable to allow for access to the equipment behind the wall for maintenance.
- A water-resistant, LED light fixture shall be mounted over the toilet vanity mirror.
- A motion-activated hand dryer/blower.
- A sliding pocket door with lock shall be provided. The lock shall be operable from the outside with a standard Amtrak coach key. A TOILET ROOM OCCUPIED indicator shall be provided on the outside of the toilet room, and a DOOR IS LOCKED WHEN LIT indicator shall be provided on the inside of the toilet room, activated when the door is locked (see Chapter 11). A decal shall provide door lock operation instructions.
- A toilet stand with shroud assembly (see Chapter 15) shall be located in the toilet room.
- An electronic flush mechanism shall be incorporated into the toilet. A back-up manual flush button shall be obvious and convenient to the user. Toilet shroud shall be constructed of stainless steel, brushed finish. The toilet seat and cover shall be constructed of reinforced fiberglass.
- A sink with a faucet to automatically blend hot and cold water shall be located convenient to the toilet. The sink shall have a one-gallon capacity and a permanently mounted strainer. The faucet shall be motion activated. Water temperature shall meet the specifications contained in Chapter 15.
- A 120VAC GFCI duplex receptacle shall be located near the sink.
- A Celeste foam soap dispenser shall be mounted on the countertop.

- A coat hook and toilet seat cover dispenser shall be provided.
- A standard facial tissue dispenser shall be provided.
- The fittings in toilet rooms shall meet the attachment strength requirements defined in 49CFR Section 238.233.

9.5.3 Toilet Room Pan and Flooring

The floor pan of the toilet room modules shall be FRP with a stainless steel overflow pan under the toilet module and shall include waterproof composite flooring covering which resists accumulation of odors. The purpose is to prevent fluids from wicking beneath the toilet room flooring, both for hygiene and also to prevent degradation of the subflooring materials. (The subfloor materials are described in Chapter 4) This pan shall be watertight and have raised edges of at least 2 in. in height. The pan's exposed edges shall be folded for safety and to provide stiffness. The floor pan shall be installed over the subfloor of the car, and the perimeter of the pan shall be fully sealed to prevent moisture from seeping under the pan. Attachment points to secure the floor pan to the subfloor shall be in the sides, rather than the bottom surface, and be watertight. The floor pan joint at the door opening shall be waterproof to the subfloor. Floor penetrations shall be avoided when possible, but where required, sealed both to make the joint waterproof and also with an appropriate material to prevent flame propagation from underfloor flame sources.

A seam-free, skid-resistant rubber floor covering shall be used in the toilet room floor area. Color and pattern selection shall be as specified in Chapter 23. The floor covering shall be coved a minimum 4 in. up the sidewalls to form the inside scuff/kick plate. The edges shall be sealed to form a watertight seal and seams shall be cold-welded.

9.6 Interior Décor

The Contractor shall develop and provide to the Customer for approval, at the interior design review stage, no less than six storyboard palettes proposing a coordinated and comprehensive concept for the major elements of the décor for the interior of each car. The elements to be proposed on this palette shall include the colors, patterns, textures and gloss levels of the:

- Seat fabric (revenue seats)
- Seat fabric (lounge area booths)
- Carpet
- Curtain fabric
- Wainscot fabric
- Melamine laminates for use on wall panels and table tops
- Fiberglass panels
- Acrylic countertops
- Thermoform plastic panels
- Skid resistance composite flooring for stairs, vestibules, toilet rooms, passageways and other non-carpeted areas
- Powder coated or anodized metal items

The Contractor's selection of these items shall be based on the development of a comprehensive décor for the car interiors that utilizes commercial and industrial design to create a contemporary and pleasant car interior. The Contractor shall present to the Customer, at the preliminary design review, the criteria that will be used to select the elements of the interior décor. The six storyboards shall be based on adequate differences so that the Customer has a wide variety of interior concepts from which to choose. Additional Customer considerations or requirements that will guide the development of the storyboard palettes are included in chapter 23. The Customer shall select the storyboard of its choice prior to the final design review.

Using the approved interior décor palette, the Contractor shall provide at the final design review a series of computer-generated conceptual images that represent the simulated appearance of the car interiors, including the fabrics, textures and patterns selected by the Customer. These images shall include (but are not limited to) several views of each of the following areas of the cars:

- Passenger seating area
- Toilet rooms
- Vestibules
- Lounge area
- Galley area

These mages shall be provided to the Customer in both electronic and large-format print. The Customer may use these images for purposes of public relations or other pre-production activities.

9.6.1 Floor Covering

9.6.1.1 Carpeting

All carpet shall be designed per Customer specification and shall be designed to provide maximum passenger comfort and safety as dictated by ergonomic requirements. The carpet shall be classified as slip resistant under ADA guidelines. See Chapter 23.

9.6.1.2 Skid Resistant Flooring

Skid-resistant, waterproof composite floor covering, that has been tested and proven, shall be used in vestibules, end passageways, operator's cab compartment, restrooms, baggage room, galley areas and other utility areas where carpet is not installed. The floor design must be compatible with the requirements in Chapter 4.

The floor covering shall have an integral cove of 4 in. radius, where specified, for easy cleaning, and shall extend from 2 in. to 6 in. up the wall, depending upon application.

Transition strips shall be provided between composite flooring and carpeted areas. Transitions between flooring types shall produce level changes in flooring surfaces less than 0.25 in.

The trim strip between the wall lining and the floor covering shall be sealed to prevent harborage, accumulation of debris or incursion of water and cleaning fluids.

Floors in vestibules and end passageways shall have a 3 in. wide high-contrast visibility strip directly adjacent to door openings to delineate the door opening for visually impaired passengers. The high-contrast strip at the side entry doors may be made of high-performance photoluminescent material so that it is integrated into the LLEPM system for exit pathway marking. The LLEPM material may be embedded in the floor system.

All flooring shall be installed using an adhesive system that is approved by the flooring manufacturer.

9.6.2 Seats and Tracks

9.6.2.1 Seats

Seats shall be provided in the upper and lower levels of all car types in accordance with the conceptual drawings shown in Figure 9-1, Figure 9-2 and Figure 9-3. Seats shall have a pitch of 41 in., unless specified otherwise in Chapter 23. See Chapter 23 for Customer specifics regarding seats, seat fabrics and other details. Seats in the cab car shall all be facing the b-end of the cab car (rear-facing), except for the operator and crew seats, and seats at workstation tables.

9.6.2.2 Seat Tracks

Revenue seats shall be mounted in seat tracks on the floor and wall of the upper and lower levels of all car types. Seat tracks shall be installed per Amtrak Drawing D 035-00244 (see Chapter 4). A rubber extrusion shall be inserted in all seat tracks (wall and floor) between seat pedestals. Seats shall be mounted to the seat track in accordance with the strength and crashworthiness requirements of APTA Standard SS-C&S-016-99.

9.6.2.3 Workstation Tables

For facing seat pairs, a fixed workstation table shall be provided, in accordance with the respective car floor plans. The table top edges facing the passengers shall be constructed using current energy absorption technology that is intended to reduce injury potential through the use of shock-absorbing crushable elements within the table top. A review of this technology shall be part of the design review process for the tables. The top shall have dimensions that allow easy access to the seats from the aisle. The table top shall have a melamine laminate top surface and composite edge machined smooth and free of sharp edges and burrs. The top shall have a raised perimeter to retain spilled liquids.

Energy absorption features shall be built into the workstation table and/or its attachments such that human injury criteria for the 50th percentile HIII male ATDs are not exceeded during dynamic sled testing, per the requirements specified in APTA Standard SS-C&S-016-99, Section 5.2.1, modified for testing with a workstation table installed. The table must meet the performance requirements specified in Section 5.2.1.3 of APTA Standard SS-C&S 016-99. The table must not become detached from its mountings and the ATDs must remain compartmentalized between the table and the launch seat.

Workstation tables shall be attached to the carbody via the wall seat track and to the floor seat track on the aisle end, in accordance with the seat track dimensions shown on Amtrak Drawing D-035-00244. The table top of each workstation table shall measure 28 in. deep by 44 in. wide. The table leg shall be round, with a minimum 2.5 in. diameter. Locations of

mounting holes and tolerances shall be consistent so any leg can be used with any table with no modifications required; likewise for the mounting to the floor seat track.

9.6.3 Curtains

A curtain track shall be provided at the top of the window area, along the length of the car for curtain installation. The curtains shall be free hanging at the bottom, but secured in the open position with a tie-back of the same fabric that is permanently attached to the curtain and secured with heavy duty Velcro-style hook and loop fastener.

Color and pattern of the curtains is specified in Chapter 23.

The fabric shall comply with the following test requirements:

Test	Method	Results
Weight	ASTM D3776-96	6.8 oz/square yard
Width	ASTM D3774-96	54.0 in.
Fabric Count	ASTM D3775-03a	Warp: 88.8 ends per in. Fill: 46.0 picks per in.

The curtain shall be able to withstand normal cleaning without stretching, pilling, puckering, shrinking, rippling, zippering, fading or other adverse effect to its appearance or function. Curtains shall be machine cleanable using water and detergent followed by machine drying. The vendor shall provide recommended cleaning instruction in the service and inspection manual. The curtains shall not require dry cleaning.

9.7 Signage and Labels

The Contractor will equip each car with adequate signage to provide passengers and crew information about the amenities and safety-related features of the cars. The signage to be provided shall include, but is not limited to, the following:

- Location of safety equipment
- Hazards such as high voltage or heat sources
- Operation of emergency exit pathway equipment
- Operation of on-board equipment such as doors and door latches/locks
- Amenities such as trash and recycling containers, potable drinking water, 120VAC outlets, etc
- Toilet room amenities
- Seat numbers
- Capacities for storage locations such as luggage racks and overhead luggage bins
- Service-related signs for maintenance and inspection
- Exterior signage for service points

The interior and exterior signage shall conform to Amtrak Specification 697, National On-Board Signage Manual. The artwork, material, location and specifications for each sign shall be submitted to the Customer for approval at the design review.

Whenever possible, existing Amtrak signs shall be used. Where new sign designs are required the Contractor shall develop artwork per the Amtrak Onboard Signage Guidelines for approval by the Customer. The Contractor will provide a signage application drawing for Customer approval identifying all signs and labels used on each car type, including text, as well as the mounting location.

LLEPM shall be installed in accordance with APTA Standard SS-PS-004-99. The LLEPM system shall be passive and shall not utilize electric components. The LLEPM system shall be charged and maintain charge under all lighting conditions except Emergency. See Chapter 11.

9.8 Doors and Latches

All interior doors shall be constructed of melamine-faced plymetal to match interior walls, and shall be built of robust materials to withstand repeated use without deforming or losing adjustment. Doors shall have a minimum of three stainless steel heavy-duty hinges, and shall open outward into the interior of the car unless specified otherwise. Access panel doors shall have a stainless steel piano hinge and shall not open upward. Doors shall close securely without requiring the use of a key, and shall remain closed without rattling or becoming loose during operation. Cab compartment, galley access, baggage room and utility locker doors shall have a grille located in the lower half of the door panel for air circulation.

Doors that shall use a standard coach key to open:

- Electrical locker
- Baggage room
- Cab compartment
- Utility locker
- Galley access (upper and lower level)

Doors that shall use a pencil lock to open (unless specified otherwise):

- Trash and recycling lockers
- Access panels
- Storage cabinets
- Emergency equipment locker

Electrical locker and utility locker doors shall have a release lever on the inside of the latch. Baggage room and galley access door latches shall be lockable with a standard coach key from the public side (the side facing the public seating area), and with a manual latch from the service side. Cab compartment doors are described in further detail in Chapter 16.

9.9 Noise and Vibration

9.9.1 Interior Noise Levels (Passenger Areas)

When a single, completely assembled and operating car shall be moving at any speed up to 80 mph on tangent, at-grade, ballast-and-tie track with clean, smooth rail, with all auxiliaries operating simultaneously at normal conditions and with the vehicle operating in any specified

mode of acceleration, deceleration, or coasting, the noise level in the car's interior (without passenger load) shall not exceed 70 Decibels (Acoustic) (dBA) in seating areas, 75 dBA in vestibules (referred to 0.0002 microbar) at any point not less than one foot from the ceiling, floor, end walls, or side walls. Compliance with this requirement shall be demonstrated using a Type 2 sound level meter as defined by ANSI Standard S1.4: *American National Standard Specification for Sound Level Meters, using the slow meter scale.*

9.9.2 Vibration

All vehicle equipment shall be designed to operate without damage or degradation of performance when subjected to vibration and shocks encountered during normal service.

All newly designed equipment and auxiliaries mounted anywhere on the car, car body, or trucks shall not cause vertical or horizontal vibrations anywhere on the car floor, walls, ceiling panels, and seat frames in excess of 0.10 in. peak-to-peak amplitude, in excess of 0.01 acceleration due to gravity (g) peak acceleration for the frequency range from 5 Hertz (Hz) to 14 Hz, and in excess of 0.045 in. per second peak vibration velocity for the frequency range above 14 Hz.

Carbody-mounted components shall be designed to withstand vibrations of not less than 0.2 g at frequencies up to 100 Hz and randomly oriented shock loads of 2 g.

9.10 Mockup Requirements

Full-scale mockups of select portions of the interior shall be constructed by the Contractor as part of the design review process. The areas to be mocked up shall include, but are not limited to, the following:

- Accessible toilet room, including wheelchair circulation in the adjacent vestibule;
- Cross-section of the upper level seating area, including side walls and windows, heater grilles and diffusers, overhead luggage bins and reading lights, facing seat pairs and workstation table, convenience outlets and curtains;
- Fully functional overhead luggage bin, including latch and hinge mechanism, mounted at the actual height above the floor;
- Wheelchair lift, including storage area and securement mechanism
- Bike rack/luggage shelf area in the lower level A-end vestibule; and
- Portions of the café/lounge and cab/baggage cars, per Chapters 14 and 16, respectively.

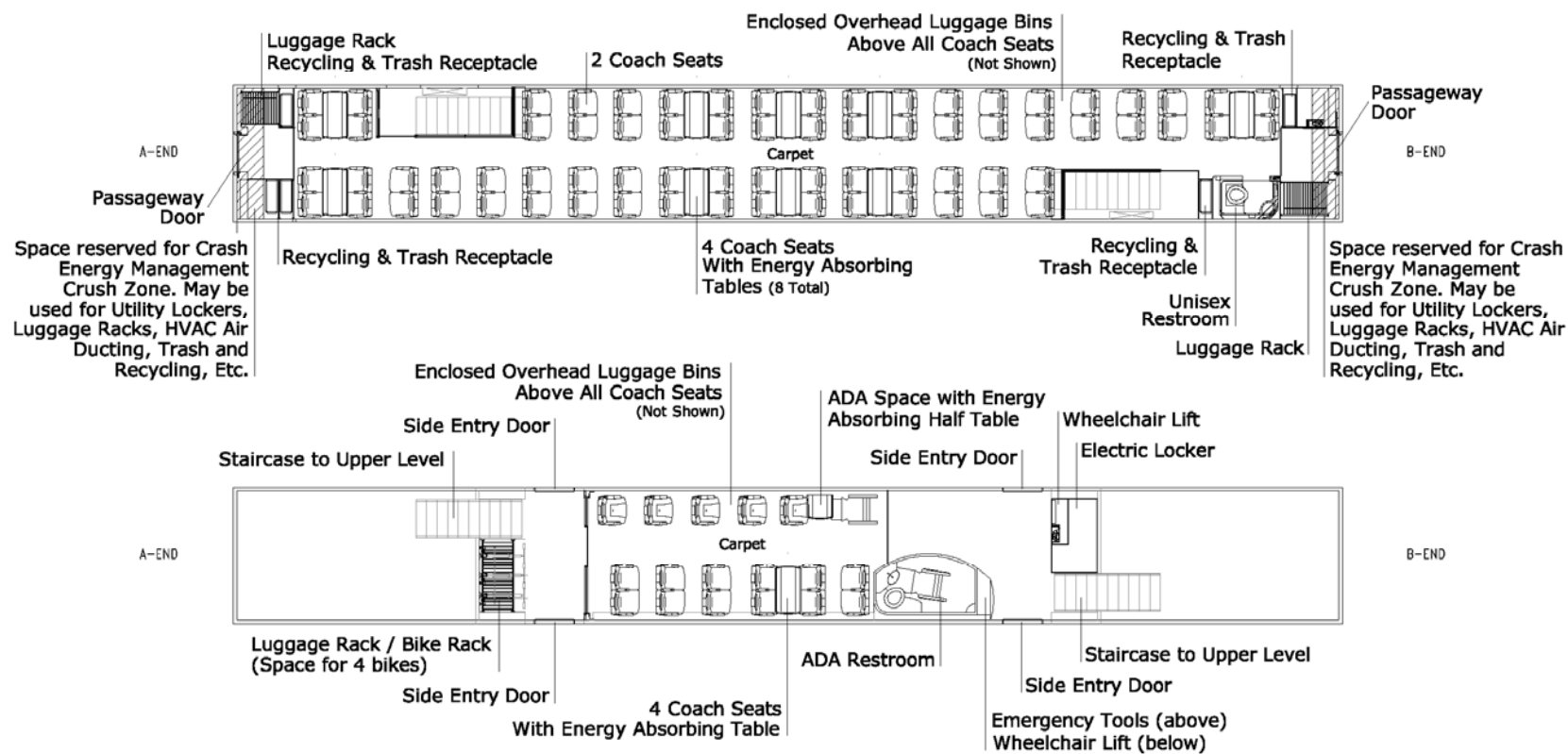
Details regarding the requirements for the construction and review of the mockups can be found in Chapter 3.

COACH CAR LAYOUT

NOTE: Drawings are strictly conceptual.
They are subject to change for actual design.

Upper Level

72 Seats, 8 Tables



Lower Level

Figure 9-1: Coach Car Interior

CAB/BAGGAGE COACH CAR LAYOUT

NOTE: Drawings are strictly conceptual.
They are subject to change for actual design.

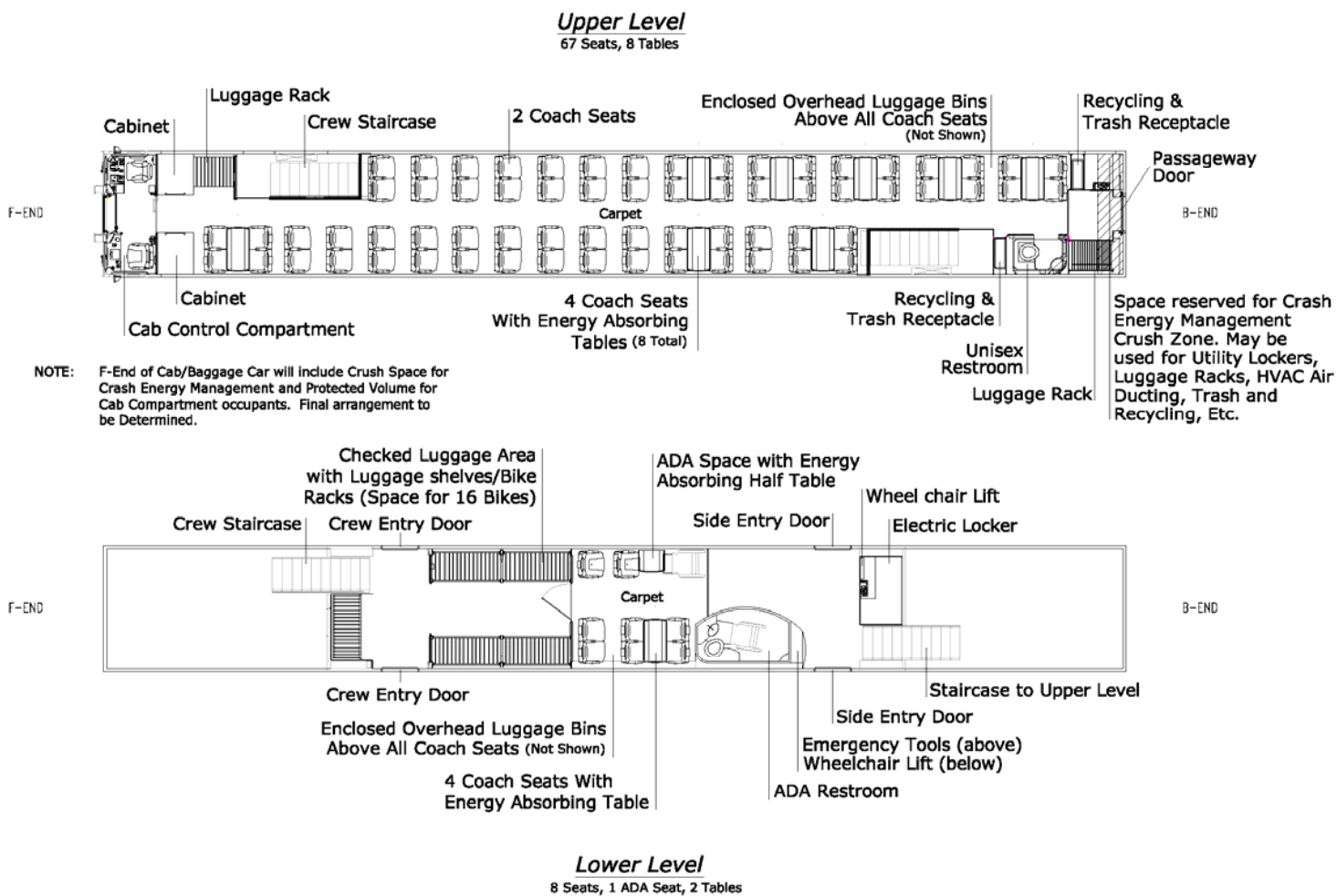


Figure 9-2: Cab/Baggage Car Interior

CAFE/LOUNGE CAR LAYOUT

NOTE: Drawings are strictly conceptual.
They are subject to change for actual design.

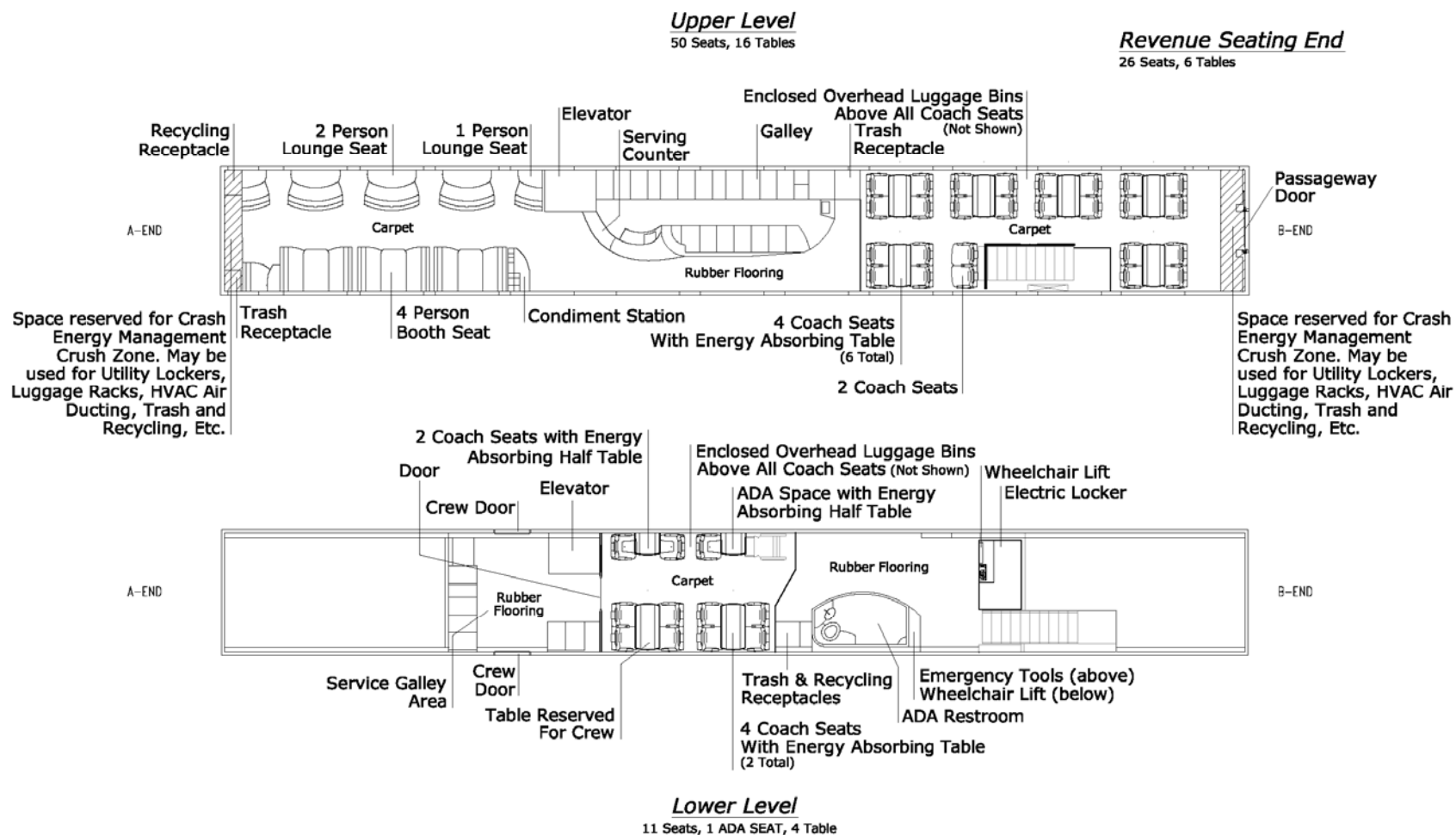


Figure 9-3: Café/Lounge Car Interior

* End of Chapter 9 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee
Bi-Level Passenger Rail Cars

Chapter 10

HVAC System

Table of Contents

10.0	HVAC System	10-2
10.1	Overview	10-2
10.2	General Requirements.....	10-2
10.3	Design Parameters	10-4
10.4	Comfort Requirements	10-4
10.4.1	Interior	10-4
10.4.2	Noise	10-5
10.5	Air Conditioning.....	10-5
10.6	Heating	10-7
10.7	Ventilation	10-8
10.8	Dampers	10-9
10.8.1	Fresh Air Dampers	10-9
10.8.2	Diversion Dampers	10-10
10.9	Controls	10-10
10.9.1	Sensors	10-11
10.9.2	Use of Controls.....	10-11
10.9.3	Status Display.....	10-11
10.9.4	Ventilation Cut-Out Switch	10-12
10.9.5	Freeze Protection	10-12

10.0 HVAC System

10.1 Overview

Each car shall be equipped with two identical units to provide Heating, Ventilation and Air Conditioning (HVAC) to the car. The HVAC units shall be removable and self-contained, and shall utilize scroll compressors and R400-series refrigerants for cooling.

Temperature control shall be provided by a microprocessor-based integrated HVAC control system that monitors ambient outside and inside temperatures and adjusts the system's cooling and heating functions to maintain a comfortable inside temperature and humidity level throughout the range of environmental and climatic conditions identified in Amtrak Specification 963.

Dampers on the fresh air intake vents shall control the amount of outside air taken in by the HVAC system. To adjust and maintain equal temperatures on both levels, diversion dampers at each end of the car shall proportion the amount of conditioned air delivered to the upper and lower levels.

Heating shall be provided by overhead heat in the HVAC units, with additional heating provided by floor heaters along the base of the side walls in the car interiors.

Freeze protection shall be provided on the side door thresholds and all fresh water system components that may be exposed to freezing conditions.

10.2 General Requirements

The HVAC system shall provide a comfortable temperature controlled environment of the interior areas of all cars as follows:

- The cars shall be designed to operate in all environmental and climatic conditions identified in Amtrak Specification 963.
- The car's interior temperature, including the engineer's cab, shall be maintained to the specified value (68°F - 76°F) under all specified circumstances.
- The lower level shall receive adequate airflow from the HVAC to maintain the specified interior temperature and be able to restore the interior temperature after the side entrance doors are opened and the interior temperature is impacted by the ambient outside temperature without affecting the upper level temperatures. If necessary, and with customer approval, auxiliary duct heaters may be used.
- Passenger load shall be assumed to be AW3 for cooling load calculations.
- Heat and cooling requirements shall include the opening of both sets of lower level side doors on alternating sides of the car every 15 minutes and held open for 2 minutes, to simulate passenger loading and unloading in all outside ambient temperatures identified in Amtrak Specification 963.
- Ambient conditions as specified and heat losses due to train motion shall be included in HVAC system performance evaluation.

- Air flow losses due to door and carbody leakage shall be included in the HVAC system performance evaluation.

A microprocessor-based, integrated HVAC system shall be provided. The system shall be designed to maintain the specified interior passenger area temperature and humidity and to also assure adequate interior ventilation. The Contractor shall prepare, and submit for the Customer's approval during design review, a detailed heating and cooling load analysis along with recommended heating, cooling and ventilation capacities. **DR**

In no case shall the heating capacity be less than 40 kilowatt (kW) not including the forced air control cab heater, nor shall the refrigeration capacity be less than 244,000 BTU/Hr. The HVAC unit manufacturer shall conduct qualification testing to verify that the units provide the design heating and cooling capacity per ASHRAE Standard 37-05. This testing is further discussed in Chapter 19.

The HVAC system shall be powered primarily from the 480VAC, 3-phase, 60 Hz supply. The temperature controls shall operate from the 120VAC, 1-phase, 60 Hz supply, and the freeze protection circuits shall operate from the 120VAC, 3-phase, 60 Hz supply. The HVAC system shall be designed to perform at the nominal voltages and operate within the voltage and frequency tolerance ranges specified in Amtrak Specification 963.

To minimize the effects of motor inrush currents on the head end power system, the controls shall incorporate a method to provide staggered starting of the refrigerant compressor motors. The start up timing shall be set to stagger the startup of the A/F-end unit at least 15 seconds before the B-end unit.

Electric baseboard floor heaters, mounted behind stainless steel guards, shall be provided along both side walls, upper and lower levels. Baseboard heaters shall also be provided in the engineer's cab in addition to the forced air heater described in Chapter 16.

Freeze protection is an essential function of the heating system. Freeze protection shall turn the heaters on when ambient outside temperatures drop below 40°F, and shut off when temperatures rise to 50°F.

The HVAC system shall be controlled by a microprocessor temperature control using a sufficient number of temperature sensors to properly regulate heating and cooling in response to temperature changes inside and outside the car. Temperature sensors in the car body shall be located to accurately reflect temperature changes without being unduly influenced by external heat sources or solar radiation.

HVAC system circuit breakers and temperature control adjustment devices shall be located in the electrical locker and be accessible only to the operating crew. Circuit breakers, controls and relays shall be inaccessible to the passengers.

The HVAC unit shall be a fully hermetically sealed system, without threaded components, or other non-welded fittings, except for two service ports equipped with high quality industrial Schrader valves.

Pressure transducers shall be provided to allow the microprocessor to monitor both the discharge and suction line pressures. A technician using a laptop/PTU shall be able to monitor both pressures without the use of pressure gauges.

The performance of the entire assembled HVAC system as installed in a completed car shall be verified at the Climate Room Test specified in Chapter 19.

10.3 Design Parameters

The following parameters are to be assumed in the design of the cooling system:

Ambient Temperature	110°F Dry Bulb/76°F Wet Bulb, with 120°F air entering the condenser
Solar Load	Equivalent to 35° North Latitude, maximum solar heat rate, in accordance with ASHRAE calculation methods
Passenger Heat Load	440 BTU/hr/person at a heat ratio of 0.60
Number of Passengers	90 seated passengers and up to 130 standees (load level AW3)
Carbody Heat Transmission	In accordance with the Contractor's car body insulation design to meet the requirements of this Specification, and not less than 1200 BTU/hr-°F for Stainless Steel.
Maximum Infiltration (Fresh Air)	1,575 Cubic Feet per Minute (cfm)
Other Heat Loads	Normal car lighting, electrical equipment and appliance loads

The following parameters are to be assumed in design of the heating system:

Ambient Temperature	-30°F Dry Bulb
Carbody Heat Transmission	In accordance with the Contractor's car body insulation design to meet the requirements of this Specification, and not less than 1200 BTU/hr-°F
Maximum Infiltration (Fresh Air)	1575 cfm
Solar Load	None
Passenger Load	None
Other Heat Loads	"Quiet car" lighting only (see Chapter 11)

10.4 Comfort Requirements

10.4.1 Interior

The following temperatures shall be maintained within the car's upper and lower levels (including toilet rooms and cab) when the associated ambient outside temperatures are present:

Outside Ambient	Interior Car Temperature
Below -30°F	As system will provide
-30°F to +60°F	70°F ± 2°F
60°F to 110°F	74°F ± 2°F (depending on functioning with or without reheat cycle)
Above 110°F	As system will provide.
Layover Cool Mode	85°F ± 2°F
Layover Heat Mode	50°F ± 5°F

During all modes of air conditioning, the interior relative humidity shall not exceed 60%.

Except within the area of the side doors and vestibules, the HVAC system shall maintain a temperature variation, within both the upper and lower levels, of the following:

- Vertical variation: (On any vertical line, 4 in. above floor to 43 in. above floor, not closer than 6 in. from walls, and not closer than 20 in. from doors): 5°F maximum difference between end points of the vertical line.
- Horizontal variation: (horizontal planes measured 4 in., 43 in. and 67 in. from floor, not closer than 6 in. from walls and not closer than 20 in. from doors.): The temperature at any point within each plane should not exceed $\pm 3^\circ\text{F}$ from the average temperature in that plane.
- The average car temperature, including the upper and lower levels, shall recover within 2°F of the required interior car temperature within three minutes maximum following a two minute door opening on one side of the vehicle. It shall be demonstrated that this requirement can be met during two hours of continuous door cycling of two minutes open and 15 minutes closed at the design conditions in both heating and cooling modes.

Temperature variation between the upper and lower levels shall not exceed 4°F at any time.

10.4.2 Noise

The overall HVAC system shall be designed to minimize noise in the passenger and crew areas of the car. The noise level from the HVAC system shall not exceed the values in the following table. Particular care shall be required at the return air grilles, cab supply vents and galley ceiling air diffusers.

With the car stationary and the HVAC unit in its loudest cooling mode:

Interior noise level: Coach seating areas, cab, toilet rooms and galley	As specified in Chapter 9.
Exterior noise level	75 Decibels (Acoustic) (dBA) max (15 ft from centerline of car)

10.5 Air Conditioning

The cars shall be cooled using electromechanical equipment that has been proven in rail service. Two self contained, hermetically sealed HVAC units shall be provided on each car. The HVAC units shall be identical, one located in each equipment room. The same unit shall be used on all car types. The units shall be designed for a 400-series refrigerant, conforming to 40CFR Part 82. All components within the unit, such as seals, shall be compatible with synthetic lubricants.

Each HVAC unit shall supply conditioned air to the entire car, upper and lower levels. The main air ducts shall incorporate diagonal splitters so that all portions of the passenger areas receive conditioned air from both HVAC units. Separate car air temperature sensors shall be used to provide independent floor heat control for the upper and lower level. The control cab in the cab/baggage car shall also have its own local thermostat.

The air conditioning system shall be designed and adequately sized to maintain interior car temperature as specified measured at the return air grille at the normal ambient conditions. For ambient temperatures at or above 110°F Dry Bulb/76°F Wet Bulb, with air entering the condenser above 120°F, the air conditioning system shall be capable of maintaining cooling at

a reduced capacity, but in no case shall the average interior temperature be more than 25°F below the outside temperature. Application and integration of the system is to be in accordance with the recommendation of the air conditioning manufacturer who shall also specify air flow requirements.

Each HVAC unit shall be totally self-contained, easily removable, and shall consist of a compressor/condenser section and an evaporator section with electric heating units. Condenser air inlet shall be through the car sidewall, with discharge through the equipment room floor. A convenient means shall be provided to install and remove the units from the equipment room through the condenser air intake door opening using a fork lift truck. Tapered guide pins or other suitable method shall be provided to guide the unit into its position in the equipment room. The unit shall be properly supported on a fork lift compatible pallet so as to reduce the amount of wear and tear on the equipment as a function of removing and reinstalling the units over the vehicle's lifetime. The installation and removal process, including removing and installing all mounting hardware, and electrical connections, shall be demonstrated on each car equipment room type for Customer approval at the design review.

The HVAC unit shall be mounted above drip pans. The drip pans shall catch the moisture (condensate) created by the evaporator. The drip pans shall be designed and constructed to prevent sloshing of the condensate while maintaining equipment room pressurization. The drained condensate shall be directed to the roadbed through the equipment room floor structure without leakage into the equipment room or car structure and shall not be discharged on car structure, wheels, brakes or electrical equipment. The exit of the condensate drain lines under the car shall be arranged in an approved manner to be readily accessible for maintenance, be protected from clogging and rodent entry, and as required for servicing the HVAC units.

The refrigeration system shall include, at a minimum, the following components and features:

- The units shall be designed for an R400-series refrigerant, conforming to 40CFR Part 82. All components within the unit, such as seals, shall be compatible with synthetic lubricants.
- A single scroll with modulation or two scroll-type refrigerant compressors working in tandem shall provide, at a minimum, both 50% and 100% capacity control. If tandem scrolls are employed, means shall be provided to alternate use of compressors during single stage cooling so as to equally distribute use and wear.
- Compressor shutdown control shall be by means of a pump down cycle that senses suction line pressure.
- Refrigerant compressor crankcase heaters.
- Refrigerant control box, containing, pressure switches, service switch, etc.
- Direct drive condenser fan and motor assemblies.
- Condenser coil assemblies with 0.008 in. thick copper fins on 0.38 in. diameter copper tubing at a spacing of 8 fins per in.
- One charging and one evacuation port equipped with high quality Schrader valves and sealing metal caps.
- Filter drier.
- Discharge line check valves, and moisture and liquid indicators.
- Direct drive supply air blower and motor assemblies.

- Liquid line solenoid valves (2 per unit).
- Thermal expansion valves (2 per unit).
- Evaporator coil assemblies with two horizontally split sections for modulated and full cooling. The assembly shall have 0.008 in. thick copper fins on 0.38 in. diameter copper tubing at a spacing of 10 fins per inch.
- High and low pressure switches.
- High and low pressure transducers.

For cab compartment air conditioning, refer to Chapter 16.

10.6 Heating

The cars shall be electrically heated. The system shall compensate for carbody losses and fresh air heating loads.

The heating system shall be designed and adequately sized to maintain interior temperature as specified throughout the car measured at the return air grille at the normal ambient conditions. Overhead heat shall be divided into stages. The size of each stage shall be chosen and controlled so that cycling of the heating contactors is minimized.

The overhead heaters shall be protected against overheating. Two protection devices shall be installed. The first device shall disable the overhead heater by disabling the control circuit to the heater; this device shall have an automatic reset. The second device shall have a slightly higher temperature setting than the first device. The second device shall disable the overhead heater and energize the shunt trip coil of the overhead heat circuit breaker and will require a manual reset. The protection method shall be reviewed by the Customer at the design review.

Antifreeze protection, activated at an outside temperature of 40°F, shall be provided for the side door thresholds, side door pockets, water tank and water drain valves. The heater circuits shall be protected by an independent circuit breaker. Refer to Chapter 15 for Water and Waste System. In addition, each equipment room shall be equipped with its own self-contained heater unit that operates independently of the main HVAC temperature controls. The equipment room heaters shall turn on when the ambient temperature in the equipment room drops to 40°F, and shall turn off when the equipment room temperature rises to 50°F.

Layover heat shall be supplied by the sidewall floor heat and shall maintain an interior temperature of 50°F ± 5°F, including the cab. During layover heating, the evaporator fans shall not operate and the fresh air shall be shut off.

The heating system shall include, at a minimum, the following components and features:

- Staged or modulated forced air electrical overhead heat.
- Heater over temperature protection devices.
- Staged or modulated sidewall heaters.

For additional cab compartment heating requirements, refer to Chapter 16.

10.7 Ventilation

The ventilation system shall include, at a minimum, the following components and features:

- Exterior fresh air intakes with water eliminators and filters
- Electrically motorized fresh air dampers
- Frame type disposable air filters
- Air distribution ducts
- Electrically motorized lower level/upper level supply air diversion dampers
- Air diffusers and grilles
- Exhaust ducts
- Exhaust fans
- Emergency fan switches

Ventilation of the car shall be accomplished by blower fans supplied as part of the HVAC units. Fresh air shall enter the car through stainless steel fresh air intakes and shall pass through stainless steel ducts which include drains for condensation and water to be diverted to the outside of the car.

Re-circulated air shall pass through a stainless steel grille(s) into a plenum chamber where it mixes with the fresh air, be filtered and pass to the HVAC unit blower. The blower fans shall move the mixed air through the cooling and heating coils and force the conditioned air into the upper and lower level, stainless steel supply air ducts. The duct shall be sized to minimize noise from air velocity.

Conditioned air is then delivered within the car through longitudinal, diagonally split supply air ducts to longitudinal diffusers which are located along the ceiling of the upper and lower levels of the car. Local diffusers shall also be provided for the operator cab, and galley in the café/lounge car.

Mechanical balancing dampers shall be used in supply air ducts to set the correct air flow between the upper and lower levels of the car. These dampers must be set and locked once the correct CFM air flow levels are determined.

The diffusers shall be designed to deliver equalized airflow through out the car and meet the temperature variation requirements specified. The maximum velocity of discharge air shall not exceed 100 feet per minute (fpm) at 6 in. below the face of the diffusers. Air delivery performance shall be verified during HVAC system proof-of-design testing. Refer to Chapter 19. The diffusers shall be fixed on all cars, except for the car designated for proof-of-design testing, where adjustable diffusers shall be used.

The total air flow from the evaporator blower fans on both HVAC units shall be determined by the Contractor to meet the interior requirements at the specified ambient temperatures, and shall not be less than 6300 cfm. The evaporator blower fans shall be sized to overcome the high external static pressure determined by the Contractor. The blower shall be centrifugal type, directly driven from the motor shaft. The motor shall be TEFC, class H insulation, resiliently mounted, and equipped with permanently lubricated sealed bearings.

Intake of filtered fresh air shall be provided for each end of the car, the required fresh air volume being between 1200 cfm and 1400 cfm, regardless of car position in a train or the car speed and shall be adequate to maintain the positive pressurization requirements of the specification.

Baffle plates shall be used to set the volumes of fresh and re-circulated air. The baffle plates shall be fixed on all cars, except for the car designated for car level testing, where adjustable baffle plates shall be used.

Because the heating and cooling loads vary between upper and lower levels of the car, electric-operated diversion dampers shall be provided to adjust the amount of conditioned supply air between the upper and lower levels of the car to maintain required temperatures on both levels. These diversion dampers shall be independently controlled by the car temperature control unit.

An exhaust fan vented to the exterior of the car shell shall be provided in each toilet room to control odors. Toilet room exhaust shall, at all operating speeds, maintain a negative pressure in the toilet room at all times as compared to the rest of the car interior. An exhaust fan shall be provided in the electric locker to assist in exhausting stale warm air. The electric locker fans shall exhaust outlet air into the equipment room, both to provide pressurization and also ventilation with some heating/cooling value.

The temperature controls shall provide for ventilation with no heating or cooling when temperature conditions do not require heating or cooling.

Ventilation detection and interlocking devices shall be provided and installed such that there shall be no overhead heat and/or cooling when absence of ventilation is detected.

The ventilation system shall provide a minimum positive carbody pressurization of 0.1 in. water gage at full fresh air flow above ambient exterior pressure with all exterior doors and windows closed and the toilet room exhaust fans running.

Fresh and re-circulated air shall be filtered at the HVAC units with disposable pleated-type filters and disposable "synthetic bulk media"-type filters. The filters shall be located for ease of replacement from outside the car via the HVAC unit service access door. It is desirable to be able to change the filters with only minimal use of a ladder on the wayside; accordingly, air filter door latches shall be as low as practical on the door, while still providing proper air-tight seal. The air filter doors shall contain a nameplate showing the correct filter orientation and airflow direction. The filters shall meet the requirements specified in Amtrak Specification 685 and be commercially available.

In addition to the disposable pleated-type unit filters, the fresh air exterior intakes shall be fitted with louvers or grilles to prevent ingress of water.

10.8 Dampers

10.8.1 Fresh Air Dampers

The Fresh Air Intakes shall be equipped with power-operated, infinitely variable, fresh air dampers, which can be in these 3 states: Fully Open, Restricting and Fully Closed. Controlled by the car temperature control panel, the dampers are used to allow full fresh air into the car under normal operating conditions. With temperatures outside the normal range, the dampers shall operate variably between OPEN and CLOSED to optimize fresh air quantity for the

purpose of maintaining the required interior temperature while providing the maximum possible percentage of full fresh air. During layover and warm up/cool down, the dampers shall be fully closed.

The damper frame, blades and hardware shall be constructed of corrosion-resistant material so they will last the life of the car with no attention other than inspection and cleaning at 8-year car overhaul. The drive motor shall be robust and off the shelf readily available.

The dampers shall incorporate a spring close feature so that they self-close upon loss of power. They shall also incorporate a position sensor to provide a feedback signal to the temperature control panel. Design of the damper unit shall keep the number of adjustments required to a minimum. Once settings are made, they shall be locked, so they remain fixed for the life of the damper.

10.8.2 Diversion Dampers

Power-operated diversion dampers shall be provided in the supply air ducts to the upper and lower levels to allow the temperature control panel to adjust the ratio of supply air between the upper and lower levels of the car to maintain a small temperature difference between levels. A- and B-end dampers shall be independently controlled. If desired, the dampers can be two-state, with the control provided on a local basis from a self-contained control module, as part of the damper assembly. If the dampers are locally controlled, a means to test operation of the unit shall be included as part of the module.

The damper frame, blades and hardware shall be constructed of corrosion resistant material so they will last the life of the car with no attention other than inspection and cleaning at 8 year car overhaul. The drive motor shall be robust and readily available. It shall also incorporate a position sensor to provide a feedback signal to the temperature control panel. Design of the damper unit shall keep the minimum number of adjustments required to a minimum. Once settings are made, they shall be locked, so they remain fixed for the life of the damper. The damper shall not require any periodic adjustment over its life. Any adjustments shall be marked so that if components must be changed, the correct settings identified for the new part automatically.

10.9 Controls

Heating and cooling control shall be controlled by a microprocessor using electronic sensors for temperature and pressure data. The output of the microprocessor shall drive solid state and electromechanical relays and contactors which shall, in turn, control electrical power to the heater elements, motors and various control devices. The changeover between heating and cooling shall be automatic and, except for the reheat stage of overhead heat, shall preclude the simultaneous operation of heating and air conditioning. The microprocessor software application shall permit maintenance personnel using the PTU to modify temperature and pressure set-points as well as various other parameters, such as timers.

10.9.1 Sensors

At a minimum, the following temperature sensors shall be required:

- Three interior temperature sensors located throughout the passenger seating area on each level.
- Return air sensor at each HVAC unit return air grille.
- Fresh air sensor at each HVAC unit fresh air inlet.
- Freeze protection thermostat located in a position that accurately measures outside temperature.
- Evaporator coil sensors to detect ice build-up on the evaporator coils.
- Cab control compartment thermostat.

10.9.2 Use of Controls

The temperature control system shall operate automatically. When the car is put into service, the mode selector switches are placed in the NORMAL position. The panel then operates without further attention until the car is taken out of service, possibly many days later.

The mode selector switches are crew-operated controls for the car temperature control system. These switches determine the operating mode of each of the two HVAC systems. The mode selector shall be able to switch from NORMAL to LAYOVER without cycling the HVAC through OFF.

Positions and functions are as follows:

Name	Function
NORMAL	Car HVAC set up shall provide normal occupied car environment. All systems operate.
LAYOVER	Used for car storage in summer to minimize energy consumption, yet still maintain interior temperature of 85°F. Used for car storage in winter to minimize energy consumption, yet still maintain interior temperature of 50°F. Only floor heat shall be available.
OFF	Used to shut off all car heating and cooling when car is being serviced or in storage. Does not shut off freeze protection.

10.9.3 Status Display

Each HVAC control panel shall include an indicator and monitor display which shall show the control logic state. Indications shall be by means of suitably labeled Light Emitting Diodes (LEDs) or by LCD screen, which shall display all calls for heating or cooling from the zones controlled from that panel. Fresh air temperature, supply air temperature, return air temperature, suction line pressure and discharge pressure shall be displayed for each HVAC unit. Overload indicators and resets shall be available for use by the train crew without exposing the crew to hazardous voltages. The HVAC controller shall be able to be downloaded by using a laptop computer that is loaded with the Contractor's HVAC diagnostic software. The HVAC software shall have the capability to monitor the HVAC system, test the HVAC system and override the control system. It shall log all faults and download history.

The control system shall include, at a minimum, the following components and features:

- Temperature control panel
- Temperature sensors
- Motor starters
- Motor protective devices
- Heat contactors
- Diagnostics and test capabilities
- Pressure transducers

The Contractor shall submit a temperature control schedule and a detailed description of operation for approval by the Customer at the HVAC system design review.

10.9.4 Ventilation Cut-Out Switch

A ventilation system isolation switch shall be located at each upper level end door passageway, and on the vestibule wall next to the electrical locker door. These switches shall turn off the HVAC system blowers on both HVAC units to prevent the circulation of smoke or fumes throughout the car in the event of an emergency. The switches shall be wired in series so that any one switch shall shut the system off. These switches shall be labeled VENTILATION CUT-OUT accordance with Figure 10-1 and Amtrak's interior signage manual. The switch shall be a two-position switch with a red spring-loaded flip-up cover that must be lifted to put the switch in the OFF position. Placing the cover in the closed position returns the switch to the on position.

10.9.5 Freeze Protection

The freeze protection system shall allow unrestricted vehicle operation of water, waste and door systems down to -30°F ambient, under all weather and train operating conditions. See Chapter 15.

* End of Chapter 10 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 11

Lighting System

Table of Contents

11.0	Lighting System.....	11-2
11.1	Overview	11-2
11.2	General Requirements.....	11-2
11.3	Lighting Plan Design Review.....	11-3
11.4	Interior Lighting Levels.....	11-3
11.4.1	Lighting Color Temperatures	11-3
11.4.2	Minimum Lighting Illumination	11-3
11.5	Interior Lighting Modes	11-4
11.5.1	Normal Lighting Mode	11-4
11.5.2	Quiet Car Mode	11-4
11.5.3	Standby Lighting Mode.....	11-4
11.5.4	Emergency Lighting Mode.....	11-4
11.6	Interior Lighting Requirements.....	11-5
11.6.1	Passenger Area.....	11-5
11.6.2	Vestibules, Stairways and other Non-Seating Areas	11-5
11.6.3	Toilet Rooms.....	11-7
11.6.4	Service and Utility Rooms.....	11-7
11.7	Exterior Lighting Requirements.....	11-8
11.7.1	Marker Lights	11-8
11.7.2	Platform Lights	11-8
11.7.3	Exterior Indicator Lights.....	11-9
11.7.4	Exterior Door ADA Lights	11-9
11.7.5	Headlights and Crossing Lights	11-9
11.8	Systems Indicator Panel.....	11-9
11.9	Lighting Fixture Requirements	11-10
11.9.1	Fluorescent Lighting.....	11-10
11.9.2	Light Emitting Diode (LED) Lighting	11-11
11.9.3	DC/AC Ballasts.....	11-11
11.9.4	Capacitor-Based Lighting	11-12
11.10	Housings, Lenses and Diffusers	11-12
11.11	Controls	11-12
11.12	Testing.....	11-13

11.0 Lighting System

11.1 Overview

This chapter describes the interior and exterior lighting system that shall be provided on all car types. The lighting system as designed shall enhance the appeal of interior furnishings and create a comfortable and pleasant atmosphere while providing for maximum passenger and crewmember safety. Normal and emergency lighting shall conform to the requirements of all applicable APTA standards and FRA regulations.

The lighting system shall provide four modes of interior lighting: normal, quiet car, standby and emergency. Interior and exterior lighting shall be provided by Light Emitting Diodes (LEDs) or a combination of LEDs and fluorescent lights. LEDs are the preferred method of providing interior passenger seating area lighting. Lights in toilet rooms, stairways, vestibules, passageways, as well as reading lights and indicator lights shall be LED. Incandescent lights shall not be used except as specified. Halogen lights shall not be used.

For lighting requirements in the lounge and galley areas of the café/lounge car, see Chapter 14. For lighting requirements in the cab control compartment and F-end of the cab/baggage car, see Chapter 16.

The Contractor shall prepare an interior and exterior lighting plan for Customer review that describes the type of lighting to be used in all applications, including fixture type, voltage and color temperature, illumination levels at specified locations for all lighting modes, and compliance with emergency lighting and signage regulations and standards. This lighting plan shall be submitted to the Customer during the design review.

11.2 General Requirements

Unless otherwise specified in this section, lighting design (both on the exterior and in the interior of the car) shall meet or exceed the minimum standards defined by APTA Standards SS-PS-002-98 and SS-PS-004-99 and APTA Recommended Practice RP-E-012-99.

Fixtures installed on the vehicle exterior, and in the interior within 2 ft of a doorway, shall be watertight, except for interior ceiling lights.

Car interior lighting shall provide adequate and convenient illumination under all ambient lighting conditions from complete darkness to bright sunlight. Lighting in all locations shall be arranged to minimize shadows, avoid glare and excessive brightness ratios. Lighting shall be appropriate for the application, easily maintainable and compliant with all regulations and standards including this specification.

All lighting lamps and fixtures shall be suitable for rough duty service found in the railroad environment throughout North America. All lamps shall be commercially available from multiple sources.

The use of LED lighting is the preferred method for interior lighting. Halogen lamps shall not be used. Incandescent lamps shall not be used, except headlights and crossing lights on cab/baggage cars, and marker lights on all car types.

Each type of lamp shall have a distinct fixture design for its specific voltage. Lamps of differing voltages shall not share the same base design and lamps shall not be interchangeable between fixtures with differing voltages.

The lighting fixture housing or socket shall not be used as a ground return for any other electrical circuits.

11.3 Lighting Plan Design Review

The Contractor shall submit their design plan incorporating all requirements listed for review and approval. Design drawings and calculations showing the complete lighting system including fixture design, fixture locations, lighting illumination, modes of lighting and electrical schematics shall be submitted for evaluation during design review. **DR**

The Contractor shall provide drawings of the lighting arrangement of each car type for Customer approval during design review. The location of each lighting fixture, circuit breaker size and location, switch, control, lamp type, color, luminance value (in foot-candles) and quantity shall be clearly identified. Fixtures providing standby and emergency lighting shall be identified. Proposed lighting levels for photoluminescent emergency exit signage and Low Location Exit Pathway Markings (LLEPM) components will be identified.

Examples of each lighting fixture shall be provided for Customer approval at the final design review.

Lighting fixtures shall not be a source of Electromagnetic Interference (EMI) and shall be included in the Electromagnetic Compatibility (EMC) plan required by APTA Standard SS-E-010.98. See chapter 19.

11.4 Interior Lighting Levels

All light level measurements shall be made in accordance with the minimum standards defined by APTA Recommended Practice RP-E-012-99.

11.4.1 Lighting Color Temperatures

The lighting color for all interior lights and lamps in the passenger rail car shall be 3500° - 4100° Kelvin (K). The Contractor is to provide suggested light color plan for Customer's review and approval during the preliminary design review. **DR**

11.4.2 Minimum Lighting Illumination

The minimum spatial average of illumination shall be at the points listed in Table 11-1, and shall meet the minimum value(s), measured in foot-candles, with all lights on and at the rated voltage when the equipment is new.

11.5 Interior Lighting Modes

11.5.1 Normal Lighting Mode

Normal lighting mode is that which is available when the car is operating from a 480VAC power source. All lighting fixtures and elements intended for use while the car is in revenue service shall be available during normal lighting mode. Minimum illumination levels for normal lighting mode are shown in Table 11-1.

11.5.2 Quiet Car Mode

Normal lighting mode in the car shall be arranged to allow the level of lighting to be reduced for passenger comfort during early morning and late evening operation, while maintaining sufficient lighting for passenger and crew safety, and compliance with standards and regulations. This reduced light level, referred to as “Quiet Car” mode, may use any combination of lighting elements so long as minimum light levels are maintained at “Standby” illumination levels throughout the car, and all light fixtures operating during quiet car mode remain powered at all times, either through the Alternating Current (AC) system or the low-voltage power supply. Car lighting during quiet car mode shall be adequate to charge the photoluminescent emergency signage and LLEPM system per the required standards. A dedicated, clearly labeled switch in the electric locker shall permit operating personnel to easily select either normal lighting or quiet car mode lighting. Minimum illumination levels for quiet car mode are shown in Table 11-1 under the “Standby Lighting” column.

11.5.3 Standby Lighting Mode

Standby lighting is that which is available when the car has lost Head End Power (HEP) but the battery has not yet discharged to load shed. This lighting mode is intended to keep sufficient lighting operational for a period of at least two hours so that short term loss of 480VAC power will not affect the passengers’ ability to safely move throughout the train. Car lighting during standby mode shall be adequate to maintain the light charge for the photoluminescent emergency signage and LLEPM system per the required standards. Minimum illumination levels for Standby mode are shown in Table 11-1.

11.5.4 Emergency Lighting Mode

Emergency lighting mode is that which is available after load drop has occurred. This lighting provides passenger orientation and sufficient light levels for passengers to move about safely within the car and if necessary, to find the nearest safe exit point. It is especially important in stairways, aisles, vestibules and enclosed spaces, such as toilet rooms. Once the low voltage system reaches a pre-determined low-voltage threshold, all standby lighting is extinguished and emergency lighting shall illuminate. This lighting system may use dedicated fixtures, may provide a reduced level of illumination from the normal lighting system, or may use some but not all of the normal lighting fixtures. The emergency lighting system shall be powered by capacitors, or by batteries if capacitors cannot comply with FRA requirements for emergency lighting, and shall provide emergency lighting for a minimum of 90 minutes. Emergency lighting shall comply with APTA Standard SS-E-013-99.

The Contractor shall provide for Customer approval during design review an Emergency Lighting Plan that describes and illustrates the emergency lighting system, including location,

type and design of all lighting fixtures and the level of illumination that shall be provided at all points as identified in APTA Standard SS-E-013-99. The Contractor shall demonstrate compliance with emergency lighting requirements and shall provide to the Customer written certification of compliance. **DR**

11.6 Interior Lighting Requirements

11.6.1 Passenger Area

The following describes the individual lighting fixture applications and specifications for all areas of the car. Lights may be fluorescent or LED unless otherwise specified. Light fixtures in toilet room ceiling, stairway ceiling, vestibule ceiling and hallway ceiling shall be identical units if possible.

11.6.1.1 Main Ceiling

Two longitudinal rows of lights shall provide the primary lighting for the seating area in the revenue seating areas of coaches, cab/baggage and café/lounge cars, and shall be located adjacent to the center ceiling panels/air diffusers. Other arrangements can be proposed but are subject to Customer approval. These LED or fluorescent fixtures provide the main light source to the car and provide lighting to the aisle as well as general lighting to the seating areas. The fixtures shall be trough-construction units, mounted end-to-end. They shall be equipped with terminal blocks wired in parallel fixture-to-fixture, including all bus wiring for the entire fixture string for normal, quiet car and standby modes. LED units shall be used in place of fluorescent tubes provided that they create an even light output and similar appearance to fluorescent lights.

11.6.1.2 Passenger Reading Lights

Individual reading lights shall be white LEDs powered by 24VDC. They shall be mounted in an adjustable gimbal mount that allows for individual directional adjustment. Each reading light shall have an ON/OFF switch. A reading light shall be provided for each coach seat and the wheelchair parking location.

Passenger reading lighting shall be mounted in an adjustable track located on the underside of the luggage rack, so that the reading light fixtures can be relocated to match the seat pitch as specified by the Customer. See Chapters 9 and 23.

11.6.2 Vestibules, Stairways and other Non-Seating Areas

11.6.2.1 Flush-Mounted Overhead Light Fixtures

Flush-mounted overhead light fixtures with LED light elements shall be provided in the following locations for the purposes of commonality and interchangeability:

- Vestibule ceilings
- Toilet room ceilings
- Stairway ceilings

- Hallway ceilings
- Checked baggage room
- Above upper-level luggage racks

11.6.2.2 Diaphragm/End Passageway

The end passageway light shall be a weatherproof, sealed LED unit mounted overhead to the side of the passageway on the diaphragm side of the end doors on all car types. The unit shall cast adequate light throughout the diaphragm and passageway area including handholds, door panel, walkway surface, signage and handbrake.

11.6.2.3 Vestibule Ceiling at Lower Level Side Doors

Flush-mounted light fixtures shall provide overhead light to the areas adjacent to the side entry doors. The lights shall provide adequate illumination to charge all required emergency signage on and around door panels and emergency door releases. The same fixture shall be used at all side entrance locations, including service vestibules in the café/lounge and cab/baggage cars.

11.6.2.4 Stairway Ceiling

Flush-mounted light fixtures shall provide overhead light to the stairways.

11.6.2.5 Stairway Sidewall

Step lights shall be sealed, recessed, wall-mounted LED units. Fixture shall be impact-resistant and shall not present a tripping hazard. Each light unit may illuminate several steps. All steps shall be illuminated. These lights will be utilized by the emergency lighting system also.

11.6.2.6 Hallway

A flush-mounted LED fixture shall provide light in the ceiling of the hallways. These lights shall be used in the following locations, at a minimum:

- Hallway at accessible toilet
- Hallway past café galley
- Hallway adjacent to utility lockers, luggage racks and toilet rooms at end doors

11.6.2.7 Luggage Rack/Bike Rack Area

A pair of recessed can-type LED fixtures shall be provided in the ceiling of the luggage rack/bike rack area in the lower level A-end vestibule of coach cars.

11.6.2.8 Checked Baggage Room

The baggage room shall be equipped with no less than four flush-mounted ceiling fixtures over the luggage racks, similar to those in the luggage rack/bike rack area in the A-end vestibule of coach cars. Each fixture shall be equipped with a robust guard to protect the lens from damage. These fixtures are in addition to those in the vestibule above the side entrance doors.

11.6.3 Toilet Rooms

11.6.3.1 Toilet Ceiling and Mirror

Two light fixtures shall be mounted on the ceiling of each toilet room to provide general lighting to the toilet room.

The lighting fixtures shall be wired in parallel and shall be provided as part of the toilet module.

11.6.3.2 Toilet Room Occupied/Out of Service Sign

The toilet OCCUPIED/OUT OF SERVICE light fixture shall be mounted on the toilet room exterior wall, adjacent to the toilet room door for all toilet rooms. This light shall consist of a two-light LED fixture with a sign containing text and/or a pictorial symbol which provides indication as to when the toilet room door is locked (occupied) and a second light that provides indication that the toilet room is “out of service” (when the toilet system is not functioning). Lights shall be on when the toilet is occupied or out of service, and shall be extinguished when the toilet is available for use. These LEDs shall be yellow. Artwork for the labels shall be submitted to the Customer for approval during the design review. **DR**

A yellow LED indicator shall be provided inside the toilet room, adjacent to the door, that illuminates when the door is locked (parallel with the toilet occupied indicator outside the toilet room). This indicator shall be labeled DOOR LOCKED WHEN LIGHT IS ON.

The LEDs used for these indicators shall be no less than 0.25 in. in diameter for clear visibility to passengers.

11.6.4 Service and Utility Rooms

11.6.4.1 Electrical Locker

The electrical locker shall be illuminated by at least two overhead lights, controlled by a wall-mounted manual ON/OFF switch located adjacent to the door. The light fixtures shall be protected by a clear shatterproof glass or polycarbonate lens, or other suitable protection, and shall not be vulnerable to damage during normal maintenance activities. Electric locker lights shall be operable during all lighting modes.

11.6.4.2 Utility Locker

At least one light fixture shall be installed in each interior utility locker, and shall be energized by means of an automatic light switch that turns the lights on when the door is opened and off when the door is closed. If necessary to illuminate the space, multiple light fixtures shall be installed and operated by the single ON/OFF switch. The lights shall be so located as to provide general illumination within the locker and be readily accessible for replacement.

11.6.4.3 Equipment Rooms

Each equipment room shall be equipped at least four flush-mounted waterproof fixtures to provide good lighting throughout the equipment rooms for inspecting and servicing the equipment. The light fixtures shall be protected by a clear shatterproof glass or polycarbonate

lens, or other suitable protection, and shall not be vulnerable to damage during normal maintenance activities. The lamps shall be LED or DC-based compact fluorescent. The light design shall provide sufficient light to illuminate the entire room interior and allow all equipment within it to be serviced in place without the need for additional portable lighting. A manual, moisture-proof, over-travel type limit switch shall be installed inside the door opening adjacent to the door.

11.6.4.4 Control Cab

Lighting requirements for the control cab compartment in the cab/baggage cars are described in Chapter 16.

11.6.4.5 Café/Lounge Galley and Lounge Area

Lighting requirements for the food service galleys (upper and lower) and the lounge seating area of the café/lounge car are described in Chapter 14, except as noted.

11.7 Exterior Lighting Requirements

11.7.1 Marker Lights

All cars shall be equipped with two red marker lights at each end of the car.

The marker lights shall be incandescent and shall meet FRA requirements in 49CFR Part 221.

The marker lights shall be operable during normal, quiet car and standby lighting modes.

The marker lights will be controlled by a 3-position switch in the electric locker, having A-END, OFF, and B-END positions (the A-END position marking will be replaced by F-END on cab cars).

The marker lights on the F-end of the cab cars shall illuminate when the selector switch in the electrical locker is placed in the F-END position, except when the headlights and/or crossing lights are illuminated. Placing the headlight selector switch in any position other than OFF shall extinguish the marker lights. Returning the headlight selector switch to OFF shall re-illuminate the marker lights when the marker light selector switch is in the F-END position.

11.7.2 Platform Lights

Each side door opening shall have a platform light that will illuminate the platform area adjacent to that door opening when those doors are opened. This light shall be mounted flush into the carshell or the threshold area and not protrude beyond the side of the car. The light shall be aimed downward so as to not shine directly into the eyes of passengers or crew standing on the platform or in the vestibule of the car, and shall be mounted in an impact-resistant and waterproof housing. The platform lights shall illuminate when one or both door panels in the adjacent door opening is opened, either by command from the door control system, or by use of the emergency door release. The platform light shall remain off when both door panels are closed and latched, or locked with a mortise lock.

At a minimum, the Contractor shall meet the requirements of 49CFR Section 38.101.

The platform lights shall also be a part of the emergency lighting system and shall conform to APTA Standard SS-E-013-99.

11.7.3 Exterior Indicator Lights

Each car shall be equipped with exterior door open indicator lights, four per car. These indicators shall be red LEDs and shall be located on the exterior of the car adjacent to doors 2, 3, 6 and 7, so that their status is visible to the engineer when viewed down the side of the train. They shall display a red indication when any door in the adjacent vestibule is open (i.e., not closed and latched, or locked with the mortise lock) and shall be dark when all doors in that vestibule area are closed and latched.

Each car shall be equipped with two exterior brake indicator light units, one on each side of the car, adjacent to doors 2 and 6. Brake indicators shall be green and yellow LEDs, and shall display the following indications:

Solid Yellow	Air brakes applied (handbrake released)
Flashing Yellow	Handbrake applied (air brakes applied or released)
Solid Green	Air brakes and handbrake released

The brake indicator unit may be combined with the door open indicator light.

The single-light door indicator units shall be Dialight p/n 566-0001-805.

The three-light door/brake indicator unit shall be Dialight p/n 566-0003-802. This unit shall be mounted with the indicator lights oriented top to bottom: green/yellow/red.

11.7.4 Exterior Door ADA Lights

A flashing blue LED fixture shall be mounted above or adjacent to each side door opening to serve as a visual beacon to ADA passengers when the adjacent door is open. This indicator shall be viewable from all angles on the exterior of the car. The light shall flash at a rate of 1 Hz when the door is open, and 2 Hz for five seconds before the door closes.

11.7.5 Headlights and Crossing Lights

Requirements for cab car headlights and crossing lights are described in Chapter 16.

11.8 Systems Indicator Panel

A multi-LED systems indicator panel shall be located on the B-end vestibule wall adjacent to the electrical locker door, and shall serve to provide a visual indication of the status of designated systems. The panel shall be mounted in a location that will prevent tampering or damage from routine maintenance or cleaning, and will be visible from the vestibule area. The indicators shall be as follows:

System	Indicator
HVAC (one indicator for each unit)	Blue (A/F-end and B-end)
Wheel slide control system	Green
Toilet system	Yellow
Battery charger	Red
Communication/public address system	White
Door system	Yellow

Specific function of the indicator lights is described in the applicable chapter for each subsystem. Indicator lights shall be flashing on and off at 1 Hz when the system has developed a fault or is not functioning properly, as defined in each chapter, and shall be on continuously when the system is functioning as intended. All LEDs shall be appropriately labeled. The systems indicator panel shall have a lamp test button to verify that the LEDs illuminate when energized.

11.9 Lighting Fixture Requirements

11.9.1 Fluorescent Lighting

LED lighting is preferred, but where fluorescent lighting exists it shall use rapid-start, T-8 lamps with a color temperature of 3500°-4100°K.

Where possible, the lighting fixtures shall be arranged with one-rapid start inverter ballast controlling two lamps in a master and slave arrangement. Stand-alone fixtures shall contain a ballast configured for efficient, single-lamp operation. The main interior light fixture shall be arranged for a F32T8 lamp or a F25T8 lamp.

Fixture design shall meet APTA Recommended Practice RP-E-012-99. Lampholder sockets shall be designed to support the ends of the lamp. Terminal pins shall not be the sole source of lamp support. Lampholders shall meet or exceed the requirements of UL542. Lamps shall be secured in the fixture and be able to withstand rough duty service as found in the railroad environment. Fixtures shall be dust and moisture resistant.

The main interior light fixture shall consist of a reflector and door joined by an integral, concealed hinge latched by captive quarter-turn Phillips head fasteners, minimum two per door. The fixture assemblies shall be positioned to maximize the light output projected towards the illuminated surface and center of the car.

The master fixture housing shall contain a ballast mounted on an integral hinged ballast plate retained by captive fasteners designed for repeated use (no self tapping screws allowed). All wiring shall be accessible by hinging the ballast plate down. The BALLAST ON LED shall be visible from the bottom of the ballast plate.

Fluorescent lamps shall be designed to use standard, commercially available length bulbs.

Each light fixture shall have a permanent label and/or stamping, visible when the light cover is removed or swung down, that contains the following information:

- Supplier part number
- Voltage and current or wattage ratings
- Lamp identification, wattage, including color

11.9.2 Light Emitting Diode (LED) Lighting

LED fixtures shall conform to the requirements of the *Energy Policy Act of 2005*, and shall utilize white LEDs. The color temperature shall be 3500°-4100°K.

An LED driver designed to ensure proper operation of the LEDs shall be mounted on the LED assembly. LED assemblies shall be removable without special hardware. Each LED assembly shall be removable after removing only the hinged lens. LED units shall be connected via interlocking, self-polarizing and modular connectors accessible when the light fixture is opened.

All fixtures shall be dust- and moisture-resistant, and shall be arranged to facilitate replacement of the LED assembly from the passenger compartment after opening the lens.

Fixtures equipped with lenses shall have a one-piece polycarbonate translucent white lens, uniform in color and smooth on the exposed side, which will provide the specified intensity of illumination on the reading plane, while diffusing the light to illuminate adjacent wall and ceiling surfaces, increasing the overall brightness level in the interior of the car. The lens shall be mounted on a hinged bezel and shall be secured with captive fasteners.

LEDs used in passenger area overhead lighting (in lieu of fluorescent lights) shall be mounted on replaceable boards installed in the light fixture. Boards shall be connected to the fixture by screws, and shall be plug-connected electrically for easy replacement. The LEDs shall be sized and spaced so that the failure of up to two LEDs on an individual board shall not create an appearance of a dark area on the fixture.

LED lighting shall be sized to provide the level of lighting as outlined in Table 11-1.

Changeable LED lamps are preferred and LED lighting may be dedicated to its fixture where the design is necessary.

11.9.3 DC/AC Ballasts

The fluorescent lighting fixtures shall contain DC inverter and/or AC electronic ballasts. Ballasts shall be high performance, rapid start and solid-state.

Ballasts shall incorporate reverse polarity, overload, open circuit, over-temperature, over-voltage, transient and internal short circuit protection. Inverter ballasts shall withstand transients of 10 Joules and have an electronic clamp to ground feature. The inverter ballasts shall be designed to operate normally from a 74VDC supply, with capability for continuous operation over 45-86VDC supply. Under-voltage protection shall be provided. The ballast shall automatically restart when voltage within the normal range is again applied, and require no reset, such as interrupting a circuit breaker under any conditions. Likewise, if a lamp is changed while the ballast is powered, no action shall be required to restart the ballast. Ballasts shall be equipped with an LED BALLAST ON indicator that illuminates when the ballast is functioning normally and power is on.

All ballasts shall have an over temperature protection feature that automatically resets when the temperature drops to an acceptable level.

The ballasts shall be integral parts of the fixtures, conveniently located and easily removed from the fixtures without disturbing other components and wiring. The ballast on ceiling

lighting fixtures shall be replaceable with the fixture remaining in position. All ballasts shall meet the requirements of ANSI C82.

11.9.4 Capacitor-Based Lighting

The capacitors must be rated for a minimum of 500,000 charge cycles. The capacitor based power source for emergency lighting shall have a label located on the side of the unit exposed for service that includes the following information:

- OEM name and manufacturer's address
- OEM part number — revision/modification level and date
- Date of manufacture
- Unit serial number
- Voltage and capacity rating

11.10 Housings, Lenses and Diffusers

The overhead light assembly shall be designed for lamp replacement from below. The hinged light lens shall swing down allowing easy lamp replacement.

No material shall suffer any loss of performance when exposed to temperatures ranging from -30°F to 150°F or exhibit degradation of properties (including color) under long-term exposure to ultraviolet light.

Lighting fixtures shall have hinged lenses, which will aid in light distribution, prevent glare and facilitate easy lamp replacement. The design of the fixture shall permit easy cleaning and easy lamp renewal. The lenses shall project light with an even brightness without patterns, and shall have a smooth surface on all sides and edges that are open to the passenger seating area to avoid injury. Tamper-proof fasteners shall retain door to the housing. A neoprene foam gasket around the lens assembly shall make the joining of door and reflector dust-resistant and rattle free. The hinged lens shall be removable for replacement. The lenses shall be easily replaceable without having to disassemble the light fixture, and shall be made of an approved Ultraviolet (UV)-stabilized polycarbonate and meet the Flammability, Smoke Emission and Toxicity requirements specified in Chapter 18.

11.11 Controls

All lighting shall be circuit breaker protected. Lights identified for ON/OFF control shall have an ON/OFF switch in addition to the circuit breaker. Controls shall be labeled AC LIGHTS and DC LIGHTS and also NORMAL and QUIET CAR and housed in the electric locker, except as listed below, where local controls shall be provided:

- Each reading light shall have a separate ON/OFF switch located adjacent to the reading light.
- Each reading light at a wheelchair location shall have an ON/OFF switch located in accordance with the requirements of ADA.
- Electrical lockers and equipment rooms shall have manual light switches located inside the equipment room adjacent to the entry door.

- Utility lockers shall have automatic light switches located inside the locker adjacent to the entry door.
- Selected lighting circuits in the food service area shall have ON/OFF switches. See Chapter 14 for details.
- Selected lighting circuits in the cab control compartment of the cab/baggage car shall have ON/OFF switches. See Chapter 16 for details.

11.12 Testing

Car lighting shall be tested for compliance with this specification as well as all applicable APTA standards and FRA regulations regarding minimum illumination requirements and recommendations during normal, quiet car, standby and emergency modes. This shall include charging light levels for photoluminescent decals as part of the emergency signage system.

Test reports shall document lighting levels achieved during these modes, test methodology used during testing, and the standard or regulated light level for all measured locations to demonstrate compliance.

The Contractor shall provide certification to the Customer that the car's lighting system meets all standards and regulations. All required material certifications shall be provided to the Customer.

See chapter 19 for more details.

Table 11-1: Minimum Illumination Levels

Area	Measured at: (See APTA Recommended Practice RP-E-012-99 for specifics)	Normal Lighting (foot- candles)	Quiet Car Lighting (foot-candles)	Standby Lighting (foot-candles)
General Overhead	Table top	30	5	5
Aisle way Lighting	Floor	30	5	5
Indirect Lighting	Table top	5	5	N/A
Stairway Lighting	Stair treads	5	5	5
Vestibules	Floor, threshold, side door panels	30	30	5
General Seating Areas	Table top	30	5	5
Reading Lights	Table top	20	20	20
End Passageway/ Diaphragm Area	Grab handles Door panel at floor level.	10	10	10
Bike/ Luggage Rack Area	Floor	10	10	5
Luggage Rack Tower	Lowest shelf	10	10	5
Toilet Room – ATR Toilet Room – UTR	Floor	30	30	10
	Sink	30	30	10
	Toilet	30	30	10
	Mirror	30	30	10
	Baby changing Door handles	30 30	30 30	10 10
Café Car-Lounge Area	Floor	30	30	5
Galley	Floor	30	30	10
Elevator	Floor	30	30	5
Service Counter Area	Counter	30	30	10
Food Preparation Area	Counter	30	30	10
Electric Locker	Floor	30	30	5
Utility Closet	Floor	5	5	5
Equipment Rooms	Floor	10	10	10
Cab Overhead	Floor, cab console	5	5	5
Cab Reading Lamp	Table height	20	20	20

* End of Chapter 11 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee
Bi-Level Passenger Rail Cars

Chapter 12

Communication System

Table of Contents

12.0	Communication System.....	12-2
12.1	Overview	12-2
12.2	General Requirements.....	12-2
12.2.1	Public Address/Intercom (PA/IC) System Components	12-3
12.2.2	OTIS/PIS System Components	12-3
12.3	Public Address/Intercom (PA/IC) System	12-3
12.3.1	Public Address (PA) System	12-3
12.4	OTIS/PIS Equipment Configurations.....	12-5
12.5	OTIS/PIS Capability	12-5
12.5.1	Wireless/Satellite/Mobile/Ethernet Internet Connectivity	12-7
12.5.2	System Operation.....	12-7
12.6	OTIS/PIS Requirements	12-8
12.6.1	Display Signs	12-8
12.6.2	Car Control Unit (CCU).....	12-9
12.6.3	OTIS/PISCU	12-11
12.6.4	Data Communication System (DCS)	12-11
12.6.5	Global Positioning System (GPS).....	12-12
12.6.6	OTIS/PIS Communication Trainline	12-12
12.6.7	Provision for Wireless Internet	12-14
12.6.8	Land Based Equipment	12-14
12.6.9	Sign System Server (SSS)	12-14
12.6.10	Antennas.....	12-15
12.6.11	OTIS/PIS Server Software.....	12-15
12.6.12	Digital Audio/Video Workstation (DAVW)	12-15
12.6.13	Client Software	12-15
12.7	Portable Test Unit (PTU) Software.....	12-16
12.8	Software.....	12-16
12.8.1	Software/Programming Requirements	12-16
12.8.2	Software License.....	12-16
12.9	Electromagnetic Interference	12-17

12.0 Communication System

12.1 Overview

This chapter describes the system requirements for the on-board communication system to be provided on each car. The communication system consists of four primary subsystems: the Public Address (PA) system, the Intercommunication (IC) system, the Onboard Train Information System/Passenger Information System (OTIS/PIS) and the Data Communication System (DCS). These four systems have discrete functions that are extensively integrated to provide a comprehensive communication system within each car and between the car and other cars in the train (via dedicated Communication (COMM) trainline circuits).

The PA and IC systems shall be fully compatible with existing bi-level rail cars operating in intercity service (*Superliners*, *Surfliners* and *California Cars*), including receiving and originating PA announcements and IC communications. Proper PA and IC volume shall be maintained in each car regardless of strength of trainline signal.

The OTIS/PIS system and wireless connectivity for passengers described here are based on current technologies. The Contractor may propose an alternative design for Customer approval. The alternative design shall be capable of utilizing up to date technologies, must include open architecture and still interface with systems that may already be installed in existing bi-level equipment operating in intercity service (*Superliners*, *Surfliners* and *California Cars*).

The car's DCS shall be capable of multiple functions, including providing a data backbone for Ethernet-based communication within each car and car-to-car that can be used for destination sign and announcement control, provision of wireless internet access for passengers and crew, diagnostics and real-time health monitoring of on-board systems and components, data transfer between the train and wayside communication systems, positive train control functions and other data communication functions as needed. See Figure 12-2.

Additional OTIS/PIS requirements that are exclusive to each customer are described in Chapter 23.

12.2 General Requirements

This specification describes the requirements for the communication systems listed in this chapter, the equipment function and performance, the installation and the logistical support required to be provided by the Contractor.

The OTIS/PIS shall provide the passengers with both visual and audible information such as the train destination, present station, next station, pre-set messages, emergency messages and visual graphics, including advertising. The information shall be provided through the interior and exterior signs and the PA system.

The OTIS/PIS shall be a fully automated system, with manual override feature. Once the system is activated, it will automatically establish train location through the Global Positioning System (GPS) and sequentially display and announce the upcoming stations at programmed locations. It shall allow for simultaneous voice and text messages sent directly from the client software through the Sign System Server (SSS) via cellular data communication. The OTIS/PIS shall support carborne Internet Service Provider (ISP) for Internet connectivity, an Inter-Vehicle Data Network (IVDN) between cars, and provision of an 802.11n access point in each car to provide wireless internet services to passengers.

These communication systems shall consist of the following equipment.

12.2.1 Public Address/Intercom (PA/IC) System Components

- PA control stations:
 - B-end lower level vestibule of all cars
 - Crew workstation at lower level of café/lounge car
 - Serving counter area at upper level galley in café/lounge car
 - Cab control compartment in cab/baggage car
- Intercom stations:
 - At all PA control stations
 - At each end passageway at upper level of each car
- Interior and exterior speakers
- Handset at each PA control station
- PA amplifier
- Interface to OTIS/PIS system
- Interface to trainlines

12.2.2 OTIS/PIS System Components

- Destination signs (interior and exterior signs); (all cars)
- Car Control Unit (CCU); (all cars)
- OTIS/Passenger Information System Control Unit (OTIS/PISCU); (master cars-café/lounge and cab/baggage cars)
- Data Communication System (DCS); (master cars-café/lounge and cab/baggage cars)
- GPS; (master cars-café/lounge and cab/baggage cars)
- OTIS/PIS communication trainline (all cars)
- OTIS/PIS communication trainline IVDN and 802.11n access points (all cars)

12.3 Public Address/Intercom (PA/IC) System

12.3.1 Public Address (PA) System

Cars shall be equipped with a PA system that provides a means for a train crewmember to communicate by voice to passengers in an emergency situation. The PA system shall also provide a means for a train crewmember to communicate by voice in an emergency situation to persons in the immediate vicinity of his or her train. The PA system shall be compatible with the units currently in use on all bi-level equipment as specified in the compatibility provisions of this Specification.

The PA amplifier shall be programmable, with power supplied directly from the car low voltage battery circuit, and protected by a dedicated circuit breaker. The PA amplifier shall interface with the CCU and with the OTIS/PISCU over a digital audio link, and drive the car speakers whenever the PA system or the OTIS/PIS generate audio messages. The CCU and the OTIS/PISCU shall allow automatic volume adjustment based on train number and car location for the purpose of quiet car operation.

The PA amplifier shall have a power output capacity sufficient to drive all the speakers on the car at the nominal speaker output power plus 25% spare capacity. The same PA amplifier unit model shall be installed on all car types.

The PA amplifier inputs and outputs shall be designed so that they may be open-circuited or short-circuited, without damage to the amplifier. Reverse polarity protection shall be provided.

The PA system (from the input to the microphone to the output of the interior speakers) shall have a 90% intelligibility rating when tested according to ANSI Standard S3.2-1989 (R1999) and shall have the following performance characteristics for all modes of operation, including manual and automated digitized and test-to-speech announcements:

Frequency Response:	± 5 dB from 250 Hz to 8 kHz
Total Harmonic Distortion:	Less than 1%
Hum or Buzz:	Signal-to-noise ratio shall be greater than 40dB

The PA amplifier shall incorporate a volume control adjustable only with the use of the Portable Test Unit (PTU).

The PA amplifier volume shall be standardized fleet-wide and measured as a part of acceptance. The sound level from the car's speakers shall be uniform within ± 5 dB at all passenger locations.

The PA amplifier shall be a programmable amplifier.

Power to the PA amplifier shall be supplied directly from the car low voltage battery circuit and shall be protected by a dedicated circuit breaker.

The unit shall incorporate at a minimum, the following indicators on the front panel:

- PA amp output level – displays audio level to speakers
- Bar graph – indicates audio output level
- On-Off Light Emitting Diode (LED) – indicates when switch is on and car battery is present

PA and intercom systems shall be backed-up by battery power for a minimum of 90 minutes of operation. See Chapter 13. Intermittent communication shall be considered equivalent to continuous communication during the last 15 minutes of the 90 minute minimum period for the purposes of Direct Current (DC) load budget calculations.

12.3.1.1 Handset and Holder

The handset shall use the standard Amtrak microphone handset and connector plugs (p/n 10623456).

Handsets shall be equipped with a push-to-talk switch. The handset cord shall be equipped with an adequate strain relief fitting where it is attached to the handset. A handset holder shall be provided with each handset.

12.3.1.2 Interior and Exterior Speakers

Each vehicle shall be equipped with a minimum of 18 speakers located throughout the interior of the car to provide a uniform audio level throughout each passenger compartment. The interior speakers shall be installed for replacement from the front, and sufficient length shall be provided in the wiring for this purpose. Each vehicle shall also be equipped with four weatherproof exterior speakers installed on the exterior of the car sides near each set of doors to enable the broadcasting of messages to passengers on the platform from the PA system from within the car.

The PA system shall be designed to allow the crew to make announcements for distribution through the interior speakers. For a crew member to initiate a PA announcement, a handset must be plugged into the PA receptacle at one of the PA control stations. Once the handset has been plugged in, the audio from the handset shall be placed on the PA audio trainlines when the push-to-talk switch is depressed. PA announcements shall be simultaneously broadcast over the interior and exterior speakers when the door control station is energized and the doors are opened.

There shall be no feedback between car speakers and the control station handset when the public address system is in use.

12.3.1.3 Two-way Crew Intercommunications (Intercom)

The IC system shall be designed to allow the crew to communicate with other personnel on the train including the Engineer in the control cab in the cab/baggage car.

For IC communication between crew members within the train consist, a handset must be plugged into the IC receptacle at one of the PA control stations. Once a handset has been plugged in, the audio from the handset shall be placed on the IC audio trainlines. To signal other crew members that an IC call has been requested, the crew member shall depress the IC CALL pushbutton located above the IC receptacle. Handset-to-handset communication shall be initiated once a crew member at an alternate lower level door control station plugs a handset into the IC receptacle.

12.3.1.4 Emergency Two-way Intercommunications (Intercom)

Cars shall be equipped with an IC system that conforms to 49CFR Section 238.121 and provides a means for passengers and crewmembers to communicate by voice with each other in an emergency situation. At least one IC station that is accessible to passengers without using a tool or other implement shall be located at the upper level end passageway at each end of each car, and in the lower level B-end vestibule.

The location of each IC station intended for passenger use shall be conspicuously marked with luminescent material and legible and understandable operating instructions shall be posted at or near each such intercom.

12.4 OTIS/PIS Equipment Configurations

The following hardware shall be installed on the following cars as described. Equipment on both upper level and lower level are noted below. The table indicates quantity by car type.

Table 12-1: Passenger Information System Equipment Configuration

Car Type	Number of Units and Location						
	Level	Interior Signs	Exterior Signs	CCU	GPS	Data Radio	PA Amplifier
Cab/baggage cars	Upper	4	4	1	1	1	1
	Lower	2					
Coach cars	Upper	4	4	1	0	0	1
	Lower	2					
Cafe/lounge cars	Upper	4	2	1	1	1	1
	Lower	2					

12.5 OTIS/PIS Capability

The OTIS/PIS shall be capable of full graphic and video display including advertising through the interior signs.

The equipment shall be designed and built for use in the rail transit environment. Special considerations for the high humidity and salt content in the air from the coastal marine areas, excessively fine dust, and from freezing temperatures to high temperatures exceeding 110°F (43.5°C) shall be incorporated into the design and shall be in accordance with Amtrak Specification 963.

The carborne equipment shall meet all the requirements of IEC Standard 60571 (latest edition), unless otherwise specified, and be tested accordingly. It is the Contractor's responsibility to supply equipment capable of operation in the rail environment consistent with Amtrak specification 963, which is subject to vibrations, transients and other environmental conditions exceeding the limits prescribed in the IEC standards. All individual components used in the fabrication of the equipment shall meet or exceed the requirements of the above standard. The Contractor shall submit documentation and calculations for all individual components for review and approval by the Customer at the Preliminary Design Review (PDR) to validate the conformance to these standards.

The equipment shall meet the requirements of IEEE Standard P1477 and all FRA, AAR and ADA applicable rules, regulations and guidelines.

The PA function of the carborne OTIS/PIS system shall utilize only digital communication signals between OTIS/PIS equipped cars, but be able to generate or use analog audio signals from other cars as specified. All data and audio digital signals shall be transmitted from car-to-car as described in the single level specification unless otherwise specified by the customer.

All carborne OTIS/PIS equipment shall be powered from the 74VDC (nominal) low voltage car supply. All equipment shall function normally and provide the specified performance for all supply voltages between 58VDC and 86VDC. For voltages lower than 58VDC or higher than 86VDC, automatic shutdown of the equipment is acceptable, followed by automatic restarting as the voltage returns to the specified levels. No permanent damage shall be caused to the equipment following these conditions. See Chapter 13.

All carborne OTIS/PIS equipment shall be protected from damage against a reversed voltage supply, and power supply shutdown and immediate reapplications.

All carborne OTIS/PIS equipment shall have integral power conversion and conditioning. External power supplies are not acceptable.

All carborne OTIS/PIS equipment shall be protected by external dedicated circuit breakers located on the car low voltage control panel. The circuit breakers shall be sized to protect the smallest size wire directly connected to the protected circuit. Fuses shall not be accepted either outside or inside the equipment. Internal circuit protection shall not be used, but if unavoidable must be a re-settable type circuit breaker approved by the Customer.

All 74VDC low voltage power supply inputs shall be isolated from ground.

All supply inputs shall be adequately filtered to minimize current and voltage ripple.

All equipment enclosures and shock-mounted equipment shall be grounded with flexible, strap-type, grounding leads bolted between a car body grounding pad and the equipment grounding pad. Grounding connection pads shall be brazed, welded or silver soldered to the frame. Connections shall be stud or bolt mounted. Grounding through equipment mounting hardware is prohibited. All grounding connections shall meet APTA Standard SS-E-005-98.

All carborne equipment enclosures shall be connected through quarter-turn, quick disconnect, multi-pin connectors with removable crimp contacts. The connectors shall be located in the front of the equipment or other easily accessible locations for quick connection and disconnection. All connectors of the same type and size shall be keyed to avoid insertion into the incorrect location. Connectors shall be identified in accordance with the schematic designation. All connector types shall be submitted to the Customer for approval during design review.

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Removal and installation of any component shall not require the removal of any other equipment.

The enclosure mounting attachments shall be accessible for easy installation and replacement of the unit. Whenever enclosures are supported by their mounting attachments, threaded studs and self-locking nuts shall be used to facilitate their installation.

All carborne equipment shall be housed in dust tight enclosures. Heat generating equipment shall have suitable heat sinks located on external surfaces of the enclosures and be cooled by natural airflow. Cooling fans are not acceptable.

12.5.1 Wireless/Satellite/Mobile/Ethernet Internet Connectivity

The OTIS/PIS system must accommodate wireless technology using satellite or mobile telecommunications ISP for internet connectivity, an Ethernet-type trainline network between cars (must utilize existing available trainlines as identified in Chapter 5) and provision of 802.11n access point in each car to provide wireless internet services to passengers.

12.5.2 System Operation

The OTIS/PIS system shall automatically identify all cars in the train by their car number and their location in the consist, as soon as the train is formed. The communication trainline loop may be used for end of train detection. The OTIS/PIS system shall determine the train location with the use of the GPS receiver.

The system shall receive its train number from the land-based station and have a manual input available for the train crew to use as a backup. The OTIS/PISCU assigns the train number to the consist in case of a malfunction or inability to receive a signal from the base station. The OTIS/PIS system shall transmit and or receive, via the DCS (Customer leased cellular data service) or Wireless Fidelity (WiFi) networks, the train number, train consist, location, time and date, and all other information as required by the Customer to and from the system server. All train consist information data will be retrieved from the PEI DS heads system utilizing data standards developed by Eta Phi Systems, Inc® for use by trains operating on the Capitol Corridor and San Joaquin routes.

The OTIS/PIS system shall access the SSS and verify if all files are up to date. Updating of files shall be automatically carried out through the modification of the affected file(s) portions only and to keep the transmission time to a minimum. All CCU units in the train shall then be updated to the latest received data.

The client software through the SSS shall be able to interrogate the on-board system at any time to obtain information such as train location, train formation, next system programmed station, system status and faults.

The client software through the SSS shall be capable of initiating pre-recorded stored messages, throughout the train or in a car, at any time to send real-time message through Cellular data service to specific trainsets.

The OTIS/PIS system shall provide the capability to the client software through the SSS to interrogate all the CCUs of the train and their monitored systems, via the DCS.

12.6 OTIS/PIS Requirements

12.6.1 Display Signs

12.6.1.1 Interior Signs

Interior signs shall be 17 in. diagonal display with a resolution of at least 1280 by 1024 pixels. They shall be capable of:

- Audiovisual automatic announcements that include information such as present station and next station and arrival times.
- Text displays that may include time and date, train number, destination, and on-time and delay information.
- Special audiovisual messages received from the SSS or initiated by the onboard personnel.
- Animated graphic displays, including entertainment and advertising.

There shall be up to 6 interior signs, 2 in the lower level and 4 in the upper level. See Figure 12-2, Figure 12-3 and Figure 12-4.

The interior signs shall be Liquid Crystal Display (LCD). The displays shall utilize the maximum available space and maximize the sign display area. The signs shall meet all the applicable ADA regulations and requirements. The minimum viewing angle shall be 160° and readable at a distance of 60 ft (18.3 meters). The display shall have at least 50000:1 contrast ratio.

The signs shall be housed in a dust-proof enclosure with a polycarbonate, non-glare display faceplate with graffiti-resistant film applied. Interior signs shall be clearly readable in all ambient light conditions including total darkness and direct sunlight. The signs shall be mounted in a tamper-proof anti-theft enclosure with tamper-proof fasteners.

All signs shall resume normal operation following supply power interruptions. No abnormal sign behavior shall follow any supply power interruption and reapplication.

The interior signs shall have self-diagnostic capability and provide fault condition information to the CCU, including sign location and type of fault. The sign unit, upon the insertion of the car wiring connectors, shall automatically recognize sign location through special coding in the sign unit or car-side wiring connector pins.

Interior displays shall be integrated with the car lighting system to control brightness under normal and quiet lighting modes. Display brightness shall match interior car illumination level under all lighting conditions.

12.6.1.2 Exterior Signs

There shall be up to four exterior signs in each car, one adjacent to each public entrance (two on café/lounge cars, adjacent to the B-end vestibule). Exterior signs shall display train number and destination with fixed and scrolling text.

The exterior signs shall be alphanumeric, color LED matrix (single color or red/green/blue), high resolution and high brightness, with full text capability. All LEDs shall be used at 50% of the maximum nominal forward current to extend LED life.

The signs shall be installed and supported to prevent any rattling, dust infiltration or movement of the sign itself. The sign support shall allow for sign tilting to allow cleaning of the glass behind the sign.

The signs shall be housed in a dust-proof enclosure with a polycarbonate, non-glare display faceplate with anti-graffiti resistant film applied. Exterior sign glazing must meet FRA type 2 projectile resistance, unless installed on the outside of the carshell. The exterior signs shall be designed to prevent fog and condensation.

The minimum viewing angle shall be no greater than 30° from parallel to the side of the car and readable at a distance of at least 115 ft (35 meters). The display shall have a high contrast ratio and have an automatic LED luminosity control for different levels of ambient light conditions. LED dimming shall also be activated automatically by the CCU, to reduce low voltage supply consumption, in case of car battery charging failure or during train layover.

Exterior signs shall be clearly readable in all ambient light conditions including total darkness and direct sunlight.

The signs shall be capable of displaying scrolling text. All signs shall resume normal operation following supply power interruptions. Self-testing or other functions shall only be activated by the CCU.

The exterior signs shall have a self-diagnostic testing capability and provide fault condition information to the CCU, including sign location and type of fault. The sign unit, upon the insertion of the car wiring connectors, shall automatically recognize its own location in the car, through special coding in the car-side connector pins.

12.6.2 Car Control Unit (CCU)

The CCU shall control all interior and exterior signs on that car for visual messages and provide digital input to the PA amplifier for audio announcements. It shall monitor the signs and PA status for fault diagnostics and shall digitally communicate with all other CCUs in a trainset over the IVDN to verify their car systems status.

The CCU shall be a microprocessor-controlled device, have an open architecture and allow expansion for communication and interface with additional other systems such as the car monitoring system, Close Circuit TV (CCTV) surveillance system and Wireless Local Area Network (WLAN). In addition to the ports required for this expandability, at least two spare ports shall be provided. It must also support 802.11n WiFi for passenger use. The CCU microprocessor usage shall not be greater than 60% of the available processor capacity.

The Contractor shall provide all the software needed to operate the CCU. The CCU software shall not utilize more than 60% of the available memory capacity when all initial control software, messages and animated graphics are loaded. Message capability shall include, but not be limited to the following:

- Standard station stops
- Advertising messages
- Public service messages
- Unique messages, including trainset specific messaging
- Emergency messages

The CCU-stored data shall be divided in several files, following their specific function, and stored in non-volatile memory. Modifications to the CCU-stored data shall be achieved by changes only to the parts affected, to minimize the transmission time.

Erasable Programmable Read-Only Memory (EPROM), Electrically Erasable Programmable Read-Only Memory (EEPROM) and flash Programmable Read-Only Memory (PROM) data storage systems shall be used for the operating software and for data storage. Back-up batteries shall not be used. Where removal of the chip is required for reprogramming, memory chips shall be socketed to make it easy to upgrade and replace. The CCU microprocessor

control shall re-initialize automatically and safely at power up, and/or following loss of supply power.

The CCU shall automatically identify the number of the car on which it is installed by the connecting hardware such as on the backplane of the rack in which the CCU is mounted.

All CCU inputs and outputs shall be galvanically isolated from the external circuits. Shorting or opening of any of the inputs or outputs shall not result in any damage to the internal circuitry of the CCU.

The electronic circuits shall be designed as removable modules or circuit boards following the function such as power supply, microprocessor control and communications, contained in several card slots. Each card slot shall be clearly identified with the function performed by the contained electronics and suitably keyed to avoid inserting cards in the wrong slots. The electronic modules shall use LED indicators to provide quick visual status information. For example, power supplies shall be equipped with LEDs to show the presence of each output voltage.

The CCU shall have, on a clearly visible location, separate from the display, a multicolor LED indicator providing indication of the car OTIS/PIS status.

LED indicator	OTIS/PIS status
Green	Normal
Yellow	Fault
Red	Failure

The status of the car's OTIS/PIS/PA system shall be displayed on the car's system status panel in the lower level B-end vestibule. See Chapter 11.

The CCU shall have a specific port for connection to a PTU for diagnostic investigations, fault log downloading, system testing, troubleshooting and software upgrading and modification. The connection between the CCU and the PTU shall be through a standard Universal Serial Bus (USB) 2.0 connection or Ethernet connection.

All CCUs shall be interchangeable and capable of performing the same functions. Whenever the train is formed, the CCU in the café/lounge car (or brain car) shall automatically become the master unit of the train, while all other CCUs shall become the slave units, including the CCU in the cab/baggage car. The cab/baggage car CCU shall become the back-up unit to the café/lounge car master CCU, and take over the master function whenever the other becomes defective.

All data communication between the train's CCUs shall be through the IVDN.

The yellow indication shows that the system is working at a diminished performance, and that investigation, reset or repair is required.

The CCU shall have a self-diagnostic capability and store faults occurring in the CCU and in the other controlled systems, such as the signs and the PA amplifier. Faults shall be recorded with reference data such as car number, time, date and location. The fault memory shall store at least 255 faults in a first-in, first-out sequence. The self-diagnostic system shall be capable of identifying the faulty electronic circuit function and indicate the electronic module, sign or PA amplifier to be replaced. This information shall be stored in non-volatile memory, together with the fault log.

The master CCU, when requested by the land based system, shall be able to upload the information from any fault log in the train and allow all the logged diagnostic codes to be viewed from a remote location. The fault log file shall also be accessible via the communication cable and the PTU while on the train.

All data communication between the train's CCUs shall be as described in the single level specification unless otherwise specified by the Customer.

Table 12-2: Trainline Pinouts

Description	COMM Wire Number
OTIS/PIS	3 & 4
Train Intercom	5 & 6
Train PA	7 & 8
Tape Music	9 & 10
Destination Sign Control	11 & 12
OTIS/PIS	24 & 25

12.6.3 OTIS/PISCU

Each Master car shall be equipped with an OTIS/Passenger Information System Control Unit (PISCU). The OTIS/PISCU shall interface between the operator and the CCU on each car. It will allow simple operations such as train number input, system start-up, message selection and initiation, and train formation display. It shall also be used as a local display for fault annunciation, system test and verification, in lieu of the PTU, but it shall not allow any reprogramming of the CCU itself.

The OTIS/PISCU shall be of rugged heavy-duty construction with keypads and a visual display. The protected keypads and display shall be impervious to liquids, dust and heat. The front panel shall have no exposed fasteners. The display shall be readable in both direct sunlight and total darkness.

The keypads shall be located in proximity to the display screen aligned in a manner readily accessible. Each key shall be a long life, durable tactile feedback switch.

The display shall be LCD with LED backlight and adjustable contrast and backlight intensity. The display shall be suitable for the function of the OTIS/PISCU.

The OTIS/PISCU shall be menu-driven for all the functions and the key legends shall correspond to the functions being performed.

Data storage, if included in the OTIS/PISCU, shall be via non-volatile solid-state memory.

Only master cars shall have OTIS/PISCU. When one unit is operated, it becomes the master and the other in the same train set is over-ridden and becomes the slave unit.

12.6.4 Data Communication System (DCS)

The Data Communication System (DCS) shall incorporate all of the data transmission radios. The DCS shall utilize both cellular and WiFi systems for data transmission between the master CCU and the Customer's system server. The DCS shall automatically utilize all available communication links so that the highest data transfer capability is available for any particular train location. Only the CCUs on the master cars shall be equipped with the DCS. Data transmitted to the master CCU shall be sent to all other CCUs of the train consist, through the IVDN as soon as it is received from the system server.

The antennas used for the DCS shall be designed and built for railway applications. The equipment shall be of robust construction and waterproof. Installation shall conform to all railroad equipment clearance restrictions and be contained in secure weatherproof enclosures.

12.6.5 Global Positioning System (GPS)

The OTIS/PIS shall utilize a Global Positioning System (GPS) for the determination of the train location and the triggering of automatic station announcements and station display. The GPS receiver shall be a stand-alone unit, powered by a dedicated power supply.

The CCU shall use the GPS for all location events. It shall not use wayside transponders or wheel rotation to determine the traveled distance. Door open signals can be used to initiate station announcements at stations that are broadcast over the exterior speakers, such as train number and destination. Whenever loss of GPS signal is experienced, the CCU shall be capable of automatically re-establishing train location once the GPS signal is again available. When the CCU loses GPS, all sign functions shall be displayed except those dependent on GPS information. All CCUs shall be equipped with GPS.

The antenna used for the GPS shall be designed and built for railway applications and shall conform to all operational and clearance requirements, including Amtrak's Bi-level Clearance Drawing B-066-0050. The equipment shall be of robust construction and weatherproof. The proposed antenna shall be evaluated during the design review process. **DR**

The Contractor shall interface the café/lounge car's CCU with the Eta Phi Systems, Inc.® system, already equipping these types of cars unless otherwise approved. The Contractor shall work jointly with the Passenger Information Display System (PIDS) supplier to achieve the following:

- Share the same OTIS/PISCU
- Provide GPS redundancy by sharing both GPS's outputs

Amtrak will provide the interface specification for communicating with the PIDS.

12.6.6 OTIS/PIS Communication Trainline

The OTIS/PIS system shall connect each car to the next one through an IVDN that includes wireline and/or wireless links to support Ethernet as required by the needs of the Customer. End-to-end latency on a maximum length train set shall not exceed the maximum permissible latency for specified performance for each piece of connected equipment and in any case not exceed the 60 milliseconds (msec) within the IVDN. Very High Speed Digital Subscriber Line 2 (VDSL2) is the preferred technology for the wireline network. The VDSL2 technology shall utilize a train Data Network Transport Unit (DNTU).

One DNTU shall be installed in each car. The DNTU in the café/lounge car shall be the master unit. Other cars shall be connected to the café/lounge car by cascading the transport units together. The system shall support a consist of up to 10 cars. The DNTU shall have at least one gigabit Ethernet port as the in-car backbone network access point and shall have at least 10 VDSL2 ports, five for connecting to the rail car coupled to the A-End and five for connecting to the rail car coupled to the B-End. The DNTU shall be functionally equivalent to the combination of the following two standard Versa Technology products: VX160R2 VDSL2 Ethernet Extender and VX-AG150 series Link Aggregator. The intercar VDSL2 link over each pair of trainlines shall be established and maintained through a pair of VDSL2 modules equivalent to VX160R2, one at each end of the intercar link.

The Signal-to-Noise Ratio (SNR) margin, impulse noise protection and line rate shall be configurable through software and shall be set initially to the following default values of 9db. A module equivalent to VX-AG150 shall aggregate the bandwidth provided by the VDSL2 modules to achieve a higher throughput backbone pipeline. The aggregation method shall be independent of protocol, session and/or address of data traffic. Aggregation shall be linear (1+1+1+1+1=5), although reasonable overhead bandwidth loss of less than 10% shall be considered acceptable. Link failure protection/fail-over shall also be supported by the

aggregator. Although throughput will be compromised, the backbone pipeline should be kept alive when as few as one pair of train lines can support a VDSL2 link.

Central Office (CO) and Customer Premise Equipment (CPE) mode selection shall be negotiated automatically between connected pairs of VDSL2 modules without the use of manual switches to ensure that the VDSL2 link can be established no matter how the rail cars are oriented. The DNTU should have interfaces for two parallel train line busses. Each train line bus is incorporated by five pair of train line cable. When the bus segment being used fails, units at both ends of the bus segment will automatically switch over to the other bus and establish a new link if the new bus is viable. The DNTU shall incorporate a fail-safe bypass. Should a power failure occur in any railcar other than the café/lounge car, the system shall automatically bypass that car. The system shall then establish a new network link between cars adjacent to the failed car.

The wired intercar network shall incorporate inline low pass splitters (one per VDSL2 module) to filter out the high frequency signal/noise and pass the voice band (low frequency) signal to support the existing voice/PA service of legacy cars. The splitters shall also serve to isolate the intercar VDSL2 links from each other so that each intercar link appears as a point-to-point link at VDSL2 frequencies. The splitter shall provide DSL insertion loss of at least 55dB in the 30 kHz to 30 MHz frequency band. The voice insertion loss at 1 kHz shall be 1dB maximum. The splitter shall support DC current up to 80 milliampere (mA) and a steady-state voltage of at least 100VDC between wires in a connected pair. The filter shall be Versa Technology part number VX170SP, or customer approved equivalent.

The DNTU shall be powered from the 74VDC supply and shall be manageable and maintainable through both a console connection via RS232/USB and an Ethernet network interface. The DNTU shall be convection cooled and sealed against dust and moisture. The IVDN shall support load balancing, bandwidth throttling, bandwidth aggregation, trunking and QoS. Wiring shall be designed to minimize the length of the IVDN inter-car loop. Connectivity among cars is used to support passenger internet access and Caltrans' applications that require internet connectivity. The IVDN shall operate as a single logical network. It shall use RailCat wire as manufactured by Huber+Suhner, or alternative approved equivalent, inside the car and also inside the inter-car connectors.

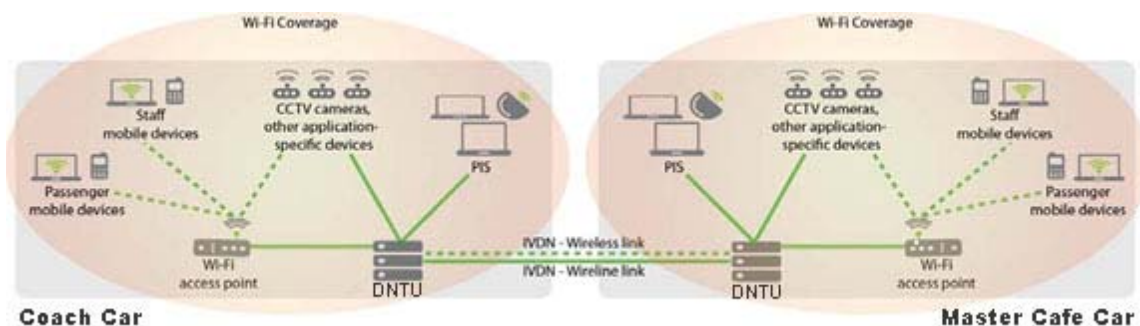


Figure 12-1: IVDN Architecture, Showing Planned and Future Applications and Devices

The OTIS/PIS system shall identify and annotate all sign communication network failures through the fault diagnostic system. Sign communication trainline interruption due to the normal removal and reapplication of car jumper cables shall not result in a fault annunciation.

12.6.7 Provision for Wireless Internet

The Contractor shall install the hardware needed to establish bi-directional broadband connections to the trackside (i.e., 4.9 GHz and 5.x GHz) and cellular infrastructure (i.e., HSPA and EV-DO). The equipment is required to support multiple cellular cards (HSPA and EV-DO; preferably two cards from each of the four leading mobile operators: Verizon, AT&T, Sprint and T-Mobile) and to be capable of supporting additional wireless interfaces, including Evolved HSPA, WiMAX and LTE, when (and if) they will become available along the ROW in the future simply by swapping the data card.

12.6.8 Land Based Equipment

The car-borne OTIS/PIS receive all information updates over the internet by utilizing either WiFi or cellular based connectivity. The SSS stores and transmits all sound, graphic, video and data files necessary to load and update the CCC. The SSS software provides the necessary logic to update the sign data on the CCUs during layovers as well as allowing the transmission of real time messages to any train or car utilizing the client software and any web browser. The digital audio/video workstation provides the ability to record, edit, upload and download recorded announcements, videos and graphics. The digital audio/video workstation uses the internet to transmit sign system data file to the SSS. The client software allows users with appropriate security rights to use any web browser to access the SSS to send messages, update files and check system status.

12.6.9 Sign System Server (SSS)

A Sign System Server (SSS) shall be provided by the Contractor and installed at a location selected by the Customer. The server shall utilize the SSS software and store all messages, graphics, databases and other data used by the OTIS/PIS system. The SSS shall have the system capability to send specific messages to any car, group of cars, trainset or the entire fleet as required in addition to all other standard tasks as defined by this Specification.

The SSS shall handle all communication to the train borne equipment through the WiFi or cellular network and shall be capable of transferring large data files. The specific cellular and WiFi data standards will be proposed by the Contractor and approved in writing by the Customer.

The SSS shall be capable of programming and performing program changes to the train CCUs using the client software and the Customer workstation.

The SSS shall transmit all messages and establish direct communications with any CCU selected, including any car, group of cars, trainset or the entire fleet.

The server shall have a storage capacity of no less than 2 terabytes in a Redundant Array of Independent Disks (RAID) 1 configuration. The stored files shall be available to all the other workstations connected to the same server.

The SSS shall interface with other computer systems such as Amtrak [Arrow and Work Management System (WMS)], and Capitol Corridor Joint Powers Authority (CCJPA) (Eta Phi Systems, Inc.®) to exchange data and transmit near real time messaging. The system shall be able to export and import system data files using an open data standard such as Structured Query Language (SQL) or Open DataBase Connectivity (ODBC).

The server shall be a latest model, standard IBM server class unit meeting these minimum standards, with all accessories such as Digital Versatile Disc - Rewriteable (DVD RW), minimum 4 Gigabyte (GB) Random Access Memory (RAM), at least three expansion slots, and 19 in. flat panel monitor to perform all the OTIS/PIS tasks. It shall be supplied with at least 100% capacity reserve. A 2 Terabyte (TB) Network Attached Storage (NAS) storage unit shall

also be provided for data backup. The server shall have at least four hard drive bays. Two 10base1000 Ethernet Network Interface Card (NIC) shall be provided.

12.6.10 Antennas

Antennas for wireless Internet links shall be mounted in such a fashion that they are not obstructed by metal panels or equipment. All exterior antennas shall fit inside the specified clearance envelope. Routers shall have two antennas pointed in opposite directions to prevent dead spots (if necessary).

12.6.11 OTIS/PIS Server Software

The OTIS/PIS Server Software shall be deployed through the SSS.

Startup message programming containing all station stops, schedules, announcements and messages for all routes shall be part of base contract. The Contractor shall be required to demonstrate that all programming is installed correctly and is capable of transmission to any CCU.

The contractor shall propose for the Customers approval an open standard lossless digital audio format for storing train announcements such as MPEG Audio Layer 3 (MP3).

The system shall provide data transmission and downloading through wireless connection and near real-time messaging updating.

12.6.12 Digital Audio/Video Workstation (DAVW)

One Digital Audio Video Workstation (DAVW) shall be provided as part of this Contract.

The DAVW shall provide all equipment and accessories necessary to record, edit and deploy system announcements, video and graphic information files. This system shall at a minimum include two studio quality microphones, hardware or software mixing capability and two monitor grade speakers to review, edit, digitize and record high quality audio. The system shall include a minimum 30 in. format Liquid Crystal Display (LCD) monitor, provisions for video input and video file storage such as High Definition Multimedia Interface (HDMI) and Firewire 800 and video files, optical drives capable of reading and recording Digital Versatile Disc (DVD) and Blu-ray discs.

All system updates, messages, status or other functions shall be accessible to the DAVW. User access to the DAVW software shall be controlled with level of access and password protection.

The DAVW shall include a professional class audio/video workstation, a standard industry version of audio editing software for voice messaging, such as Logic by Apple and video editing software, such as Final Cut Pro by Apple.

All system updates, messages, status or other functions shall be accessible to the DAVW.

The software and associated hardware shall allow for the utilization of both recorded professionally produced messages and Customer staff recorded audio/video messages and perform updates.

12.6.13 Client Software

Client software shall allow users to access and manage the OTIS/PIS remotely from workstations. The software shall utilize standard browsers to allow Web-based access to the OTIS/PIS. The software shall allow the workstation to quickly activate or schedule preprogrammed or manually selected messages at chosen car signs and remotely configure CCU units. The software shall be able to program the system, including new routes and new stations, using pull down menus and point-and-click selection with a mouse and keyboard. The workstation shall allow storing special messages, set alarms, inserting graphic displays

and allowing deployment of messages using a variety of display styles. The software shall have features such as spell checking, printing messages and capability for rapidly searching and locating specific messages in the database. The software shall facilitate the development, validation and scheduling messages to be displayed by date, time and location or at specific time intervals, and transmit real time messages to special equipment, including trainsets and railcars at any time. The software shall be easily expandable to include future additional systems such as a car monitoring system and a Close Circuit TV (CCTV) system.

12.7 Portable Test Unit (PTU) Software

The Portable Test Unit (PTU) software shall be designed to perform the following:

- Download software into the CCU
- Download sign information/updates to the CCU
- Retrieve the fault file from the CCU
- Perform system diagnostic and troubleshooting
- Perform equipment adjustment and calibration such as PA amplifier volume
- Perform system testing, message annunciations, graphic display, etc.

The PTU software shall be menu-driven, browser-based and user-friendly. The software and its functions shall be submitted to the Customer for approval at the design review. All PTU software is reproducible without additional cost as needed by the Customer to support the on-board sign system.

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The contractor shall use a USB cable, or Ethernet cable to communicate with carborne equipment. The Contractor shall provide two communication test cables, 10 ft in length. The cable shall connect between the PTU and the CCU or the OTIS/PISCU.

The Contractor shall supply a schematic, identifying the pin outs of the cable connectors, as part of the running maintenance manual and integrated schematic manual.

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12.8 Software

12.8.1 Software/Programming Requirements

All software used shall be provided to the Customer with all pertinent documentation, including the source code except for the following: 1) commercial operating systems, 2) commercial applications and drivers, 3) proprietary firmware embedded in commercially available chips. This should apply to custom application software developed for this project or software that is not generally available on the open market. The information provided shall enable the Customer to maintain the software and modify it, if necessary, to make changes, improvements and additions.

For non-commercial software, it is permitted to place all the relevant information, including source code, in an escrow account, and made available to the Customer in case the original supplier no longer supports the software. The Contractor bears all costs to sustain any such escrow accounts.

12.8.2 Software License

In support of the program the Customer retains non-exclusive rights to Contractor-provided OTIS/PIS system software to copy, distribute and use as needed to support the sign system in the passenger rail application. The Customer may not sell or license Contractor supplied software. The Customer retains the right to use, modify and alter software via the Contractor or a third party to support the Customer's rail operations without any additional cost or

restrictions. The Customer shall agree to be bound by non-disclosure rules and retains the right to use the software freely.

12.9 Electromagnetic Interference

All carborne supplied equipment and its wiring shall be electromagnetically compatible and have no negative impact on:

- All other components on the cars;
- All components of the communication system;
- Operational electronics used by crewmembers, including radios, wireless ticketing devices and others;
- Consumer electronics used by passengers, including cell phones, computers, radios and others; and
- Wayside equipment including signaling systems.

The Contractor shall develop an Electromagnetic Compatibility (EMC) control plan, which shall describe the methodology used to measure control and mitigate all the Electromagnetic Interference (EMI) emissions by the supplied equipment. This plan shall be submitted to the Customer as part of the PDR for the communication system. **DR**

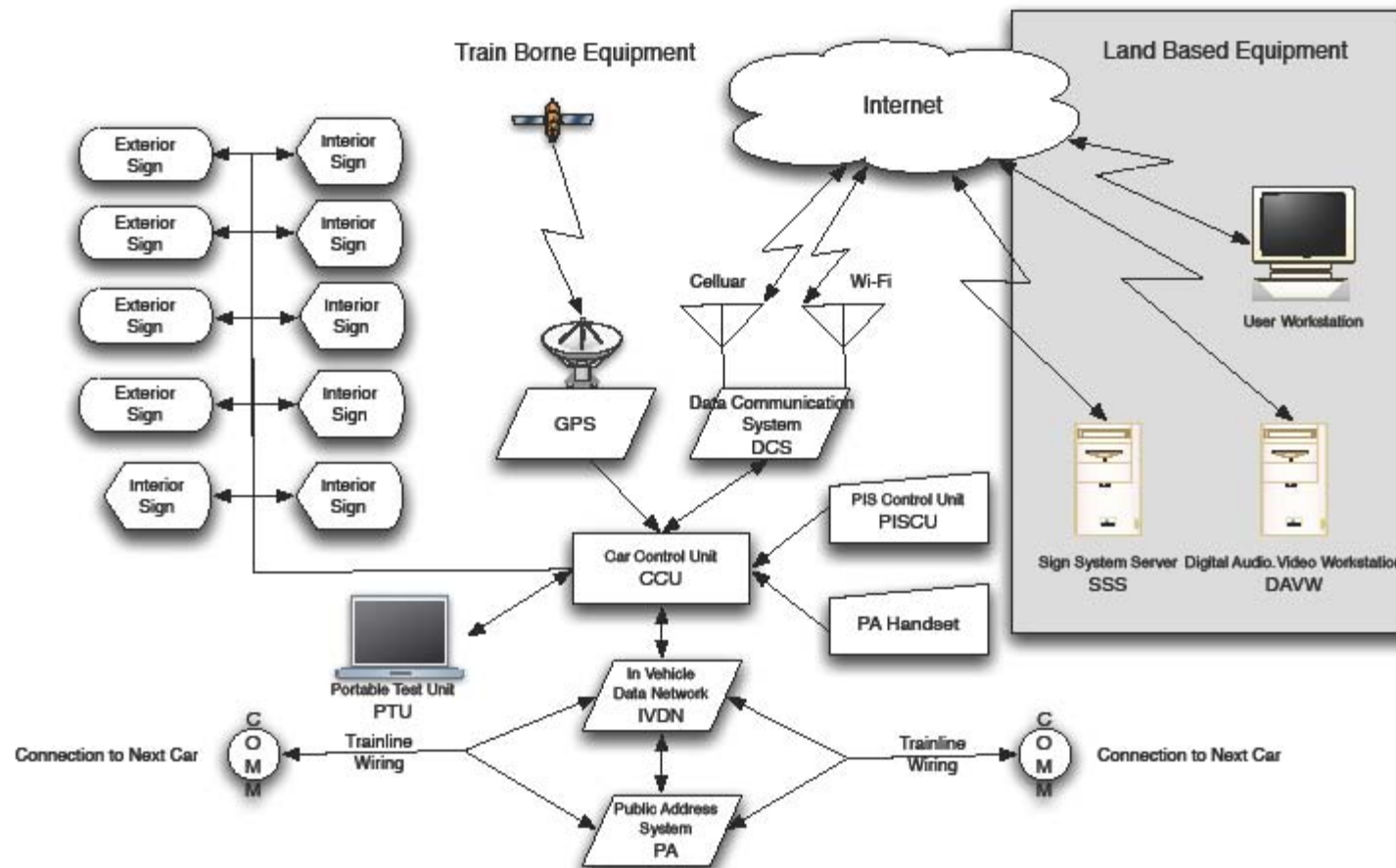


Figure 12-2: Passenger Information System Diagram

* End of Chapter 12 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee
Bi-Level Passenger Rail Cars

Chapter 13

Electrical System

Table of Contents

13.0	Electrical System	13-2
13.1	Overview	13-2
13.2	General Requirements.....	13-2
13.3	27-Pin Trainline Systems	13-2
13.3.1	Communication Trainline	13-3
13.3.2	Multiple Unit (MU) Trainline	13-3
13.3.3	Trainline System Application to Vehicles	13-3
13.3.4	Trainline Junction Boxes	13-4
13.4	480 VAC Head End Power (HEP) Trainline System	13-4
13.4.1	Receptacles and Jumpers	13-5
13.4.2	Wiring and Connections	13-5
13.4.3	Power Junction Boxes	13-6
13.5	480 VAC Power Distribution.....	13-6
13.5.1	Main Circuit Breaker	13-6
13.5.2	Power Transformers.....	13-6
13.6	120 VAC Power Distribution.....	13-7
13.6.1	Passenger Convenience Outlets	13-7
13.6.2	Interior Service Outlets.....	13-7
13.6.3	Equipment Room Service Outlets	13-7
13.7	Battery Charger	13-8
13.8	Battery System.....	13-11
13.8.1	Batteries.....	13-11
13.8.2	Battery Performance.....	13-11
13.8.3	Battery Markings.....	13-12
13.8.4	Battery Enclosure.....	13-12
13.9	DC Power Distribution System	13-13
13.9.1	74VDC Power System	13-13
13.9.2	24VDC Power System	13-13
13.10	Electrical Panels.....	13-13
13.10.1	Switch and Circuit Breaker Panel Arrangement	13-14
13.11	Integrated Schematics.....	13-14

13.0 Electrical System

13.1 Overview

This chapter describes the major electrical power distribution and control systems required for each car, and for car-to-car power and signal trainline circuits. The systems include, 480 Volt Alternating Current (VAC) Head End Power (HEP) trainline and power distribution, 120VAC power distribution, 74 VDC Low Voltage Power Supply (LVPS) power distribution, battery, 27-pin trainlines for car-to-car multiple unit (MU) and communications (COMM), and electrical locker circuit breaker panels.

13.2 General Requirements

Hotel power to the train shall be provided through trainline cables from a separate 480VAC, 3-phase, 60 Hertz (Hz) source not located on the vehicle. The system shall be designed for normal operation using power supplied by a locomotive HEP source, or from a wayside 480VAC power source.

All cars shall be equipped with 27-point locomotive control (MU) and communication (COMM) 27-wire trainlines. All trainline wires shall run the entire length of the car and be connected from end-to-end.

Receptacles for MU, COMM and HEP shall be located in accordance with Figure 4A of APTA Recommended Practice RP-E-016-99.

All electrical systems and components utilized on all cars shall be electromagnetically compatible with other electrical systems and components, including the crew radio, the passenger information system, passenger cellular telephones and laptop computers.

The electrical power distribution, lighting and communication systems shall be in accordance with all applicable FRA regulations, APTA standards and recommended practices and industry standards.

13.3 27-Pin Trainline Systems

Car-to-car communication for MU and COMM shall be provided by 27-pin jumper cables and receptacles. Connection between cars shall be provided by jumper cables. LVPS power shall not be trainlined. The trainline system shall be compatible with APTA Recommended Practice RP-E-017-99.

The 27-pin COMM, 27-pin MU and 480VAC HEP trainline control circuits shall be run in separate conduits between the ends of the car.

13.3.1 Communication Trainline

This trainline provides car-to-car connections for systems such as door control, door closed summary circuit, public address, passenger information and brake status lights. In normal operation, a single 60 in. COMM jumper cable shall be connected between adjacent cars or a single 71 in. COMM jumper shall be connected between the locomotive and the car adjacent to the locomotive.

For COMM trainline pin assignments, see Table 13-1.

13.3.1.1 End of Train Functions

On the rear end of the last car of the train, a jumper is connected between the right side COMM receptacle and an adjacent white dummy COMM receptacle shall provide end-of-train detection for on-board systems including the door closed summary circuit. Looping relays shall be provided for each end of the car to establish “end of train” for the four communication trainline circuits (#19, #20, #23 and #26). The looping relay shall be energized when the 27-pin COMM jumper is connected between the COMM receptacle and the adjacent dummy receptacle at the end of the train.

13.3.2 Multiple Unit (MU) Trainline

In push-pull operation with a cab car leading and the locomotive trailing, locomotive control functions shall be transmitted through the train from the cab/baggage car to the locomotive by means of a standard multiple unit (MU) trainline.

A single 60 in. MU jumper cable is connected between adjacent cars, and a single 71 in. MU jumper is between the locomotive and adjacent car.

For MU trainline pin assignments, see Table 13-2.

13.3.3 Trainline System Application to Vehicles

The following receptacles and jumper cables shall be in accordance with APTA Recommended Practice RP-E-019-99 and be provided at each end of the car:

- 27-pin communication receptacle, painted blue, complete with contact insert and wiring: Amtrak Drawing D-63-7439.
- 27-pin communication dummy receptacle, painted white, complete with contact insert and wiring: Amtrak Drawing D-63-7440.
- 27-pin communication jumper cable, 60 in. car-to-car with blue heads: Amtrak Drawing C-01-1498.
- 27-pin MU receptacles, painted black, complete with contact insert and wiring: Amtrak Drawing C-63-7437.
- 27-pin MU jumper cable, 60 in. car-to-car with black heads: Amtrak Drawing C-63-7422.

Receptacles and fixed jumper flanges shall be mounted to the carbody with stainless steel bolts and self-locking nuts. Trainline receptacles shall be electrically insulated from the end sheet.

Two sets of COMM and MU receptacles shall be installed on each end of all cars, one on each side of coupler pocket, in accordance with Figure 4A of APTA Recommended Practice RP-E-017-99. One MU and one COMM 27-point jumper cable shall be connected between adjacent cars as well as to the locomotive. Jumpers and receptacles shall be color-coded as well as keyed to prevent cross-connection.

The plate to which receptacles and jumper flanges are mounted shall be designed to resist a 500-pound force, without deforming, produced by pulling the locked jumper (with the receptacle cover locked down utilizing a rubber-O ring type retainer) out of the receptacle.

There shall be no interference that restricts the receptacle cover from being fully opened to allow insertion or withdrawal of jumpers.

Under all operating conditions, a minimum of 2 in. clearance for the trainline cables shall be provided between trainline jumpers and the carbody and all appliances including air hoses, couplers, uncoupling levers and other equipment.

Each car shall be delivered with one loose jumper cable of each type.

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13.3.4 Trainline Junction Boxes

Separate stainless steel weatherproof junction boxes shall be provided at each end of the car for the communication and MU trainline systems. Trainline junction boxes at the F-end of cab/baggage cars shall be located behind the F-end truck or other Customer approved protected location.

The inside of the box shall be painted with an insulating paint or varnish. All wires shall be terminated using ring tongue lugs, mounted onto terminal blocks in the junction boxes. Trainline junction boxes shall be located where they are shielded from roadbed debris and car system liquid drains. All trainline junction boxes shall be weatherproof.

13.4 480 VAC Head End Power (HEP) Trainline System

HEP shall be provided to the car through receptacles at standard locations on each end of the car and on both sides of the coupler, in accordance with APTA Recommended Practice RP-E-016-99.

In addition to the three main power conductors, the jumpers also include three control pins, which provide locomotive trainline complete signal (indicating all jumpers throughout the train are in place), and a car-to-car carbody ground bond. HEP circuit assignments shall be in accordance with Amtrak Specification 963.

The loads between phases shall be balanced so that the load on one phase will not exceed more than 5% of the load on either of the other two phases.

13.4.1 Receptacles and Jumpers

Each end of each car will be equipped with two fixed jumper cables and two receptacles with housings per APTA Recommended Practice RP-E-017-99 (Figure 4A) and APTA Recommended Practice RP-E-018-99. Components shall include:

- 480VAC fixed jumper (length to run from end sheet to transition bulkhead)
- 480VAC receptacle: Amtrak Drawing D-12-7191
- 480VAC receptacle housing: Amtrak Drawing D-12-7191

The receptacles shall be mounted with a downward slope of approximately 15 degrees to provide drainage. Receptacles and fixed jumper flanges shall be mounted to the carbody with stainless steel bolts and self-locking nuts.

The plate to which receptacles and jumper flanges are mounted shall be reinforced to resist a 500-pound force, without bending, produced from pulling the locked jumper out of the receptacle, with the receptacle cover locked down utilizing a rubber o-ring type retainer.

Receptacles and fixed jumper flanges shall be mounted in a manner with adequate clearance between uncoupling rods under all operating conditions. There should be no interference that restricts the receptacle cover from being fully opened to allow insertion or withdrawal of jumpers.

The HEP jumpers shall be of adequate length to reach from the end sheet to the trainline junction box at the transition bulkhead without requiring connectors, splices or intermediate terminals. No portion of the HEP cables shall hang down to within 3 in. of the top of rail (vertically) when connected to an adjacent car on straight, level track.

13.4.2 Wiring and Connections

13.4.2.1 Power Cable

The 3-phase HEP trainline power cables per APTA Recommended Practices RP-E-002-98 and RP-E-009-98, with 1600 amp capacity, shall be routed along the length of the car. Line drop shall not exceed 3.5V, at capacity load, between receptacles at opposite ends of the car.

The wire used in the trainline power cables shall be 4/0 as specified in APTA Recommended Practice RP-E-016-99. The voltage drop due to the impedance of the power trainline at the extreme end of the 12-car consist shall be minimized under the train's heaviest load. The Contractor shall supply a line voltage analysis showing the voltage loss from one end of a 12-car train to the opposite end under the heaviest load case.

The HEP cables shall run between junction boxes on the underside of the lower level of the car in a protected wire race. All cables and conduits shall be supported by suitable cleats at appropriate intervals not exceeding 24 in. Spare trainline wires shall be identified in the end-of-car junction boxes.

13.4.3 Power Junction Boxes

An HEP trainline junction box shall be located at each transition bulkhead where the jumpers and leads from the receptacles on the end sheet shall be terminated and connected to the cables running the length of the underside of the lower level of the car. The B-end junction box shall provide connection to the 480VAC power distribution circuit for the car.

13.5 480 VAC Power Distribution

The 480VAC power is distributed throughout the cars utilizing power transformers, switch and circuit breaker panels located in the electrical and/or equipment lockers. Power is controlled and fed to all loads through this distribution system.

13.5.1 Main Circuit Breaker

A main circuit breaker shall be provided in the electrical locker to allow isolation of the car from the 480VAC trainline systems.

13.5.2 Power Transformers

All transformers shall be of a dry type, and convection cooled, in accordance with Amtrak Drawing D-65-7449, rev. A. Calculations shall be provided to demonstrate that the transformers provided have sufficient capacity to supply their intended loads. All inputs and outputs shall be circuit breaker protected.

At a minimum, the following types of transformers shall be provided:

- All car types: Set of three single-phase 480/120VAC transformers connected delta-delta, ungrounded, to provide 120VAC service.
- All car types: Single-phase 480/120VAC single-phase Ground Fault Circuit Interrupter (GFCI), grounded to provide 120VAC.
- Café/lounge car: 3-phase 480/208-120VAC, delta-wye, to provide 120-208VAC, 3-phase service with grounded neutral.

All transformers shall be located inside the electrical lockers or equipment rooms. The Contractor shall demonstrate that there is sufficient ventilation to prevent component failure and/or damage resulting from excessive heat buildup, with Heating, Ventilation and Air Conditioning (HVAC) system off.

Transformers and inductors shall be derated at least 10% for current, or other appropriate approved factor, based upon duty cycle.

13.6 120 VAC Power Distribution

The 120VAC power is distributed throughout the car utilizing three 480/120VAC step down transformers, and switch and circuit breaker panels located in the electrical equipment lockers. Power is controlled and fed to all 120VAC loads through this system.

A master circuit breaker shall control power distribution to all 120VAC circuit breakers.

13.6.1 Passenger Convenience Outlets

A flush-style 120VAC duplex convenience outlet shall be installed in the wall panel at each seat pair location using the GFCI circuits. The outlets are intended to provide power for passenger electronic equipment, such as laptop computers. Convenience outlets shall also be provided at each table in the lounge end of the café/lounge car.

Outlets shall be located on the sidewall 24 in. forward from the front of the seat back. Two duplex outlets shall be installed at each table, located such that the table or seat does not interfere with access to the outlet. Power strip conduit and cover are to be powder-coated in a color approved by the Customer. An Amtrak-standard 120V decal (Amtrak p/n 0065NS), per Amtrak Specification 697, shall be installed on the power strip conduit cover at each outlet location, 0.50 in. from outlet, between the outlet and the seat facing the outlet.

The passenger convenience outlets in each car shall be protected by four separate power circuits, each of which shall be equipped with a 20 amp GFCI breaker with test and reset buttons. The convenience outlets on each car shall be evenly divided into the four power circuits.

13.6.2 Interior Service Outlets

Duplex service outlets shall be located in each toilet room, equipment room, electrical locker and utility lockers in all car types, in locations and quantities suitable for their intended use in those areas.

The galley area of the café/lounge car and the cab area of the cab/baggage car shall also be equipped with service outlets as specified in Chapter 14 and Chapter 16, respectively.

Service outlets shall be protected locally by duplex service proven GFCI type circuit breaker rated for 120VAC, single phase, 60 Hz, 20 amps at each service outlet location. In addition, these circuits shall be protected by separate circuit breakers.

13.6.3 Equipment Room Service Outlets

Duplex service outlets shall be provided in both equipment rooms in all car types. The outlets shall be located in a manner to provide for convenient use while servicing the car. Service outlets shall be a service proven GFCI type receptacle rated for 120V single phase, 60 Hz, 20 amps with spring loaded water resistant cover.

13.7 Battery Charger

A solid-state 74VDC, battery charger shall be provided. The battery charger shall be mounted in the equipment room, near the battery enclosure, oriented so that the indicator lights can be seen from outside the car with the equipment room door open. The battery charger shall be rated appropriately for the DC load it will be supplying.

The battery charger provides DC power to support all 74VDC loads while the car is operating with HEP on. With the loss of HEP or the failure of the battery charger, the battery charger automatically transfers the 74VDC load to the battery system. The battery charger provides for charging of the battery system whenever HEP is available.

The 74/64VDC battery and battery charger system shall be responsible for feeding car loads and systems which must be available for operation independent of the availability of the 480VAC HEP, such as public address, side and end door systems, standby lighting, cab functions, and others, as specified in Table 13-3.

The battery and charger system is comprised of:

- Battery charger with temperature sensor
- Battery (multiple cells)
- Load drop device

The same battery type and battery charger shall be used on all car types.

13.7.1.1 Operation

The battery charger shall be connected in parallel to simultaneously charge the battery while supplying power to the car DC bus. The charger shall incorporate two modes of operation, current limit and float, the latter when the output voltage is regulated at a battery temperature-compensated value. The charger shall be sized with sufficient capacity to simultaneously recharge the battery from a fully discharged state and to support the maximum possible DC bus loads plus a 25% reserve beyond the worst case continuous load condition. Recharge time of a fully discharged battery shall not exceed five hours to reach at least 80% of capacity at 77°F, with all normal car DC loads on. On the cab/baggage car, this includes headlights and crossing lights, and all cab loads from an active cab. The Contractor shall provide at design review a load budget assessment that includes calculations to demonstrate that the charger provided has sufficient capacity to meet these needs.

13.7.1.2 Basic Charger Characteristics

Basic charger characteristics shall include the following:

Input Voltage	480VAC nominal (tolerance range +10%/-15%), 3-phase, 3-wire
Input Frequency	60 Hz nominal (tolerance range 56-64 Hz)
Input Protection	3-pole circuit breaker (external reset)
Output Voltage, Temperature Compensated	73.6VDC at 20°C ambient; 80VDC maximum
Temperature Compensation	In accordance with the battery manufacturers recommendation.
Ripple	Maximum of 2 volts peak-to-peak any load within rating
Audible Noise	62 dBA maximum for components mounted inside the car
Ability to automatically recharge the battery from any state of discharge, including 0 volts on battery terminals.	
Charging voltage ambient temperature compensated as sensed at the battery.	
Following a HEP power outage, the charger shall restart with a reduced current load for a period of time after restoration of HEP in order to minimize the short-term startup HEP load.	
Only a single circuit board, containing all charger control functions.	

13.7.1.3 Circuit Breakers

The charger shall be equipped with two circuit breakers on the front face, one for the charger output and one for the battery disconnect.

13.7.1.4 Indicators

The charger shall include individual status indication LEDs that are displayed from the front face. These shall include:

Supply 480VAC On	Green
Current Limit (in current limit mode)	Amber
Load Dump Relayed Energized	Amber
Supply 480VAC off/out of tolerance	Red
Rectifier Failure	Red
Temperature Sensor Failure	Red

A lamp test pushbutton shall be provided, which when pressed will cause all lamps to light.

The charger shall include three meters on the front face:

DC Amps (total charger output)	0-100 amps
Battery Amps (current into/ out of battery)	100-0-100 amps (zero center)
DC volts (charger output voltage)	0-100 volts

The charger shall include an output to a remote battery charger fault indicator, located on the system status indicator panel outside the electric locker. The single red LED fault light shall be illuminated under any of the following conditions: 480VAC failure, rectifier failure or temperature sensor failure.

13.7.1.5 Self-Protection

At a minimum, the charger shall be self-protected against the following fault conditions:

- Open circuited battery or wiring
- Short circuited battery or wiring
- Battery ground fault
- Temperature sensor fault
- Low input voltage
- Input phase loss
- Reversed phase rotation
- Reversed battery connections
- System overload
- Voltage or current over limit

13.7.1.6 Temperature Sensor

The temperature sensor shall be sealed and be incorporated onto a terminal lug to allow it to be mounted onto one of the battery posts of the battery.

13.7.1.7 Operation of Battery Charger

Operation of the battery charger is as follows:

Normal: 480VAC HEP “ON”; DC system “ON”

- All AC and DC loads available
- All DC loads fed by battery charger

Standby: 480VAC HEP “OFF”; DC system “ON”

- Battery voltage above 58 VDC
- All DC loads fed by battery

Immediately after loss of HEP, the car shall go into standby mode, where most of the car lighting, all doors and the communications system remain in operation. All cab equipment and exterior lighting shall also remain operational. See Load Shed in Table 13-3.

Emergency: 480VAC HEP “OFF”; DC system “OFF”

- Battery voltage below 45VDC
- All DC loads are without power because the load drop device has disconnected the battery system or the battery system is disabled due to equipment failure.

In emergency mode only independently powered emergency lights remain on. See Chapter 11 for details.

Upon restoration of HEP, all DC loads shall be available immediately, including those that were disconnected as part of standby, emergency or load drop. DC load transfer by the battery charger shall be independent of the state of the battery when HEP is available.

13.7.1.8 Load Drop Device

The battery charger shall be equipped with a switching device, which shall shed load from the battery as follows:

Load Drop Device: Opens as the battery voltage falls below approximately 45VDC (the battery is essentially discharged.) This device disconnects all DC loads so the battery is not damaged by running cell voltage to zero. Independently powered emergency light fixtures turn on automatically upon Load Drop. This condition is called Emergency.

13.8 Battery System

The battery shall provide power for necessary systems when the HEP system is not available. The battery system shall be compliant with APTA Recommended Practice RP-E-007-098R1.

13.8.1 Batteries

The Contractor shall submit a battery design that:

- Meets the load requirements found in Table 13-3 with at least 25% extra capacity;
- Provides the longest life-cycle cost effective system; and
- Provides the latest technology that is available in passenger rail battery design.

All car types shall utilize the same type of battery cell. The batteries shall be recharged by the battery charger as specified above.

Batteries shall be nickel-cadmium (Ni-CAD), lithium ion or nickel-metal hydride, whichever provides the most optimum performance as specified.

The batteries shall be housed in cases of a fire-retardant design. The batteries shall be a low-maintenance type and shall not require the frequent addition of electrolyte. The battery system may utilize a centralized electrolyte fill apparatus.

The battery shall be designed to minimize hazards to operating personnel during service, operation, line maintenance and shop maintenance.

13.8.2 Battery Performance

Nominal battery voltage of 64VDC shall be provided to the DC power distribution system in each car when HEP is not present and the batteries are fully charged.

The batteries shall have a design service life of no less than four years and shall be capable of withstanding a minimum of 1000 deep cycles without failure. A deep cycle shall be defined as discharging the battery to 0.8V/cell and recharging it to 80% of its rated capacity at 77°F in no more than five hours.

The battery system shall be sized to carry the full DC load after loss of HEP, as defined in Table 13-3, for no less than two hours before the activation of the load shed relay. After load shed, the car's DC systems shall operate at reduced performance per Table 13-3 for no less than four hours before the load-drop relay terminates the DC load draw from the batteries and the car goes into emergency lighting mode. The battery system shall provide a 25% power safety margin above the calculated load. On cab/baggage cars, the DC load shall include all cab loads plus headlights and auxiliary lights. Café/lounge cars shall include battery capacity to power the food service chillers for one hour through an inverter. This shall be accomplished through the use of a separate battery supply from that used to power the café/lounge car's base DC loads.

A DC load budget shall be developed by the Contractor and submitted to the Customer for approval during the design review process, demonstrating that the battery system as proposed meets all requirements and provides adequate capacity for the required loads for the required duration.

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13.8.3 Battery Markings

Each battery cell or battery unit shall be permanently marked with the following information:

- Manufacturer's name
- Battery type
- Catalog or part number
- Nominal rated capacity at five- and eight-hour discharge rates
- Serial number
- Date manufactured
- Customer name
- Customer part number
- Warning and safety precautions (i.e. USE NO ACID, etc.)
- Blank space where installation date can be written

Markings shall be resistant to the chemical and mechanical environment encountered in service for the design life of the cell.

Polarity of the positive cell terminal shall be identified by a red post insulator or bushing and/or a plainly marked P, POS or + symbol. Polarity of the negative post shall be identified with a black post insulator or bushing and/or a plainly marked N, NEG or - symbol.

13.8.4 Battery Enclosure

The batteries shall be housed in a stainless steel enclosure accessible from trackside through hinged access doors. The battery enclosure shall be ventilated. Ventilation openings shall be equipped with stainless steel mesh to prevent ingress of leaves and other foreign matter.

The battery enclosure shall be constructed of unpainted type 304 stainless steel. Batteries shall be installed and secured in accordance with 49CFR Part 238 requirements.

The batteries shall be mounted for ease of inspection, maintenance and replacement. Battery enclosure shall be designed for removal through the use of a standard forklift truck. Fork pockets shall be fully enclosed with end caps to prevent fork penetration past the enclosure base.

13.9 DC Power Distribution System

Power for all DC loads shall be distributed throughout the car through switch and circuit breaker panels located in the electrical equipment lockers.

13.9.1 74VDC Power System

Systems and components that are operated on 74VDC shall be powered from the battery charger through a power distribution system that includes control switches, circuit breakers and load shed and load drop relays located in the electrical locker. Circuit breakers shall be sized and labeled according to their circuit and function. A master circuit breaker shall control power distribution to all 74VDC circuit breakers.

13.9.2 24VDC Power System

Passenger reading lights shall be powered from 24VDC. A DC-to-DC converter shall be used to convert DC power as supplied from the battery charger or batteries (74VDC to 58VDC) to 24VDC for the reading lights. Power shall be provided to the reading lights when the car is in standby mode. The reading lights shall be protected by a dedicated 24VDC circuit breaker.

13.10 Electrical Panels

An electrical locker shall be provided in the B-end vestibule of all car types. All control switches, circuit breakers and indicators shall be located in this locker unless specified otherwise.

All circuit breaker and switch panels shall meet all recommendations of APTA Recommended Practice RP-E-002-98.

The circuit breaker panels shall be dead front type, with removable front covers, of a design such that all components are front serviceable. Bus bars shall be arranged to have tapped holes along their entire length, and be of a design such that all phase combinations are available at each circuit breaker site. Circuit breakers shall be arranged so that the handles move vertically, with the ON position up.

The panels shall be conveniently located, in the electrical locker, for ease of access by service personnel. Reduced wiring and ease of maintenance shall be of prime consideration. If it is impractical to house all circuit breakers in the electrical locker, additional circuit breaker panels may be proposed for Customer approval.

A wiring gutter shall be provided along the top, sides and bottom, for the routing of high-voltage leads to their designated circuit breakers.

The circuit breaker panel shall be configured for easy removal so that maintenance and repair action are not impeded.

13.10.1 Switch and Circuit Breaker Panel Arrangement

Each circuit breaker panel shall carry apparatus arranged to be easily accessible to connections and designed to prevent an operator from coming in contact with live voltage when operating switches or circuit breakers.

All switches and circuit breakers shall be provided with a nameplate clearly identifying the electrical circuit it controls. The ampere rating for each circuit breaker shall be indicated on the toggle lever. All circuit breakers and switches shall indicate ON with toggle up and OFF with toggle down.

Circuit breakers for the 24VDC, 74VDC, 120VAC and 480VAC power distribution systems shall each be grouped with their respective voltage and be labeled according to the appropriate voltage. A master circuit breaker shall be provided for each voltage level.

13.11 Integrated Schematics

The Contractor shall prepare and submit, for acceptance by the Customer, an integrated schematic diagram package showing all electrical systems and including all components and wiring on the car. See Chapter 22.

Table 13-1: Communication Trainline Pin Assignments

Pin	California Department of Transportation Standard	Amtrak Standard (for information only)	APTA Standard (for information only)
1	Shield (Common)	Shield	Shield (Common)
2	Battery Negative	Battery Negative	Battery Negative
3	Reserved for digital trainline/passenger information	PA/Tape Music #1 (black)	PA/Tape Music #1 (black)
4	Reserved for digital trainline/passenger information	PA/Tape Music #1 (white)	PA/Tape Music #1 (white)
5	Intercom (black)/analog with digital overlay	Intercom (black)	Intercom (black)
6	Intercom (white)/analog with digital overlay	Intercom (white)	Intercom (white)
7	PA Control (black)/analog with digital overlay	PA Control (black)	PA Control (black)
8	PA Control (white)/analog with digital overlay	PA Control (white)	PA Control (white)
9	Reserved for digital trainline/passenger information	Passenger Info (black)	Music-3 (radio)(black)
10	Reserved for digital trainline/passenger information	Passenger Info (white)	Music-3 (radio)(white)
11	Brake Application (not used)	Brake Application (spare-reserved for future use)	Brake Application
12	Brake Release (not used)	Brake Release (spare-reserved for future use)	Brake Release
13	Brake Negative (not used)	Brake Negative (spare-reserved for future use)	Brake Negative
14	Open Doors - Right Hand Side	Open Doors R.H.	Open Doors R.H.
15	Open Doors - Left Hand Side	Open Doors L.H.	Open Doors L.H.
16	Close Doors - Right Hand Side	Close Doors R.H.	Close Doors R.H.
17	Close Doors - Left Hand Side	Close Doors L.H.	Close Doors L.H.
18	Door Closed Light	Door Closed Light	Door Closed Light
19	Brake Released Light	Brake Released Light	Brake Released Light
20	Brake Applied Light	Brake Applied Light	Brake Applied Light
21	Hot Journal Light (not used)	Hot Journal Light	Hot Journal Light
22	Conductor's Signal	Conductor's Signal	Conductor's Signal
23	Door Close Light	Conductor's Door Closed Light	Door Close Lt
24	Reserved for digital trainline/passenger information	Tape Music #2 (black) (spare)	Tape Music #2 (black)
25	Reserved for digital trainline/passenger information	Tape Music #2 (white) (spare)	Tape Music #2 (white)
26	Conductor's Door Light Feed	Conductor's Door Light Feed	Conductor's Door Light Feed
27	Attendant Call	Attendant Call System (not active)	Attendant Call
Shielded pairs	3&4, 5&6, 7&8, 9&10, 24&25	3&4, 5&6, 7&8, 9&10, 24&25	3&4, 5&6, 7&8, 9&10, 24&25
Source		Amtrak dwg A-63-7676-1 (under revision)	APTA Std RP-E-017-99

Table 13-2: Multiple Unit (MU) Trainline Pin Assignments

Pin	California Department of Transportation Standard	Amtrak Standard (for information only)	APTA Standard (for information only)
1	Spare	Spare	Spare (reserved for cruise control)
2	Alarm Bell	Alarm Bell	Alarm Bell
3	Engine Speed Solenoid "DV"	D Throttle	D Throttle
4	Control Negative	Control Negative	Control Negative
5	Emergency Sand	Emergency Sand	Emergency Sand
6	Generator Field	Generator Field	Generator Field
7	Engine Speed Solenoid "CV"	C Throttle	C Throttle
8	Forward	Forward	Forward
9	Reverse	Reverse	Reverse
10	Wheel Slip Indicator	Wheel Slip	Wheel Slip
11	Spare	Spare	Spare
12	Engine Speed Solenoid "BV"	B Throttle	B Throttle
13	Control Positive	Control Positive	Control Positive
14	Spare	Spare	Spare
15	Engine Speed Solenoid "AV"	A Throttle	A Throttle
16	Engine Run	Engine Run	Engine Run
17	Dynamic Brake Setup	Dynamic Brake Setup	Dynamic Brake Setup
18	Remote Load Meter Line 1	Remote Loadmeter	Remote Loadmeter
19	Remote Load Meter Line 2	Remote Loadmeter	Remote Loadmeter
20	Dynamic Brake Warning	Dynamic Brake Warning	Dynamic Brake Warning
21	Dynamic Brake Start	Dynamic Brake Start	Dynamic Brake Start
22	Spare	Spare	Spare
23	Manual Sanding	Manual Sanding	Manual Sanding
24	Dynamic Brake Excitation	Dynamic Brake Excitation	Dynamic Brake Excitation
25	Spare	Spare	MU Headlight
26	Remote Fault Reset	Remote Fault Reset	Remote Fault Reset
27	Brake Emergency	Brake Emergency	Brake Emergency

Table 13-3: Power Phase Matrix

Condition	Normal	Standby	Emergency
Description of Condition	HEP Power. Normal operation. All systems on and functioning.	After loss of HEP. Systems powered by main car batteries. ALL DC loads on.	No battery power. Lights are independently powered per FRA requirement.
Timeline	normal	2 hours	90 minutes
Threshold	normal	after HEP loss	after load drop
Battery voltage	normal	64-58V DC	below 45V DC
AC Lights:			
Seating Area	yes	no	no
DC Lights:			
Seating Area	yes	yes	no*
Vestibules	yes	yes	no*
Stairways	yes	yes	no*
Toilet Rooms	yes	yes	no*
Reading	yes	yes	no
Electrical Locker	yes	yes	no
Equipment Rooms	yes	yes	no
Exterior Platform	yes	yes	no*
Passageway	yes	yes	no*
Marker	yes	yes	no
Capacitor Lights (*)	no	no	yes
Café Sconce	yes	no	no
Doors:			
Side Door control	yes	yes 40 sec every 20 min	no
Side Door operators	yes	yes 40 sec every 20 min	no
End Door Controls and Operators	yes	yes 30 sec every 5 min	no
Door Closed Summary Circuit	yes	yes	no
PA	yes	yes 20 sec every 5 min	no
HVAC	yes	no	no
Toilet Systems	yes	no	no
Toilet Room Exhaust Fans	yes	yes	no
Destination Signs/PIS	yes	yes	no
Wheelslide	yes	yes	no
Convenience Outlets	yes	no	no

Condition	Normal	Standby	Emergency
Description of Condition	HEP Power. Normal operation. All systems on and functioning.	After loss of HEP. Systems powered by main car batteries. ALL DC loads on.	No battery power. Lights are independently powered per FRA requirement.
Cab:			
Headlights and Crossing Lights (cab only)	yes	yes	no
Cab Radio	yes	yes 20 sec every 5 min	no
Locomotive Control	yes	yes	no
Event Recorder	yes	yes	no
Alerter	yes	yes	no
PTC	yes	yes	no
Café/ Lounge:			
Chillers	yes	Yes*	no
Coffee Maker	yes	no	no
Point of Sale	yes	Yes*	no
Elevator	yes	no	no
Elevator Controls/Interlocks	yes	yes	no

* End of Chapter 13 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 14

Food Service

Table of Contents

14.0	Food Service	14-4
14.1	Overview	14-4
14.2	General Requirements.....	14-5
14.3	Café/Lounge Car Interior Arrangement	14-5
14.3.1	Base Configuration.....	14-5
14.3.2	Upper Level Galley.....	14-6
14.3.3	Upper Level Lounge/Booth Seating Area.....	14-7
14.3.4	Upper Level Revenue Seating Area.....	14-7
14.3.5	Lower Level Service Galley	14-8
14.3.6	Lower Level Standard Seating and ADA Accessible Seating.....	14-8
14.3.7	Conductor's Workstation	14-8
14.4	Galley Design Requirements.....	14-9
14.4.1	Countertops and Serving Counter	14-9
14.4.2	Design Requirements.....	14-9
14.4.3	Structural Requirements	14-9
14.5	Galley Appliances.....	14-10
14.5.1	Coffee Maker	14-11
14.5.2	Microwave Ovens.....	14-11
14.5.3	Combination Oven.....	14-12
14.5.4	Freezer - Upper and Lower Levels	14-12
14.5.5	Toaster.....	14-13
14.5.6	Point-of-Sale (POS)	14-13
14.5.7	Refrigerator for Crew Use.....	14-13
14.6	Cart System Operation Overview	14-14
14.6.1	Cart Docking.....	14-14
14.6.2	Cart Securement	14-15
14.6.3	Food Service Carts.....	14-15
14.7	Chiller-Based Cart Refrigeration System	14-15
14.7.1	System Performance	14-15
14.7.2	Chiller Units	14-16
14.7.3	Chiller Air Duct System	14-17
14.7.4	Drain Pan.....	14-18
14.8	Food Cart Elevator	14-18
14.8.1	Performance	14-18
14.8.2	Design Requirements.....	14-19
14.8.3	Elevator Operation	14-19
14.8.4	Frame and Tracks	14-19
14.8.5	Drive System	14-19
14.8.6	Elevator Construction.....	14-20

Table of Contents**14-2**

14.8.7	Elevator Lighting	14-20
14.8.8	Doors	14-20
14.8.9	Elevator Safety	14-21
14.8.10	Controls	14-22
14.8.11	Manual Operation	14-24
14.8.12	Elevator Maintenance	14-24
14.8.13	Elevator System Testing	14-25
14.9	Ancillary Café/Lounge Appurtenances	14-25
14.9.1	Display Case	14-25
14.9.2	Cart Tray Shelf	14-26
14.9.3	Ice Well	14-26
14.9.4	Dispensers	14-26
14.9.5	Recycling and Trash Receptacles	14-27
14.9.6	Jump Seat	14-27
14.9.7	Condiment Station	14-27
14.9.8	Menu and Photograph Holders	14-28
14.10	Galley Electrical System	14-28
14.10.1	Battery Backup with Inverters	14-29
14.10.2	Circuit Breaker Panel - Upper Level Galley	14-29
14.10.3	Circuit Breaker Panel - Lower Level Service Galley	14-30
14.10.4	Service Receptacles	14-31
14.10.5	Convenience Receptacles	14-31
14.10.6	Dedicated Outlets	14-31
14.11	Water System and Drains	14-31
14.11.1	Water Distribution	14-32
14.11.2	Water Heater	14-32
14.11.3	Sinks	14-32
14.11.4	Drains	14-33
14.11.5	Freeze Protection	14-34
14.12	Doors and Latches	14-34
14.12.1	Upper Level Galley	14-34
14.12.2	Lower Level Service Galley	14-35
14.13	Galley Security	14-35
14.13.1	Upper Level Galley	14-35
14.13.2	Lower Level Service Galley	14-36
14.14	Lighting	14-37
14.14.1	Galley Lighting	14-37
14.14.2	Lounge Area Lighting	14-37
14.15	Materials and Workmanship	14-38
14.15.1	Materials	14-38
14.15.2	Mechanical Design	14-38
14.16	Safety, Health and Environmental Requirements	14-39
14.16.1	Sanitation	14-39

<i>Table of Contents</i>	<i>14-3</i>
14.16.2 Fire Safety	14-39
14.16.3 Emergency Equipment	14-39
14.16.4 Noise	14-40
14.16.5 HVAC System	14-40
14.17 Mockup Requirements	14-40

14.0 Food Service

14.1 Overview

The café/lounge car shall provide the food service element of passenger rail service, through the incorporation of a number of elements into the car. These elements may include a galley, serving area, lounge area and revenue seating area on the upper level of the car and a small service galley, crew and passenger seating area and accessible toilet room on the lower level as specified in this chapter. The café/lounge car specified here uses food service carts that shall be moved between levels of the car via a dedicated elevator. However, these elements may be deleted and/or modified to meet the specific service objectives of a region or corridor service in subsequent versions or supplements to this Specification. The specifications contained in this chapter are considered the standard base specification for the café/lounge car and shall be the default specification unless expressly indicated by the Customer.

Modifications to this standard cafe-lounge car specification should generally be confined to items such as interior arrangement and appliances. Every effort should be made to minimize changes to the mechanical and electrical systems. It is envisioned that modifications may include such interior arrangement options as:

- Business class seating instead of coach seating
- Coach or business class seating instead of a lounge area
- Replacement of a combination oven with a microwave

The café/lounge car shall provide a positive atmosphere for passenger dining and a safe and efficient work space for the food service employees and train crew.

The following are all part of the standard base specification for food service:

The A-end of the upper level shall consist of a lounge area, with tables and booth seating for parties of one, two or four people. The lounge is intended to be for non-revenue seating by passengers. The design of the lounge, including lighting and amenities, shall provide a comfortable and distinctive area for passengers to eat, converse and relax. Convenience outlets, recycling and trash containers, a condiment station and accent lighting shall be provided. There shall be no stairway, curtains, reading lights or overhead luggage storage in the lounge area.

The serving counter and food preparation galley shall be located in the center of the upper level, with the serving counter facing the lounge area. A hallway provides passage around the galley from one end of the car to the other.

The B-end of the upper level shall be configured similarly to the revenue seating in the coach cars, with seats and workstation tables mounted in seat tracks on the floor and side wall. Overhead luggage storage, curtains, reading lights and a staircase to the lower level shall be provided. There will not be a toilet room on the upper level of the café/lounge car.

The lower level shall consist of a service galley at the A-end and a revenue seating area and Accessible Toilet Room (ATR) at the B-end.

14.2 General Requirements

The café/lounge car shall consist of an upper level service area and galley, lounge seating and a revenue seating area. The lower level shall consist of a small service galley area, a conductor's workstation, a wheelchair storage area and ADA accessible seating and restroom.

The components of the galley and food storage area shall be modular. The food service galley and lounge areas shall conform to all applicable regulations, including health and safety and food preparation requirements. Certification of compliance with FDA regulations shall be required.

This chapter specifies those systems, features and components found only on the café/lounge car. Areas of the café/lounge car that are not defined or specified in this chapter shall be governed by the applicable equivalent system requirements found elsewhere in this specification, unless specifically identified otherwise.

14.3 Café/Lounge Car Interior Arrangement

There are two possible configurations for the café/lounge car, to be specified at the direction of the Customer.

14.3.1 Base Configuration

The café/lounge standard base configuration shall have the following major features:

Upper level:

- Lounge seating (A-end)
- Galley and serving counter, with hallway to provide public access around the galley (center)
- Condiment station (adjacent to serving counter)
- Elevator to move carts from lower level to upper level (adjacent to galley)
- Revenue seating and staircase to lower level (B-end)

Lower level:

- Revenue seating, including wheelchair parking spot
- Conductor's workstation
- ATR
- Vestibule with side entrance doors, wheelchair lift and door control panels (B-end)
- Service galley, with side entrance doors and elevator lobby (A-end vestibule)
- Staircase to upper level (B-end)

The café/lounge car interior configuration shall be in conformance with the conceptual drawing provided as Figure 14-1 through Figure 14-7. Upper level galley layout shall be in conformance with Figure 14-2 through Figure 14-4.

Base configuration items are detailed further in sections 14.3.1 through 14.14 inclusive.

14.3.1.1 Optional Configuration

The café/lounge car interior arrangement may be modified from the standard base specifications. The details of this shall be contained in Chapter 23 in this Specification.

14.3.2 Upper Level Galley

The upper level galley shall be located about mid-point in the car, be modular in design and installation and shall contain the following features. See Figure 14-1 through Figure 14-4.

- Serving counter
- Display case with sliding Lexan doors
- Countertops with adequate space for food preparation and storage
- Two chiller units, with each chiller cooling four carts
- Cart storage areas for eight refrigerated carts
- Cart storage areas for six non-refrigerated carts
- One hand washing sink and one utility sink, with hot water supply, paper towel and soap dispensers and an under counter storage area for cleaning supplies
- Mirror and accent light above hand washing sink
- Galley appliances:
 - Coffee maker
 - Microwave ovens (two)
 - Combination oven
 - Toaster
 - Freezer
- Point-of-Sale (POS) unit
- Trash and recycling compartments – two of each
- Public address (PA) unit, with handset and function selector switch
- Emergency equipment (first aid kit, fire extinguisher and snap lights)
- Jump seat
- Crew storage locker
- Security screen with storage locker
- Eight duplex service receptacles, four along each side wall of the galley, (exclusive of dedicated outlets)
- Heating, Ventilation and Air Conditioning (HVAC) diffusers, with an air adjustment feature, to provide air supply to galley
- Circuit breaker panel with door and paddle latch
- Dispensers:
 - Coffee cups
 - Coffee cup lids

- Cold cups
- Carryout boxes
- Overhead storage shelf with capacity for four trays
- Upper level elevator lobby and elevator control panel
- Rear galley access door and serving counter swing door

14.3.3 Upper Level Lounge/Booth Seating Area

Booths with seats and tables for one-, two- and four-person seating shall be located on either side of the aisle way at the A-end of car, in conformance with the conceptual layout shown in Figure 14-1. Lounge area seating shall be oriented to provide the passengers an unobstructed view through the side windows when seated. The aisle shall be wide enough to provide room for a line of passengers to form at the serving counter while permitting other passengers to pass through the lounge area unobstructed.

The booth seats shall be made of Fiberglass Reinforced Plastic (FRP) and shall be equipped with back and bottom cushions. The booth seats facing the side of the car shall have a handrail at the back, near the top of the seat back, for passengers passing through the aisle or standing in line to use as a handhold. Design of the booths and tables shall be in accordance with the ergonomic requirements for the range of passengers from the 5th percentile female to the 95th percentile male. Table edges shall be rounded and shall include a small lip around the perimeter of the table top to contain spilled liquids. Duplex convenience outlets shall be installed adjacent to each table.

The booths shall be easily cleaned and cushions shall be easily removed for cleaning and shall be attached to the booth in accordance with component attachment strength requirements. Food particles shall not be permitted to collect in any area of the lounge. Adequate clearance shall be provided under the booths and tables for cleaning of the floor, or the area under the booths shall be closed off.

Upholstery and fabric selection for the booth seats shall be submitted to the Customer for approval as part of the interior décor palette. See Chapter 9.

14.3.4 Upper Level Revenue Seating Area

The B-end of the upper level shall consist of passenger seating identical to the revenue seating in the coach and cab-baggage cars. Seats shall be installed in facing pairs with a workstation table between each pair. Seats and tables shall be mounted in wall and floor tracks per the requirements of Caltrans Drawing D-9-901. Overhead luggage bins and curtains shall be provided. See Chapter 9 for details of the design requirements of the revenue seating area.

There shall be no Unisex Toilet Room (UTR) on the upper level of the café/lounge car.

There shall be one public-access staircase from the lower level B-end vestibule to the upper level B-end seating area. There shall be no staircase at the A-end of the café/lounge car.

14.3.5 Lower Level Service Galley

The lower level galley, located at the A-end of the lower level (See Figure 14-5 and Figure 14-6), shall serve as a storage area and have the following features:

- One chiller unit
- Space for three refrigerated carts
- Space for three non-refrigerated carts
- Under-counter freezer
- Refrigerator (for crew use only)
- Microwave (for crew use only)
- Stainless steel countertop above cart storage areas
- Trash and recycling receptacles – one each
- Lower level elevator access doors and elevator control panel
- Circuit breaker panel
- Lockable under-counter storage area for crew use
- Two duplex service receptacles on back wall (above refrigerated cart storage area) plus dedicated simplex outlets for crew microwave and refrigerator
- HVAC diffusers, with an air adjustment feature, to provide air supply at lower level storage area
- Storage location for a fire extinguisher and Customer-provided Automated External Defibrillator (AED)

14.3.6 Lower Level Standard Seating and ADA Accessible Seating

The café/lounge car shall include an accessible seating area and ATR restroom in the B-end of the lower level. The accessible seating area shall include a single seat, a small table and a wheelchair parking spot at the table, per 49CFR Parts 27, 37 and 38. The ATR shall be identical to the ATR on coach and cab/baggage cars. All seating on the lower level shall be mounted in seat tracks per Caltrans Drawing D-9-901.

14.3.7 Conductor's Workstation

A standard four-passenger seating area with a table shall be located on the lower level for the train crew to use as office space. The seats and table shall be bounded on forward and rearward sides by Lexan partitions. An extra pair of duplex outlets shall be provided for the crew to use for charging of radios, cell phones and other equipment. The table shall be labeled "Reserved for Amtrak Crew".

A Public Address (PA) system control station, with handset and intercom, shall be provided at the conductor's workstation.

The overhead luggage bin above the conductor's workstation shall be fitted with a standard coach key lock.

14.4 Galley Design Requirements

The galley, serving counter and lounge areas shall be designed to provide an aesthetically pleasing and efficient area for passengers and crew. The Contractor shall be responsible for providing a comprehensive and unified appearance throughout all areas of the café/lounge car, as well as being complimentary and consistent with all other car types built to this specification. Choice of finish materials shall be submitted to the Customer for approval.

14.4.1 Countertops and Serving Counter

Galley countertops shall be approximately 39 in. above the floor. The countertops and cart storage areas shall provide space for food storage and crew work area, including counter area for basic food preparation, hand washing and utility sinks, ice well, cutting board and basic appliances.

The serving counter shall be 48 in. above the floor and shall be no less than 14 in. deep (from passenger side to galley side). The serving counter shall be made of WilsonArt Gibraltar Solid Surface 100% acrylic countertop material, with raised exposed edge and cove molding where it abuts vertical surfaces. Color of the countertop shall be provided for to Customer approval at the design review.

14.4.2 Design Requirements

The upper level galley and lower level service galley area shall be composed of several essentially self-contained modules that are attached to the carbody floor, wall and ceiling structure at several points.

The design and installation of countertops, wall panels, floor-to-wall joints, recycling and trash receptacles and lockers and component mounting shall not permit food particles, debris, liquids or moisture to harbor behind, over or under any of their surfaces. Countertops shall have a raised edge on all exposed faces and a cove on all edges adjacent walls and bulkheads and be properly sealed and caulked. All outside corners formed by two planes shall have a minimum radius of 0.25 in. Corners formed by three planes shall have a minimum spherical radius of 0.375 in.

The size and quantity of recycling and trash receptacles shall be adequate to accommodate the volume of recyclables and trash generated during revenue service. Amtrak standard 30 gal and 55 gal trash cans should be used.

14.4.3 Structural Requirements

All food service equipment shall meet the crashworthiness standards of 49CFR Section 238.233 and APTA Standard SS-C&S-006-98, including the complete upper level galley, security screen, elevator, lower level service galley equipment, appliances and cart and chiller units. Compliance with 49CFR Section 238.233 shall consider the worst case scenario of the food service equipment.

This shall include the securement of:

- The upper and lower level galley structure when fully loaded with all supplies and an entire stock of fully loaded carts.

- Carts, chiller units and trays to galley structure, including the food service trays when held in the angled tray storage shelf.
- Galley appliances to the countertops.
- The security screen when stored.
- The elevator doors when loaded with full complement of fully loaded carts.

The wall on which the jump seat is mounted shall provide structural strength to support a downward load of no less than 300 lbs. on the jump seat without deformation.

14.5 Galley Appliances

The following commercial appliances shall be mounted in the upper and lower level galleys as noted:

- Coffee maker
- Microwaves
- Combination oven
- Freezers
- Toaster
- POS terminal
- Refrigerator for crew use

Locations for these appliances are shown in Figure 14-2 through Figure 14-5.

Countertop space provided for these appliances shall include adequate room to replace appliances with a different model or style with similar capacity.

Appliance change-out time (the time to remove a defective unit, install a replacement unit and verify function of the replacement unit) shall not exceed 30 min. for the galley appliances specified in this section.

All appliances shall be mounted within the galley in a manner that complies with regulations regarding attachment strength and resistance to acceleration forces. The retention mechanisms shall not interfere with appliance operation or routine cleaning or servicing and shall allow the removal and replacement of the appliances within the specified times.

All appliances shall be installed to provide adequate ventilation for cooling/heat dissipation and to prevent heat buildup on adjacent surfaces, per the appliance manufacturer's recommendations.

Each appliance shall be powered through a separate dedicated, labeled circuit breaker with matching label at the protected simplex outlet. All appliances shall be properly grounded to the carbody.

All commercially available appliances shall be approved by Underwriters' Laboratories (UL) and the National Sanitation Foundation (NSF).

14.5.1 Coffee Maker

A single Wilbur-Curtis Gemini G3 series coffee maker, model GEMTS16A1000 shall be provided, located on the working counter of the galley per Figure 14-2 and Figure 14-3. The coffee maker shall include two coffee urns and an in-line water filter. The installation and securement design for the coffee maker shall be as configured for revenue service (coffee maker and both urns filled with water).

A drain pan shall be provided under the coffee maker urn spigots, with a 0.75 in. drain to ground, to catch spills and drips from the coffee spigots as well as to allow the unit to be drained for cleaning or servicing/replacement. The drain line shall be equipped with a check valve, which shall be located to facilitate replacement and maintenance.

The coffee maker shall be powered through a dedicated circuit breaker and the case shall be grounded to carbody.

Dispensers for coffee cups and coffee cup lids shall be located in the immediate vicinity of the coffee maker.

Basic characteristics:

- Coffee server capacity: 3 gal total (1.5 gal per urn)
- Coffee maker dimensions are 26 in. wide by 30 in. tall by 9 in. deep
- 208VAC, 3-phase, 7800W, 20-amp service
- Protection for heater element when no water is present
- Hot water faucet - adjustable, set to 180°F
- Manual drain to empty the brewer water tank
- Plug and receptacle type: NEMA 6-20R
- Quick disconnect fittings: Wilbur-Curtis JB-H20QC (female on coffee maker and male on galley side of water supply line)

14.5.2 Microwave Ovens

Two commercial microwave ovens, Panasonic NE-1257R, shall be provided in the upper level galley, elevated above the work counter as identified in Figure 14-2 and Figure 14-3. These microwaves shall be mounted one above the other, in a frame that permits removal of one microwave without requiring the disturbance of the other.

A third microwave oven shall be mounted in the lower level galley for crewmember use only and shall be labeled FOR USE BY CREW ONLY. NOT TO BE USED FOR FOOD FOR PUBLIC SALE.

The microwave ovens shall meet all current radiation and labeling requirements of the Federal Communications Commission.

Basic characteristics:

- Capacity: 0.62 ft³
- Microwave Dimensions are 16 in. wide by 12 in. tall by 12 in. deep

- 1200 W cooking power
- 120VAC, 18 amp service
- Plug and receptacle type: NEMA
- Labels at oven: MICROWAVE OVEN 1 (upper), MICROWAVE OVEN 2 (lower)

14.5.3 Combination Oven

An Amana ACE14 combination convection/microwave oven shall be mounted on the countertop as identified in Figure 14-2 and Figure 14-3. The oven shall include one shelf rack.

The combination oven shall meet all current radiation and labeling requirements of the Federal Communications Commission.

Basic characteristics:

- Capacity: 1.2 ft³
- Combination Oven Dimensions are 19.25 in. wide by 18.25 in. tall by 26.25 in. deep
- 2700 W cooking power, convection mode
- 1400 W cooking power, microwave mode
- 208VAC, 20 amp service
- Plug type: NEMA 6-20P
- Galley receptacle type: NEMA 6-20R
- Label: COMBINATION OVEN

14.5.4 Freezer - Upper and Lower Levels

An industrial/transportation grade, self-contained under counter freezer shall be provided in the galley below the working counter in the upper and lower level galleys, to be used for storing bagged ice cubes, ice cream and other frozen food. Freezers shall meet all FDA and NSF requirements. The freezers shall be SubZero model 249FF. See Figure 14-4.

Freezer condensate shall drain into a drain pan integrated into the unit. No external drain shall be required.

Basic characteristics:

- Operating temperature: 0°F or colder (thermostat setting locked)
- Freezer dimensions are 24 in. wide by 34 in. tall by 18 in. deep
- Capacity: 4.6 ft³
- Rating: capable of consistently maintaining food at the FDA required 0°F or colder under all combinations of the following:
 - Continuous operation with the galley at an ambient temperature of up to 90°F.
 - Under all state-of-load situations: empty, partial load, fully loaded.
 - Attain a pull-down to 0°F or below within 45 min of startup from an overnight soak of the refrigerated space at 90°F.

- Door hinged on left side on upper level freezer, hinged on right side on lower level freezer.
- Door shall have a positive self-latching handle.
- Door shall have a padlock hasp to permit the freezer to be locked with a crew-issued padlock (0.25 in. inside diameter hole in hasp).
- A digital thermometer, reading internal box temperature, shall be installed on the upper section of the front face of the door.
- 120VAC, 15 amp service, with NEMA type plug and receptacle

14.5.5 Toaster

A commercial-grade, four-slice toaster, Waring Commercial model WCT 708, shall be provided in the galley area per Figure 14-2 and Figure 14-4. The toaster shall operate on 120VAC with a rating of 1800 W and shall have a plated steel case with a brushed chrome finish. The toaster shall be installed on the countertop using a securement mechanism that prevents unauthorized removal but permits maintenance – Bell Plastics Toaster Holder, Black - p/n TH 127. The toaster dimensions shall be 12 in. wide by 7 in. tall by 7 in. deep.

14.5.6 Point-of-Sale (POS)

An Amtrak standard Point-of-sale (POS) unit will be provided in the upper level galley per Figure 14-2 and Figure 14-3. The POS unit shall be manufactured and installed in accordance with Amtrak POS standards in effect at the time of design and manufacture of the café/lounge cars.

The POS operation shall be supported during Head End Power (HEP) outages by an inverter that supplies 120VAC from the chiller backup battery source.

Provision shall be made for the POS to communicate with the car-based wireless/Ethernet communication system for real-time inventory reporting, credit card transactions, etc. See Chapter 12 for details.

14.5.7 Refrigerator for Crew Use

An industrial/transportation grade, self-contained under-counter style refrigerator shall be provided in the lower level service galley for the use of the crew and not for storage of food to be sold to the public. This refrigerator shall be SubZero model UC-24R.

Refrigerator condensate shall drain into a drain pan integrated into the unit. No external drain shall be required.

Basic characteristics:

- Capacity: 5.7 ft³
- Refrigerator dimensions are 24 in. wide by 34 in. tall by 18 in. deep
- Door hinged on right side. Door finish to be brushed stainless steel.
- Door shall have a positive self-latching handle.
- Door shall have a padlock hasp to permit the refrigerator to be locked with a crew-issued padlock (0.25 in. inside diameter hole in hasp).

- 120VAC, 15 amp service, with NEMA type plug and receptacle

The refrigerator shall be clearly labeled FOR USE BY CREW ONLY. NOT TO BE USED FOR FOOD FOR PUBLIC SALE.

14.6 Cart System Operation Overview

Food and supplies for the galley and on-board food sales will be delivered to the train via free-rolling, airline-style insulated food storage carts. Carts containing perishable items shall be docked at locations with access to chilled air ducts to provide cooling for the perishable items. Self-contained chiller units will circulate refrigerated air through the carts, with the chilled air returning to the chiller for re-refrigeration. Chilled and return air will be transferred to and from the carts through magnetic rubber seals on the ducts that make contact with steel plates on the rear of the cart. The duct openings shall be equipped with a spring-loaded, hinged flapper that closes and seals the duct opening when no cart is docked and automatically opens when a cart is docked at that location to allow chilled air to circulate into the cart. The chilled carts shall be docked under the countertop on the right side of the galley (the side adjacent to the exterior of the carshell) and in the lower level service galley.

Carts containing "dry" items (non-perishable food and other supplies) shall be docked at non-chilled locations under the counter on the left side of the upper level galley (the side adjacent to the hallway) and in the lower level service galley.

Carts will be loaded onto the car through the lower level service galley and will be transferred to the upper level galley by use of a two-cart service elevator. Carts will be docked under the working counters and will be retained in position using quarter-turn latches.

14.6.1 Cart Docking

Food service carts and chiller units will be docked in assigned locations in the upper level galley and lower level service galley. The design of these docking sites shall include the necessary guides to ensure the carts are held securely in position on an individual basis and shall not rely in any way on an adjacent cart to be held into the proper position. Docking sites for dry goods carts shall be wide enough to allow the cart to be parked in position with the door opened flush along the right side of the cart.

Docking sites for food service carts shall include the following features:

- Flat floor to allow the carts to be moved in and out easily;
- Lower guide along the side of the cart cavity walls;
- Top "T" guide to locate the top of the cart and separate adjacent carts;
- Condensate pan and drain on floor (chillers and chilled carts only);
- Magnetic rubber seal and hinged flapper on chilled air duct (chilled cart docking locations only);
- Rear stop to prevent the cart from moving too far into the cavity but will allow adequate contact with the magnetic rubber seal on the chilled air ducts;
- Quarter-turn retaining latch to secure the cart in place;
- Each cart position numbered using label kit; and

- Sufficient clearance in the guides and aisle so that any cart can be removed and replaced without the need to disturb any other cart.

14.6.2 Cart Securement

Carts shall be retained in place using aircraft-style quarter-turn retention latches. The quarter-turn retaining latches shall be spring loaded with a detent at the 3 and 6 o'clock position and shall be indexed so that they cannot be rotated out of position. Latches shall be red anodized aluminum. The latches shall be installed underneath the edge of the countertop so that the edge of the counter is free of latches or other protrusions that may pose a safety risk to the attendant. The latches shall not interfere with the normal operation of the cart doors.

The retaining latch and rear stop shall be designed so that, when secured with the latch, the cart is held in place against the rear stop and has adequate contact with the magnetic rubber seal on the chilled air ducts to ensure a tight duct seal but is not crushing the magnetic seal.

The cart securement mechanism, including latch, countertop structure and fasteners shall be designed to provide adequate cart retention under regulated acceleration forces for fully loaded carts.

14.6.3 Food Service Carts

Each café/lounge car shall be delivered with three sets of food service carts, manufactured in accordance with Caltrans Specification 14-105.

14.7 Chiller-Based Cart Refrigeration System

The perishable food refrigeration system is composed of: a self-contained chiller unit that cools air to prescribed temperature and distributes the chilled air to the food service carts through a series of enclosed ducts. Spring-loaded, hinged flappers on the ducts open automatically when a cart is docked and permit chilled air to enter the cart and return air to be vented from the carts and returned to the chiller unit for re-cooling. Magnetic rubber seals shall provide a low-leakage connection between the carts and the ducts. The spring holds the flapper door tightly closed when no cart is docked.

Hot exhaust air from the chiller shall be vented to the outside of the carbody through a dedicated duct and vent.

14.7.1 System Performance

The performance of the food refrigeration system (including chillers, carts and ducts) shall meet all applicable FDA and Amtrak requirements regarding the maintenance of perishable food temperatures between 33° and 40°F consistently under all combinations of the following conditions:

- The café/lounge car is operating in revenue service, with the café open and serving (frequent cart door openings to access contents);
- The café/lounge car is in layover between trips, but still stocked (such as overnight layover);

- The café/lounge car interior temperature is maintained within the range of 65°F to 90°F under normal HVAC operation;
- The café/lounge car exterior ambient conditions are within the ranges specified in Caltrans Specification 1-106;
- Chilled carts may be empty, partially loaded or fully loaded; and
- Chillers may be operating with as few as two carts in position on that chiller's duct circuit.

Qualification testing of all refrigeration systems shall be included in car qualification tests, as described in Chapter 19.

14.7.2 Chiller Units

Conditioned air to chill the food service carts within the required temperature range shall be provided through the use of self-contained, roll-in chiller units. Three identical chiller units shall be provided in accordance with Caltrans Specification 14-107 and installed beneath the countertop in the upper level galley and lower level service galley of the car, adjacent to the food service carts they chill.

Each chiller shall provide chilled air for up to four food service carts. To balance the air flow and temperature distribution, the carts to be chilled shall be docked on both sides of the chiller. (If the chiller provides chilled air to four carts, two carts shall be docked on each side of the chiller.) The chiller compartment shall be separated from the adjacent cart docks by an insulated wall, made of heat-reflecting aluminum foam-core material no less than 0.5 in. thick, to minimize heat transfer from the chiller to the carts.

14.7.2.1 Electrical requirements

Each chiller unit shall be powered from its own circuit breaker, and the chiller unit case shall be grounded to the carbody through the wiring harness. In addition, a toggle switch shall be provided for each chiller unit to allow the unit to be switched off manually. A green Light Emitting Diode (LED) pilot shall be provided for each switch, wired so that it will illuminate when power is on at the load side of the respective closed chiller unit switch.

Power for the chiller is provided through a seven-pin connector (Amphenol MS3102A16S-1PF) mounted at the front of the top of the chiller unit. The male half of the connector is mounted on the chiller case and the female half is on the carbody wiring harness. Wiring for the electrical connector shall conform to Caltrans Specification 14-107. The wiring harness shall be long enough for easy attachment and disconnection of the plug without having to remove the chiller from the compartment.

14.7.2.2 Chiller securement

The chiller units shall be wheeled into position and secured with a quarter-turn latch and compartment door.

The compartment in which each chiller is mounted shall have a hinged door that closes off the chiller compartment, to reduce the noise and heat of the chiller from entering the galley work space. This door shall have a small round window so that the temperature gauge on the chiller is visible through the door. The door shall also have a perforated stainless steel grille to allow

intake air to pass through the door and enter the chiller. The door shall be secured with a paddle latch and shall provide as much noise and heat reduction as possible.

Each chiller shall be positively secured in place using a heavy-duty aircraft-style quarter-turn latch. The latch and its attachment to the galley structure shall be able to restrain the chiller against regulated accelerations per 49CFR Section 238.233 and APTA Standard SS-C&S-006-98. The latch shall not interfere with the normal operation of the chiller, or with the view of the temperature gauge.

14.7.3 Chiller Air Duct System

There shall be three distinct ducts for each of the groups of chillers and refrigerated carts:

- Chilled supply air
- Return air
- Chiller unit condenser exhaust air

The supply and return air ducts connect the chiller with four adjacent refrigerated carts. The ducts shall be mounted on the lower level wall of the galley and shall be well insulated on all sides, including the side adjacent to the carbody side frame. Each chiller's duct circuit shall be separated from the other duct circuits.

All ducts shall be insulated to prevent heat transfer from any adjacent heat source, including the chiller, the exterior of the car, the cavity between the back wall of the galley and the inside of the carshell, or any other galley component.

The supply, return and exhaust ducts shall be designed and installed to properly interface with the carts and chillers as specified. The interface between the duct and the carts and chiller unit shall be with a magnetic rubber seal (similar to commercial refrigerators). When the refrigerated cart or chiller is in its operating position, it presses against the seal, allowing the magnetic seal to contact a steel plate on the rear of the cart or chiller and providing a low-leakage seal.

14.7.3.1 Supply and return ducts

Both the supply and return air ports at each of the cart docking positions shall be equipped with a magnetic rubber seal that mate with the rear of the cart and a spring loaded flapper door, which will seal the port when a cart is not docked at that position. The seals shall be easily replaceable. The magnetic rubber seals shall be sufficiently robust to withstand routine duty cycles of removal and installation of carts.

A non-adjustable boss on each flapper will push the flapper open when a cart is positioned and locked in place with the quarter-turn latch. The ducts shall be deep enough to allow the flapper to open sufficiently to allow adequate air flow into and out of the carts. Flappers shall be hinged on the top edge and will have a return spring to close the flapper and seal the air port when no cart is present.

A rear stop shall be mounted on the back wall of the cart docking spot to ensure that the cart is not inserted too far into the slot and flatten the magnetic seal.

The ducts shall be designed to provide an even, stable, non-turbulent air flow to and from each of the carts and will be designed so that each cart receives 25% ($\pm 5\%$) of the total chiller

supply air flow. Airflow volume into and out of each cart will be verified for each food service cart position as part of the chiller system acceptance test on each car. The air flow and chiller system functional test shall be conducted with a full complement of carts in place and properly loaded with perishable food items.

14.7.3.2 Chiller exhaust duct

The chiller exhaust duct will convey the hot air emitted by the operating chiller unit to the exterior of the car, through an insulated duct made of stainless steel. The exhaust vent shall have a screen to prevent entry of vermin into the car interior and shall be oriented downward to prevent collection of rainwater. Each chiller shall have its own exhaust duct; two or more ducts may share a common vent to the outside provided that the vent does not restrict the flow of the exhaust air.

14.7.4 Drain Pan

Each chiller and chilled cart docking site shall be equipped with a drain pan with removable screen to catch chiller unit condensate or defrost water and drain it outside the car. The design of the drain pan shall be adequate to capture and drain all condensate and defrost water produced by the chilled carts and chiller units so that no water drips onto the galley floor. The drain shall be equipped with a removable screen and backflow preventer and shall drain to ground under the car.

14.8 Food Cart Elevator

A screw-driven, fully enclosed elevator shall be provided to convey loaded and empty food service carts and other stock items between the upper and lower levels of the café/lounge car. The elevator system shall be designed to facilitate the movement of loaded and empty carts between the elevator and the side entrance doors on the lower level and between the elevator and the upper level galley cart docking stations. The elevator will be used both when the café/lounge car is stationary as well as when moving at various speeds. The elevator shall operate in a tower enclosure.

The design of the elevator system shall incorporate safety features to ensure that the elevator is operated in a safe and efficient manner. Interlocks to prevent movement of the elevator without all elevator doors being closed and latched shall be provided.

The elevator drive system shall operate on 208VAC, 3-phase, 60-cycle power. The control circuit for the elevator shall operate on 120VAC, 60-cycle.

14.8.1 Performance

The elevator shall accommodate a minimum of two fully loaded food service carts with a weight of up to 250 lbs each, plus an additional 100 lbs, for a total revenue load of 600 lbs. The elevator system shall be designed with a minimum safety factor of 2, for a total design load of no less than 1,200 lbs.

The travel time for the elevator to move between floors shall not exceed 60 seconds, from the time the control button is pushed to the moment the elevator reaches its destination level.

14.8.2 Design Requirements

The elevator shall be designed to be used in a demanding mechanical, electrical and operating environment without failure or creation of unsafe conditions. The design of the elevator system shall utilize components that have a proven history of reliable performance and are commercially available for long-term maintainability. The elevator design shall be tolerant of dimensional changes that will occur because of carbody flexing, component wear or environmental conditions (temperature changes, dirt, moisture, car motion, etc) and shall not require any adjustment more often than annually. All components and wear surfaces shall be designed to remain fully functional for at least eight years between overhauls.

14.8.3 Elevator Operation

The following conditions are required to operate the elevator under normal conditions:

- Elevator door is closed and latched.
- Upper and lower level tower doors are closed and latched.
- The access door to the manual operation equipment is closed and latched.
- Mechanical safety interlock on elevator track is in run position.
- Key switch is rotated to the ON position on the elevator control panel on either the upper or lower level.
- Either of the control buttons (UP or DOWN) is pressed on the activated elevator control panel.

Once the control button is pushed, the elevator slow-starts, then moves at normal speed. Once the elevator is moving, the coach key can be removed from the key switch panel and the elevator will continue moving until it reaches its destination level. As the elevator nears the upper or lower floor level, it slows and moves at reduced speed until reaching the correct level within ± 0.5 in.

The elevator drive system design shall not allow over-travel in either the upward or downward directions.

Signage describing proper elevator operation shall be provided on the upper and lower levels.

14.8.4 Frame and Tracks

The elevator frame and track structure shall be designed to function within the carbody structure and shall be designed to adequately accommodate the inherent flexing of the carbody without binding the movement of the elevator. The frame shall be mounted to the carbody so that while the frame remains rigid, flexing of the carbody is compensated for by resilient mountings, if necessary. The elevator frame shall be designed to be moved into the car in the fewest number of subassemblies possible.

14.8.5 Drive System

The elevator shall use a screw drive to provide travel. The screw shall be driven by an electric motor driving the screw via a worm and gear box. The drive control shall provide for soft starts and stops. An integral brake shall be included in the drive system. The brake shall function to provide positive stop and alignment at the upper and lower stops and also provide a safety

function if electric power is lost or elevator is stopped during transit. The motor shall be protected against possible failure modes such as over-temperature and motor overload.

14.8.6 Elevator Construction

The elevator shall be constructed of steel. Elevator walls shall meet the strength requirements of the service intended for the life of the car, as well as crashworthiness requirements. There shall be no small radius corners throughout the interior. Rubber bump strips shall be mounted, using recessed mechanical fasteners, on all walls on the inside of the elevator to protect the carts and elevator walls. The roof and structure shall have adequate strength to support a maintenance employee while standing on the roof of the elevator to perform maintenance of the elevator track and equipment.

The elevator shall include a door to prevent carts, utensils or food from falling out while in transit. A slightly raised threshold shall be provided across the elevator door opening to prevent carts from unintentionally rolling into and out of the elevator.

The elevator shall be grounded to the carbody through a flexible wiring harness.

14.8.7 Elevator Lighting

The elevator shall be equipped with durable cool white 74 VDC LED lighting. The lighting components shall meet the requirements of APTA Recommended Practice RP-E-012-99. The lighting will be normally extinguished but will come on in response to activating either elevator key switch. The lighting will stay on for 15 minutes after both key switches are in the OFF position and then self-extinguish.

Light level throughout the elevator floor shall be no less than:

- Normal lighting mode: 30 foot-candles
- Standby lighting mode: 5 foot-candles

14.8.8 Doors

Elevator doors shall be of robust construction to endure the life of the car. Doors shall be secured to the door frame with a suitable stainless steel piano hinge. All doors shall have sufficient floor clearance so that they cannot drag along the floor surface, even if they sag slightly from wear and age. The tower doors shall be larger than the elevator door so that the elevator door can open at least 90 degrees.

14.8.8.1 Elevator door

The elevator door shall have the following characteristics:

- The door must open to permit a clear path for cart movement on both the upper and lower levels. This shall require that the door be designed so that it folds, recesses, retracts, or is otherwise removed from blocking cart movement. The door design must be robust to withstand harsh use. The Contractor shall submit proposed designs to the Customer for approval during design review. **DR**
- Sufficient strength to retain a full complement of fully loaded carts under accelerations per 49CFR Section 238.233 and APTA Standard SS-C&S-006-98.

- Rub strip, attached with countersunk screws, on the inside of the door to protect the carts and elevator door.
- Spring latch on the door handle to allow the door to be opened from either side.
- Proximity sensors to detect that the door is closed and the latch is engaged.
- Device to hold the door fully open.

14.8.8.2 Elevator tower doors

The elevator tower door used for both upper and lower levels of the car elevator tower shall be equipped with the following features:

- The door shall open out into elevator lobby, with the hinge on the left edge of the door on the upper level and on the right side of the door on the lower level.
- There shall be a spring latch on the door, using a coach key to unlock from the outside and a handle on the inside so it can be opened from inside the elevator.
- Doors shall be equipped with proximity sensors to detect that the door is closed and latch engaged.
- A floor-mounted, foot released hold-open device shall be installed for each door.

14.8.9 Elevator Safety

The elevator system shall include a series of electrical and mechanical interlocks to prevent accidental movement of the elevator. Limit switches, safety switches and mechanical interlocks must be of robust construction and mountings shall be rigid to keep switches in their proper location.

14.8.9.1 Mechanical interlock

To prevent the elevator from moving when a person is on top of it or below it, a mechanical bar shall be manually set to engage the elevator track above or below the elevator to physically prevent the car from moving either up or down. The device shall be red powder coated steel and shall be oriented on the elevator track so that the elevator cannot move when the mechanical interlock is in place. In addition, it shall be interlocked with an electrical switch that interrupts electrical power to the drive motor.

14.8.9.2 Electrical interlocks

The elevator will not move when any elevator system door is open:

- Elevator door
- Upper and lower level tower door
- Manual operation equipment access door

The elevator will immediately stop and remain stopped if in motion when any of the following happen:

- The emergency stop push button is pressed;

- The elevator motor or control circuit loses electrical power or the circuit breaker is turned off;
- The drive motor detects an obstruction in the track and shuts off;
- The access door to the manual operation equipment is opened; or
- The elevator door or either of the tower doors is opened.

Once the condition that caused the elevator to stop has been corrected, the elevator shall not start moving again until a new elevator motion command is given by activating the elevator key switch and pressing the up or down push button again.

The elevator door shall be interlocked so that it cannot be opened unless the elevator is in alignment with the upper or lower level floor. The elevator tower doors can be opened regardless of whether the elevator is aligned with either floor.

Signage describing elevator safety instructions shall be provided on the upper and lower levels and as necessary.

14.8.10 Controls

The elevator shall be controlled by a primary drive system control with interlocks and position sensors. The control circuit shall operate on 120VAC, with the elevator drive system operating on 208VAC, 3-phase, 60-cycle power.

The control system shall provide an LED indication of the status of the elevator and tower doors, the location of the elevator (upper or lower level) and the interlocks.

The elevator control system logic shall be fail-safe. Any open control circuit shall prevent the elevator from moving, or stop the elevator if it is in motion. The control system shall protect the drive mechanism from damage.

14.8.10.1 Control panels

An elevator control panel shall be mounted on the face of the door frame of the upper and lower level elevator towers, to provide control functions for the elevator and indications of the elevator and tower doors and interlocks.

The elevator control panels shall have a key switch that activates the control panel and turns on the indicator lights. The key switch shall be activated by inserting an Amtrak coach key and rotating it 90°. The key shall only be removable when the panel is deactivated. It shall be possible to initiate motion of the elevator from one control panel, then deactivate that control panel and have the elevator continue motion.

Each elevator control panel shall include pushbuttons for commanding the elevator to move up or down. The pushbuttons shall only be active when the panel is keyed to the ON position. It shall be possible to have both upper and lower level control panels activated at once. Only one motion command shall govern elevator movement at a time. Once elevator motion is initiated, a new command cannot be made to direct the elevator to move in the opposite direction until the elevator has stopped motion at its original destination level, or is stopped for another reason.

Each elevator control panel shall have LEDs to provide indication of the position of the elevator, the doors and the interlocks as follows:

- Elevator door open (red)
- Elevator door closed (green)
- Upper level tower door open (red)
- Upper level tower door closed (green)
- Lower level tower door open (red)
- Lower level tower door closed (green)
- Elevator in motion (green)
- Elevator system status – no fault (green)
- Elevator mechanical interlock active (red)

A test button shall be installed on each control panel to verify that all indicators illuminate.

The elevator control panels shall be modular, easily replaced or repaired and sealed against moisture, dust and dirt. All pushbuttons, key switches, relays, etc shall be sealed against moisture for long term reliability.

14.8.10.2 Controller

The elevator controller shall be a modular unit, located in the immediate vicinity of the elevator tower on the lower level of the car. The unit shall be located behind a hinged door, accessed with a coach key, with the LED indicator light display visible to the Service Attendant through a transparent panel in the door. The controller shall receive inputs from the elevator control panels and interlocks/sensors and control the power to the drive motor. The enclosure shall include the following features:

- The controller shall be housed in a dust-tight, drip-proof enclosure.
- The controller case shall be grounded to the carbody.
- The wiring entry/connection point shall be on the bottom of the unit and shall be a modular plug-style connector.
- LED indicators shall show the state of all position sensors of the elevator system
- LED fault indicators shall provide a visual status of the system.
- Separate circuit breakers shall be provided for the drive motor and control circuits.
- The elevator control panels and controller shall utilize standard, off-the-shelf, commercially available electrical components.
- The elevator control unit shall not use a battery for any purpose.
- The elevator system shall not require any type of reset, calibration, adjustment or other special repair after a loss of power to the elevator control system, regardless of the duration of loss of power.

14.8.11 Manual Operation

A manual crank mechanism shall be provided to permit the elevator to be manually moved to the upper or lower level in the event that there is a power outage or drive mechanism failure, or as required for servicing. The manual operation equipment shall be stowed behind a hinged and labeled door adjacent to the lower level elevator door and secured by a coach key latch. The manual operation mechanism shall not require more than 25 lbs to operate and shall include a method of releasing the drive screw brake.

Operating instructions for manual operation, including brake release, shall be installed on the inside face of this access door, or in another readily available location.

The access door to the manual operation equipment shall be electrically interlocked with the elevator control system and must be fully closed before the elevator will operate electrically.

Manual operation procedure shall be as follows:

1. Release drive mechanism brake
2. Pull gear shift handle to engage manual drive
3. Pivot manual drive handle out of control box
4. Turn handle clockwise to lower or counter-clockwise to raise elevator
5. After operation, return manual drive handle to original position in box
6. Push gear shift handle to disengage manual drive
7. Return drive mechanism brake to storage position

14.8.12 Elevator Maintenance

All elevator maintenance and lubrication points shall be readily accessible. If remote lubrication is required, grease lines shall be provided to a central lubrication point. Slides, guides, wear blocks, rollers, etc. shall be accessible for inspection and replacement when required. The area above and below the elevator shall be easily accessible for cleaning and inspection. The elevator drive system and suspension shall not require lubrication or adjustment more frequently than annually.

Because the elevator is vital to the quick stocking of the car, its reliability is essential. In addition, should the unit fail to function properly, it shall be designed to facilitate the diagnosis of problems and make necessary repairs. Diagnosis and replacement of the following components shall not exceed the times indicated below:

Thirty minutes:

- Elevator key switch panel
- Elevator control panel
- Controller
- Limit switches, proximity switches and other sensors
- Door latches

Four hours:

- Drive mechanism components: screw, nut, gearbox, etc.
- Wear surfaces
- Light fixtures in elevator
- Drive motor

Prior to release of the first café/lounge car from the Contractor's facility, the Contractor shall provide to the Customer a troubleshooting, installation and repair guide for all elevator components to illustrate compliance with this requirement.

14.8.13 Elevator System Testing

The Contractor shall prepare an elevator test plan for Customer approval. The test plan shall verify proper operation of all elevator functions, including power operations, interlocks, drive system protective circuits, manual operations and safety equipment. The test plan shall provide proof-of-design verification for the elevator system, as well as production tests to verify proper operations. The elevator shall be tested under a range of load conditions from empty to total design load.

Qualification testing of the complete elevator system shall be included in car qualification tests, as described in Chapter 19.

14.9 Ancillary Café/Lounge Appurtenances

The following ancillary galley appurtenances shall be provided.

14.9.1 Display Case

A display case of at least 36 in. wide by 30 in. tall by 12 in. deep shall be provided adjacent to the serving counter to display various items for sale in the café. Access to the inside of the display case shall be provided through opaque sliding panels on the back of the case. The case shall be lockable with a commercially available ratcheting showcase lock (to be provided by the Customer) that secures the two panels against each other. The sliding doors shall have a small handle to facilitate opening and closing. The glazing on the front of the case shall be of Lexan or equivalent material and shall not be removable from the front side of the case.

The case shall be equipped with two adjustable-height transparent shelves, each equipped with an anti-slip surface or material so that the contents of the display case do not move due to train motion. The shelf adjustment mechanism shall be built into the display case and shall not have any clips, pins, or other small components that must be moved to change shelf height. The range of shelf adjustment shall be in 0.5 in increments from 5 in. from the top of the case to 5 in. from the bottom of the case. The shelves shall be strong enough to support a full complement of beverage cans and bottles without flexing. An intermediate support may be used to hold up the shelf.

The display case shall include a dedicated LED light source to illuminate the contents of the case.

14.9.2 Cart Tray Shelf

An angled shelf for storing four standard food service cart drawers shall be mounted on the right side wall of the upper level galley approximately 24 in. above the countertop. See Figure 14-2 and Figure 14-4. The shelf shall be able to securely accommodate standard drawers that are either 4 in. or 6 in. tall. These food cart trays shall be used for storing and dispensing non-perishable goods. Trays shall be stored with their long dimension perpendicular to the centerline of the car. The trays shall be appropriately secured when stored on this shelf. The shelf shall be designed to adequately support a total combined tray weight of 130 lbs.

14.9.3 Ice Well

A stainless steel ice well shall be mounted in the countertop at the serving counter, approximately 9.5 in. deep, 12 in. wide and 11.5 in. tall, with a folding hinged cover. The design of the ice well shall facilitate easy cleaning, with no sharp edges or tight radius corners. The bottom of the ice well shall slope to the center, where the drain is located. The well shall be integral with the countertop and have a raised edge so fluids spilled onto the countertop do not drain into the ice well. The underside of the ice well shall be sufficiently insulated with a suitable material to prevent heat gain, surface condensation and rapid ice melt. Melt water from the ice well shall drain to ground on the underside of the vehicle via a dedicated drain line. The ice well drain shall be segregated from the other galley drains and shall have a backflow preventer to ensure there is no contamination of the ice well contents through the drain system.

14.9.4 Dispensers

The galley countertops and adjacent areas shall be equipped with the following dispensers. All dispensers shall be kitchen-grade stainless steel unless otherwise specified.

- Carryout box dispenser:
 - For fold-up boxes sized 9.25 in. wide by 6.875 in. deep
 - Capacity 100 boxes
- Cold beverage cup dispenser:
 - For cups sized 3.375 in. diameter by 3.5 in. tall
 - Capacity 100 cups
- Coffee cup dispenser:
 - For cups sized 3.375 in. diameter by 4.25 in. tall
 - Capacity 50 cups
- Holder for coffee cup lids:
 - For lids 3.375 in. diameter
 - Capacity 50 lids
- Paper towel dispenser with push button latch:
 - For tri-fold towels sized 9.25 in. by 3.125 in. (when folded)
 - Capacity 200 towels

- Soap dispenser:
 - Celeste Industries, TR-BR10W/F (foam pump)

14.9.5 Recycling and Trash Receptacles

Recycling and trash receptacles shall be provided in the passenger areas on the upper and lower levels. A minimum of two of each type shall be provided on upper level and a minimum of one of each type on the lower level. All recycling and trash receptacles shall meet all applicable FDA and NSF requirements for recycling and trash containers and their materials. To the degree possible, the receptacles shall utilize Amtrak standard trash bins:

- Small bins use Amtrak 30 gal liner (16 in. by 14 in. by 36 in.)
- Large bins use Amtrak 55 gal liner (22 in. by 14 in. by 58 in.)

The receptacles shall be stored in lockers, with openings in the locker doors for depositing trash and recyclables. Flaps shall cover the openings, shall close by gravity and shall not open and close from car motion. The locker doors shall be secured closed with a paddle latch consistent with the rest of the galley. The locker shall use as few joints as possible in fabrication and shall be permanently sealed against moisture and vermin. All corners shall be of large radius to make the enclosure easy to clean. The opening for inserting recyclables and trash shall be as wide as possible and shall direct the contents into the bin to keep spillage to a minimum.

Recycling receptacles (including locker doors and flaps) shall be colored green and shall have a different size and style opening that will permit the depositing of the recyclable material but discourage placement of trash in the receptacle. Signage shall clearly label each type of receptacle.

14.9.6 Jump Seat

A folding jump seat shall be provided for the service attendant. The seat shall be secured to suitable structural members of the galley and be designed to support a load of no less than 300 lbs. The jump seat shall be located such that the attendant may see passengers approaching the service counter.

14.9.7 Condiment Station

A condiment station shall be provided near the galley service counter, located on top of the service island. See Figure 14-1. The design shall be easy to clean without requiring removal of any components and shall have no pockets, cavities, square corners or other locations where residue can collect. See Figure 14-7.

The condiment station shall include the following:

- Countertop
- Condiment holder:
 - 14 separate condiment containers
 - Stainless steel, seamless construction
 - Containers shall be 4 in. diameter by 4.5 in. deep

- Napkin dispenser - stand-type with capacity for 500 napkins
- Recycling and trash containers

The countertop shall be made of solid surface 100% acrylic countertop material, or approved equivalent, with raised exposed edge and cove molding where it abuts vertical surfaces. Color of the countertop shall be subject to Customer approval.

The recycling and trash receptacles shall have vertically mounted doors that are integrated into the design of the condiment station and shall not be able to slam closed. Recycling and trash bins shall have appropriate labels and signage.

14.9.8 Menu and Photograph Holders

A minimum of five metal-framed menu holders shall be provided to accommodate 24 in. by 24 in. menus. The menu shall be inserted by sliding the menu sideways into the frame. They shall be installed:

- On the upper level elevator door so that it is visible to passengers placing an order at the serving counter;
- In a location visible to passengers waiting in line to place an order;
- On the upper level A-end bulkhead near the end door;
- On the passageway wall at the B-end of the galley, facing the revenue seating area; and
- On the lower level, to be visible to passengers seated at the wheelchair parking location.

Four metal-framed food photograph holders shall be provided. Each holder shall measure 11 in. wide by 17 in. tall, for insertion of a tabloid-format photograph by sliding it into the frame from the top. The frames shall be mounted in the following locations:

- Along the hallway around the upper level galley;
- One on a bulkhead at each end of the upper level; and
- One on the lower level, in the seating area.

14.10 Galley Electrical System

The café-lounge car electrical distribution system will provide 208VAC, 3-phase, 60 Hz 4-wire (grounded neutral) and 120VAC single-phase 60 Hz neutral-grounded power to the galley (see Chapter 13). Circuit breaker panels shall be located in the upper and lower level of the car to distribute this power to the various galley and associated system loads, such as the elevator. These panels shall contain all terminal boards, circuit breakers and other items required for distribution of electrical power. Each circuit breaker shall interrupt all lines of the circuit. Circuit breakers and electrical outlets intended to provide a dedicated power circuit to a specific galley appliance shall be permanently and clearly labeled for that appliance.

The Contractor shall provide both a complete electrical schematic and a wiring diagram for all galley equipment. This shall show power distribution circuitry from the 480VAC HEP to the 208VAC and 120VAC transformers, through the circuit breaker panels and to the loads. Switch and receptacle terminal identification shall be provided for each receptacle and device.

14.10.1 Battery Backup with Inverters

The chillers, freezers and POS shall have a backup power supply using a separate battery bank and inverters to provide 208VAC 3-phase and 120VAC single-phase power to keep these appliances functioning during loss of HEP for a period of no less than one hour. The backup battery shall be separate from the main car battery. A 74VDC to 208VAC inverter shall provide power to the chillers. A 74VDC to 120VAC inverter shall provide power to the freezers and POS. The physical dimensions, design and operation of the backup power supply shall be submitted to the Customer at the design review. **DR**

An indicator light shall be installed on the car's system status panel in the B-end vestibule to indicate whether the inverters are on or not.

- Green – system working normally (HEP is on and power is being provided to the galley equipment)
- Flashing green – HEP is off and inverters are working (power is provided to galley equipment)
- Red – HEP is off and inverters are not working (no power to the galley equipment)

14.10.2 Circuit Breaker Panel - Upper Level Galley

The upper level panel shall include circuit breakers for the galley equipment as well as control switches for each chiller unit and galley lighting. It shall be covered with a Lexan door (to allow the positions of the switches and circuit breaker to be seen) with a paddle latch to keep the door closed.

Power switches for the chillers shall include a green LED indicator that is illuminated when the chiller is powered on.

Circuit breakers shall include, at a minimum:

- Chiller unit # 1
- Chiller unit # 2
- Freezer - upper level
- Microwave oven #1
- Microwave oven #2
- Combination oven
- Coffee maker
- Water heater
- Toaster
- POS
- Service receptacles - chilled side (GFCI)
- Service receptacles - dry side (GFCI)
- Lights (AC)
- Lights (DC)

- Two spare circuit breaker locations that will accommodate either 120VAC or 208VAC outlets

Switches shall include, at a minimum:

- Chiller unit # 1
- Chiller unit # 2
- Counter lights
- Ceiling lights
- Display case light
- Service counter lights

14.10.3 Circuit Breaker Panel - Lower Level Service Galley

The lower level circuit breaker panel shall include circuit breakers for the lower level equipment and the elevator. The ground point for the 208VAC neutral shall be located in this panel, with a grounding pad welded to the carbody. The panel shall be covered with a Lexan door (to allow the positions of the switches and circuit breaker to be seen) with a paddle latch to keep the door closed.

The power switch for the chiller shall include a green LED indicator that is illuminated when the chiller is powered on.

Circuit breakers shall include, at a minimum:

- 208VAC main
- Elevator power
- Elevator control
- Chiller # 3
- Freezer - lower level
- Crew microwave
- Crew refrigerator
- Service receptacles (GFCI)
- One spare circuit breaker location that will accommodate either a 120VAC or 208VAC outlet
- Lights

Switches shall include, at a minimum:

- Chiller #3
- Lights

14.10.4 Service Receptacles

The walls of the upper level galley and lower level service galley shall be equipped with 120VAC 20A duplex GFCI-type service receptacles as follows (excluding dedicated appliance outlets):

- Upper level galley:
 - Above chilled carts: two duplex outlets adjacent to the POS unit; two additional duplex outlets evenly spaced between the POS and hand washing sink.
 - Above dry carts: four duplex outlets evenly spaced.
- Lower level service galley: two duplex receptacles at each working countertop.

14.10.5 Convenience Receptacles

All public seating areas of the café/lounge car, including revenue and non-revenue seats on the upper and lower levels, shall be equipped with duplex convenience outlets for passenger use. See Chapter 13 for details regarding the installation of convenience outlets.

14.10.6 Dedicated Outlets

Dedicated simplex outlets shall be provided for the galley appliances. The outlets shall be labeled for the appliance and each outlet shall be protected by a dedicated circuit breaker labeled for the appliance it protects.

- Upper level galley:
 - Coffee maker
 - Microwave #1
 - Microwave #2
 - Combination oven
 - Freezer
 - Toaster
 - POS
- Lower level galley:
 - Crew refrigerator
 - Crew microwave
 - Freezer

14.11 Water System and Drains

Potable water shall be provided to the upper level galley for the hand washing and utility sinks and the coffee maker. Drains shall be provided for each sink, the ice well, the coffee maker pan and the condensate drain on each chiller. All fresh water lines and drains shall conform to applicable health and safety codes.

All drains shall have backflow preventers. All check valves and backflow preventers shall be located to facilitate access and replacement.

The grey water from the sinks shall be captured and sent to the waste tank, either through gravity flow or a sink tank. The ice well, condensate drains and coffee drain shall flow to ground under the car.

The Contractor shall submit a water distribution and plumbing system drawing for the galley, identifying water and drain line sizes, materials and sink fittings.

14.11.1 Water Distribution

Pressurized potable water from the rail car supply tank shall be provided to the galley for distribution to the utility and hand wash sinks and the coffee maker.

The potable water supply to the galley shall have a particulate filter and an antibacterial filter to purify the water to Public Health Service (PHS) standards. These filters shall be located between the fresh water tanks and the galley equipment and shall be located for easy cleaning and replacement. These filters shall be identical to those specified for the potable water system on the coach cars, to the extent possible. See Chapter 15.

At a minimum, separate ball type shut off valves shall be provided for the following:

- Hand wash and utility sinks (single valve that feeds water to water heater as well as cold faucet valves)
- Coffee maker

Manual ball type drain valves shall be provided to allow draining all of the galley piping, either for water system servicing or manual draining of the car in advance of storage, or in anticipation of freezing conditions. These valves shall drain the water system to the ground under the car.

14.11.2 Water Heater

A one-gallon, 120VAC hot water tank shall be provided beneath the hand wash sink area to provide hot water to the utility and hand washing sinks. The water heater element shall be protected from damage when no water is in the tank. The water heater installation shall facilitate easy replacement of the element as well as replacement of the tank. Access shall be provided to facilitate adjustment to the tank thermostat.

14.11.3 Sinks

Separate utility and hand wash sinks shall be provided as an integral part of the countertop. See Figure 14-2 and Figure 14-3.

Each sink shall measure 12 in. wide by 14 in. deep by 10 in. tall. The sinks shall be formed of 300-series stainless steel, with rounded corners and edges, a raised edge around the perimeter of the top of the sink and the bottom of the sink sloping to the drain. A permanent drain screen shall be provided for each, with a maximum hole or mesh size of 0.125 in. The underside of the sinks shall be insulated to prevent condensation. An FDA-compliant splash guard shall be provided between the two sinks.

Each sink shall have its own single-handle faucet. Each faucet shall be capable of swiveling the width of the sink, but shall not swivel to the other sink. Faucets and controls shall

represent best commercial design and be commercially available standard plumbing fixtures. Faucets shall be tall U-shaped swivel design.

All drain lines, screens and fittings shall be easily cleanable and corrosion-resistant.

All water supply lines shall include FDA-approved backflow prevention devices.

14.11.3.1 Utility sink

A utility sink shall be mounted in the countertop and shall be equipped with an industrial grade single-handle faucet and a flexible hose with spray nozzle. The design and location of the utility sink shall be adequate to easily clean the coffee urns.

The faucet shall be self-venting and drip-free, with the swivel outlet approximately 8 in. above the sink-top level.

The flexible spray nozzle and hose shall be kitchen grade and shall recess into a holder on the countertop. The hose, when retracted under the sink, shall not contact or interfere with any under-counter appliances or equipment.

14.11.3.2 Hand wash sink

A hand wash sink shall be mounted in the countertop and be equipped with an industrial grade single-handled faucet.

The faucet shall be self-venting and drip-free, with the swivel outlet approximately 8 in. above the sink-top level. The faucet shall have a pre-set mixing valve to deliver hand washing water at a temperature consistent with FDA and Amtrak health code requirements, but not less than 100°F.

The hand wash sink shall be labeled HAND WASHING ONLY.

14.11.4 Drains

The drains and piping in the upper and lower level galleys shall be designed for reliable operation, ease of cleaning and free of sharp bends and fittings that may contribute to clogging.

The galley shall be equipped with the following drains:

- Hand wash and utility sinks

Minimum drain line inside diameter shall be 2 in.; minimum bend radius of the drain line shall be 5 in. The drain line shall have a minimum downward slope angle of at least 3 degrees to avoid water traps. The drain shall be covered with a permanent strainer to prevent food particles from entering drain. The sinks shall drain to the waste tank, either through gravity or by use of a sink tank and pump. The drain for the sinks shall include an overflow system that will allow the grey water to drain to ground in the event of a sink tank or waste system failure.

- Coffee maker drain pan

A drain pan shall be provided under the coffee maker urn spigots to catch spills and drips from the coffee spigots as well as to allow the unit to be drained for cleaning or

servicing/replacement. The coffee maker drain shall be a minimum of 0.75 in. inside diameter and shall flow to ground under the car.

- Ice well

The ice well shall include a drain for melt water. The ice well drain shall have a minimum inside diameter of 0.75 in and shall flow to ground. It shall be fully segregated from other drains and shall include a backflow preventer, per FDA requirements.

- Chiller

Each chiller unit shall be equipped with a drain pan to catch chiller condensate or defrost water. Chiller condensate shall drain to ground. The chiller drain shall be designed to capture all chiller condensate, to ensure that no condensate flows onto the galley floor. The chiller drain shall have a minimum inside diameter of 0.75 in and shall include a screen to keep the drain from clogging from debris.

14.11.5 Freeze Protection

An air-temperature-sensing automatic drain valve shall be provided to cause automatic draining of the galley water piping to avoid freeze damage, should the galley approach freezing temperatures. See Chapter 15.

14.12 Doors and Latches

All hinged doors shall be double-wall constructed, except as noted. All hinges shall be made of stainless steel. Hinges for the serving counter swing door shall be of a heavy duty design capable of withstanding a 250-pound downward force (applied to the top edge of the door) without deformation or loss of alignment. All doors shall be capable of opening 180 degrees (if possible) with sufficient clearance to prevent any tendency to bind. Paddle latches shall be used on all doors unless otherwise specified. The rear galley door on the upper level and the lower level crew door shall have a stainless steel grille mounted in the lower portion of the door to provide air circulation from one side of the door to the other.

All latches shall be stainless steel. Strikers shall be used with all latches and shall be one-piece formed or die-cast stainless steel and shall be easily replaceable. Latches shall be easily operated, require no lubrication and maintain full door closure. A hasp for use with a padlock, with an inside diameter of 0.25 in. to 0.375 in., shall be installed on doors as identified below.

14.12.1 Upper Level Galley

- Circuit breaker panel door – Lexan with paddle latch
- Under-sink storage cabinet for cleaning products – paddle latch
- Under-counter storage cabinet for crew use – paddle latch with lock hasp
- Recycling and trash receptacles – paddle latch
- Chiller compartment - paddle latch
- Under-counter cabinet below ice well – paddle latch
- Security screen storage compartment – paddle latch

- Rear galley access door – standard self-latching lock, opened with a handle on galley side and standard Amtrak coach key on passenger side; equipped with a small safety window; swing open into galley area; hinged on dry cart side
- Serving counter swing door – sliding deadbolt latch on galley side of door – no key required, no lock hasp; swing open into elevator lobby; hinged on edge away from elevator
- Display case doors – Two-piece opaque sliding panels to be secured with a ratcheting showcase lock (provided by Customer)

14.12.2 Lower Level Service Galley

- Under counter storage cabinet for crew use – paddle latch with lock hasp
- Recycling and trash receptacle – paddle latch
- Chiller compartment - paddle latch
- Lower level crew door – standard self-latching lock, opened with a handle on galley side and standard Amtrak coach key on passenger side; equipped with a small safety window; swing open into the service galley; hinged on side away from elevator

14.13 Galley Security

The upper level galley and the lower level service galley must be secured when the car is unoccupied to prevent unauthorized access and potential pilferage of food, supplies or equipment. When secured properly, access to the galleys will be restricted to authorized crew with an Amtrak coach key. All food items shall be secured with padlocks issued to the service attendant. A galley security assessment, demonstrating that the galley can be secured by crew members in accordance with this specification, shall be provided by the Contractor for Customer approval.

14.13.1 Upper Level Galley

14.13.1.1 Security screen

A sliding security screen shall prohibit access to the galley at the serving counter when the attendant is not present. The screen shall compress for storage in a locker adjacent to the elevator tower and shall slide smoothly when being deployed or stored. The screen shall provide security for the entire width of the serving counter, from elevator tower to the hallway wall and shall secure the counter area and the display case. When deployed, the screen shall be locked in place from the galley side using a standard crew-issue padlock in a hasp with a 0.25 in. opening. The screen shall be secured at the top and bottom and shall not require a visible lower track on the counter, potentially being secured on the underside of the countertop. The security screen shall be aluminum or stainless steel and designed to be tamper-resistant and sized to keep passengers from reaching through the screen mesh to the countertop. The screen shall be functional as well as visually attractive. The storage locker for the screen shall have a door, equipped with a paddle latch that will adequately secure the screen in place while the car is in motion and meet the required deceleration resistance. The screen mechanism shall be free of pinch points or other safety hazards.

14.13.1.2 Galley rear door

The galley rear door shall be constructed of durable materials and be equipped with a standard self-latching lock. The door shall have a handle on the galley side and a lock, operable with a standard Amtrak coach key, on the hallway side. This door shall not have a padlock hasp. The door shall also be equipped with a small window for safety.

14.13.1.3 Serving counter swing door

The serving counter door shall be constructed of durable materials and be equipped with a sliding deadbolt-type latch on the galley side. No means of unlatching the door from the passenger side shall be provided. This door shall swing open into the elevator lobby and be hinged on the edge away from the elevator.

14.13.1.4 Cart security

Each cart shall have a padlock hasp for securing by a padlock issued to each attendant. See Caltrans Specification 14-105.

14.13.1.5 Freezer security

Each freezer and refrigerator shall have a padlock hasp for securing by a padlock issued to each attendant.

14.13.1.6 Display case security

The display case shall be secured by a ratcheting showcase lock that will be provided by the Customer.

14.13.2 Lower Level Service Galley

14.13.2.1 Lower level crew door

The crew door shall divide the passenger seating area and the food storage area on the lower level of the café/lounge car. This door shall have a self-latching lock that is operable by using a latch with a handle on the serving galley side and a key lock on the passenger side, keyed to the standard Amtrak coach key. This door shall be labeled CREW ACCESS ONLY – NOT AN EXIT on the public side of the door. This door shall be equipped with a small window for safety.

14.13.2.2 A-end service galley side entrance doors

The side entrance doors in the service galley shall be isolated from train line control. Operation of these doors shall be from a Door Control Panel-Local in the service galley. See Chapter 8. The exterior emergency door release mechanism shall have a 0.25 in. diameter hasp for securing the side doors with a crew-issued padlock. The exterior of the car shall be equipped with a sign adjacent to the emergency releases that states THESE DOORS MUST REMAIN UNLOCKED DURING REVENUE SERVICE.

14.14 Lighting

Food service area lighting shall be in accordance with APTA Recommended Practice RP-E-012-99 and U.S. Public Health Service Food Code of 2005. All normal light levels in the food service and galley areas shall be a minimum of 30 foot-candles, except for the food preparation area which will be a minimum of 50 foot-candles. Standby lighting will provide a minimum of 10 foot-candles in all areas of the galley.

Lighting in the upper level galley and lower level storage area shall be along the entire length of the countertops, including track lighting over the service counter and storage shelves. Accent lights shall be installed above the service counter, in the display case and above the sink area.

Decorative sconces shall be installed in the lounge area and along the hallway next to the exterior wall of the galley.

Lower level service galley lighting shall be provided over the entire length of the storage galley using overhead lighting.

Types and styles of lighting fixtures shall be presented by the Contractor for approval by the Customer during the design review. **DR**

14.14.1 Galley Lighting

Light locations shall be located so they will not produce glare, nor shine into the face either of passengers or food service attendant. The fixtures selected shall be suitable for the railroad environment: robust, easy to clean, maintainable for the life of the galley.

Functioning galley lighting shall be subject to specific design approval by Customer.

Lighting shall be provided in the following locations (LED is preferred):

- Recessed mounted LED or fluorescent ceiling lighting along the length of the galley
- Surface mounted LED or fluorescent counter lighting shall be mounted on the underside of the overhead shelves
- LED or fluorescent lighting over the serving counter
- LED or fluorescent lighting over the dry goods on display
- LED or fluorescent lighting in the display case
- LED or fluorescent lighting in the elevator car

Switches controlling this lighting are described in the circuit breaker panel section of this chapter.

14.14.2 Lounge Area Lighting

Lighting in the lounge area shall provide overhead and accent lighting for illumination of the aisle and table tops. Lighting levels for the lounge area shall be equal to those specified for the revenue seating areas of the coach cars. See Chapter 11.

14.15 Materials and Workmanship

All materials and appliances for the café/lounge car shall meet all applicable UL, NSF FRA and FDA requirements.

All components and materials used shall be durable, easy to clean and easy to replace if damaged or worn.

The installation of walls, ceilings, counter tops, sinks, etc. shall be in accordance with manufacturer's recommendations. Countertops and working surfaces shall be free of fasteners, holes, joints or cracks. Fasteners shall not interfere with the operation or appearance of any surface, component or appliance.

14.15.1 Materials

The primary structural material for the galleys shall be honeycomb composite sandwich panels, or approved equivalent, with a minimum core density of 4 lbs./cu. ft. and face sheets of FRP with a thickness of at least 0.020 in. Panel thickness shall be selected on the basis of required strength determined by finite element analysis, durability, impact resistance and minimum weight.

Countertops shall be formed from stainless steel finish #13, except for the upper level serving counter and condiment station, which shall be 100% acrylic, 13mm solid surfacing. Color of serving counter material shall be submitted to the Customer for approval as part of the interior décor palette. See Chapter 9.

Flooring in the galleys, elevator, serving counter area, hallway and area adjacent to the condiment station shall be seamless rubber flooring that conforms to the flooring material requirements in Chapter 9. Color and texture of the flooring material shall be submitted to the Customer for approval as part of the interior décor palette.

Carpeting shall be installed in the revenue seating and lounge areas, in conformance with the carpeting requirements in Chapter 9. Carpet in the revenue seating area shall match the carpet in the seating areas on coach cars. A sample of the carpet in the lounge area shall be submitted to the Customer for approval as part of the interior décor palette.

Unless otherwise specified, the wall and ceiling panels shall be made of the same material as the wall and ceiling panels in the coach cars. The wall panels in the hallway shall have a decorative laminate that compliments the décor of the café/lounge area. See Chapter 9.

14.15.2 Mechanical Design

Food service components shall be designed to minimize noise. Anti-squeak tape shall be used at all locations where walls and bulkheads are attached, or where they come into contact with structure or other interior components.

Easy access shall be provided for all items that require periodic maintenance, defect repair or replacement. Panels and doors providing access to this equipment shall be hinged where possible and fastened with approved captive fasteners in a manner that facilitates maintenance. Replacement of any major appliance shall not require any disassembly of the galley structure.

All wiring and piping shall be installed in a manner that provides future access as may be needed for repairs. Stainless steel fasteners shall be used to attach the galley structure to the carbody. Use of vibration-damping inserts shall be required for all galley-to-car structure attachments. Metal surfaces of the galley shall be suitably grounded to the carbody to prevent electrical shock.

14.16 Safety, Health and Environmental Requirements

The galley and all ancillary food service equipment shall be designed to accommodate passengers and crews from the 5th percentile female to the 95th percentile male ranges. Safety of passenger, crew and maintenance personnel shall be a prime consideration in design of all food service equipment.

Projections from the galley face or edge of countertop which could injure crew members, including knobs, switches, outlets and latches, shall be recessed. There shall be no finger pinch points anywhere in the galley area, elevator or elsewhere in the café/lounge car.

14.16.1 Sanitation

The food service equipment shall meet all applicable requirements of the U.S. Public Health Service Food Code of 2005.

Sealing and construction of the modules shall not permit liquids/moisture to harbor behind/over/under any of their surfaces. Countertops shall have a raised edge on all exposed faces and a cove on all edges adjacent walls/bulkheads.

All approvals, including approvals from FDA, are the responsibility of the Contractor. All cars shall be certified for conformance with FDA regulations. All approvals shall be supplied with each vehicle history book.

14.16.2 Fire Safety

All food service system materials shall meet the flammability and smoke emissions requirements of 49CFR Section 238.103.

The Contractor shall provide a Fire Safety Analysis for Customer review and approval in accordance with APTA Recommended Practice RP-PS-005-00 (see Chapter 22).

14.16.3 Emergency Equipment

In addition to the basic emergency equipment to be provided on all car types, as identified in Chapter 17, the café/lounge car shall also have the following emergency equipment:

- The upper and lower galley areas shall be equipped with a dry-chemical 2.5 pound 1-A:10 type B/C fire extinguisher;
- The upper level galley shall be equipped with a standard first aid kit and a set of snap lights, identical to that specified in chapter 17; and
- The lower level galley shall be equipped with a storage location for an Automatic Electronic Defibrillator (AED), to be provided by the Customer, in accordance with Amtrak's AED installation specification.

The emergency equipment storage locations shall be labeled in accordance with all applicable signage requirements.

14.16.4 Noise

Noise levels in the car's interior shall be kept to a minimum. Continuous noise level in the upper level galley and lower level service galley shall not exceed 73 dBA, with chiller units running and car HVAC system in operation and shall not exceed 68 dBA in the adjacent passenger revenue seating and lounge areas.

14.16.5 HVAC System

The car HVAC system will provide ventilation, heating and cooling to the upper level galley and lower level storage areas as part of the overall car HVAC system. The lower level areas will include supply air into the storage area from crew adjustable ceiling-mounted diffusers.

The car's basic HVAC system, as described in Chapter 10, shall maintain the environment throughout the range of operating conditions to which the food service system is exposed. The Contractor shall ensure that the HVAC system in the café/lounge car is designed to remove the heat produced by the chiller units, freezers, coffee makers, ovens and any other heat sources. The Contractor will supply a heat load analysis to the Customer for review. See Chapter 10.

All galley food service equipment shall be installed in the galley with sufficient free space between the unit and the galley walls to permit circulation of cooling/ventilation air, as needed for cooling in accordance with the manufacturer's recommendations.

14.17 Mockup Requirements

The Contractor shall create a series of soft and hard mockups of the galleys, lounge and elevator and associated areas of the café/lounge car, to assist the Customer in evaluating the design, layout and detail of assembly for efficiency, compliance, ergonomics and aesthetics. See Chapter 3 for details.

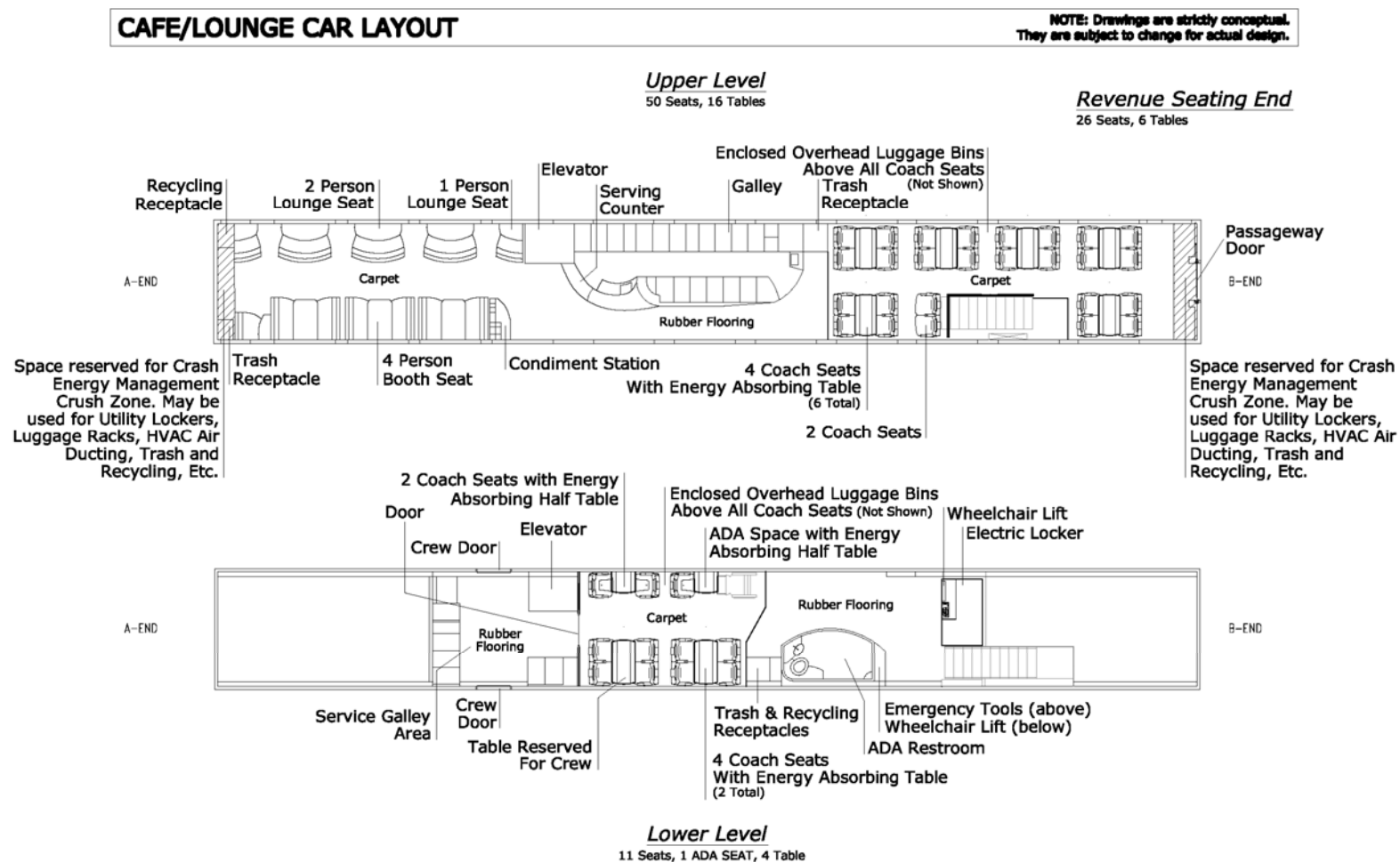


Figure 14-1: Café/Lounge Conceptual Floor Plan

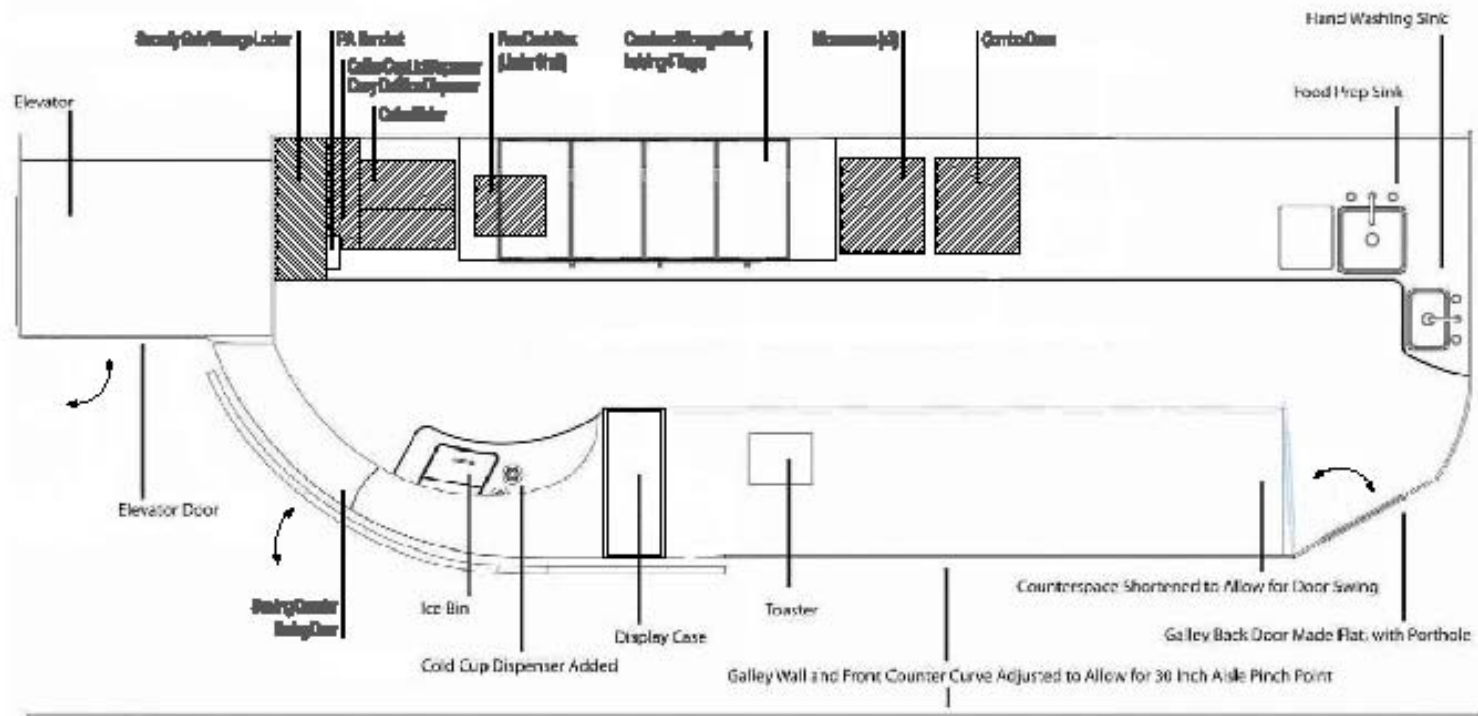
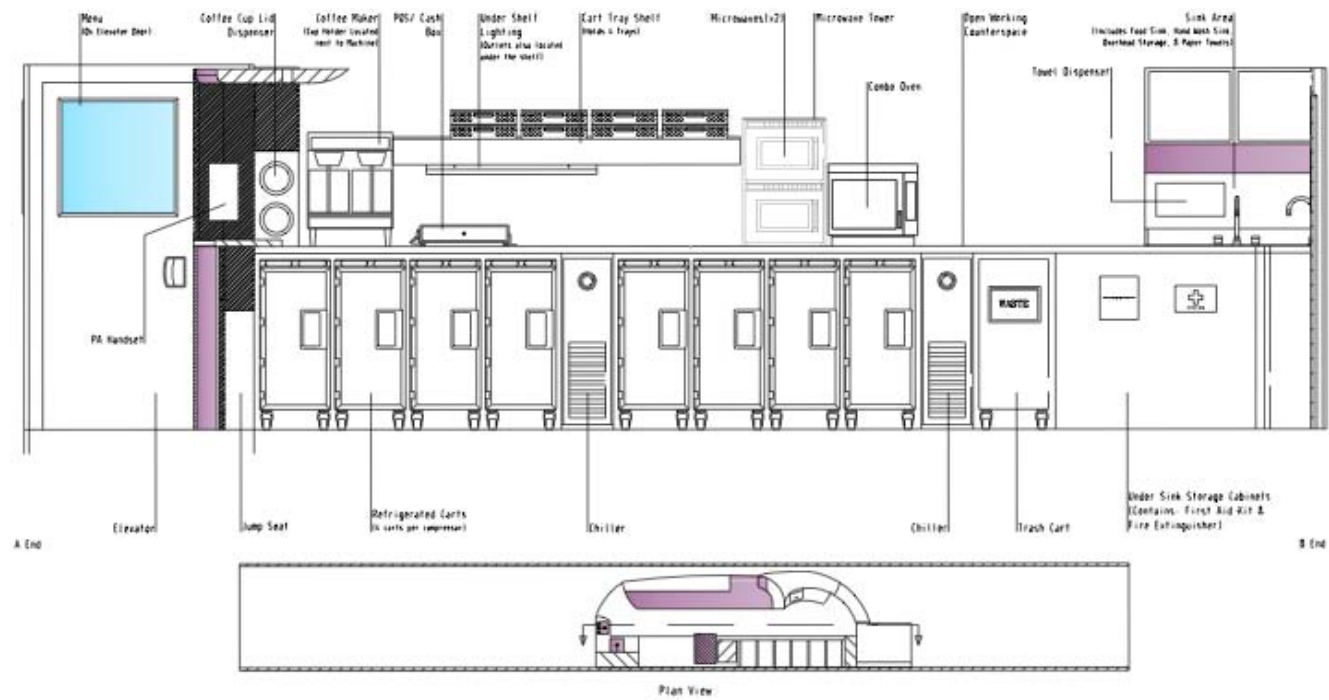


Figure 14-2: Plan View: Upper Level Galley

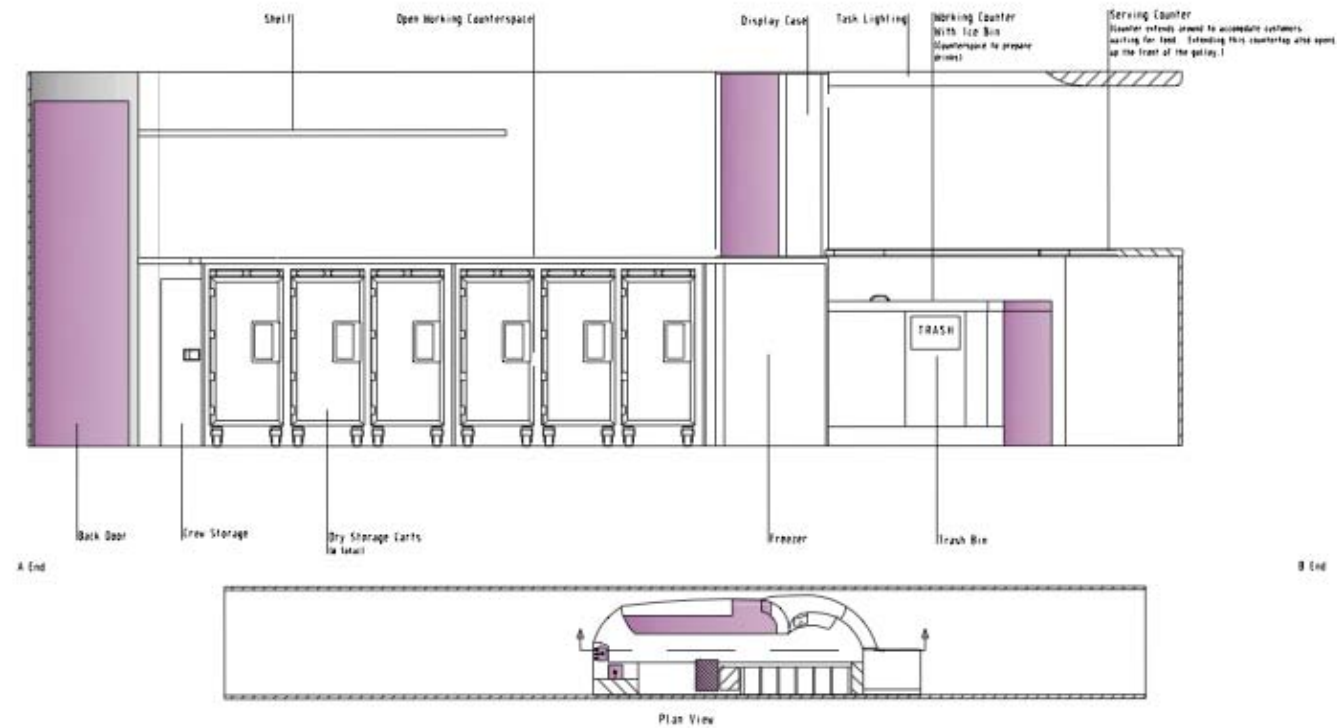
SURFLINER III UPPER LEVEL GALLEY - Outer Wall Section - Left Side Elevation



Drawing File: Surf3-Galley.dwg
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Figure 14-3: Upper Level Galley Side Elevation Right Side Wall

SURFLINER III UPPER LEVEL GALLEY - Inner Wall Section - Right Side Elevation



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Figure 14-4: Upper Level Galley Side Elevation Left Side Wall

SURFLINER 111 LOWER LEVEL GALLEY - Profile View

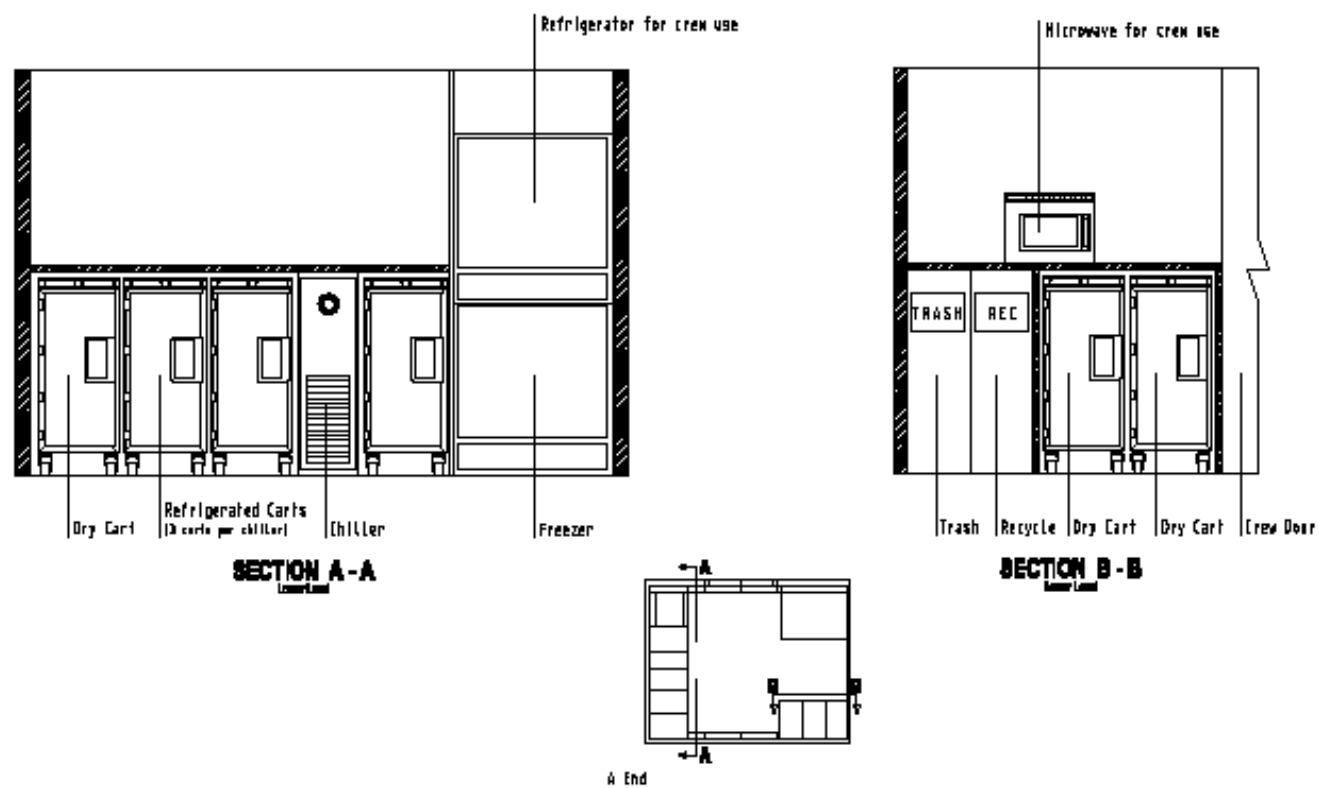
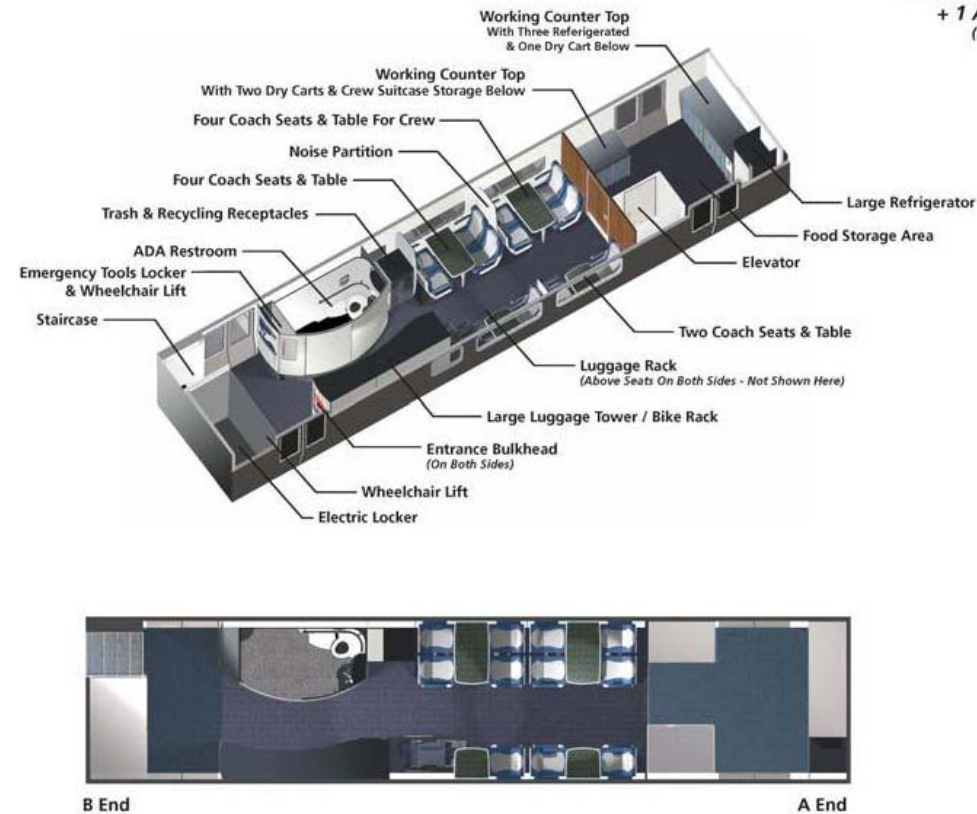


Figure 14-5: Profile View: Lower Level Galley

SURFLINER III CAFE / LOUNGE CAR - Lower Level Conceptual Design

NOTE: Drawings are strictly conceptual.
They are subject to change for actual design.

**11 Revenue Seats
+ 1 ADA Seat
(Lower Level)**



Industrial Design
Rolling Stock Engineering



Figure 14-6: Lower Level Isometric Rendering

SURFLINER III - Condiment Station Concepts

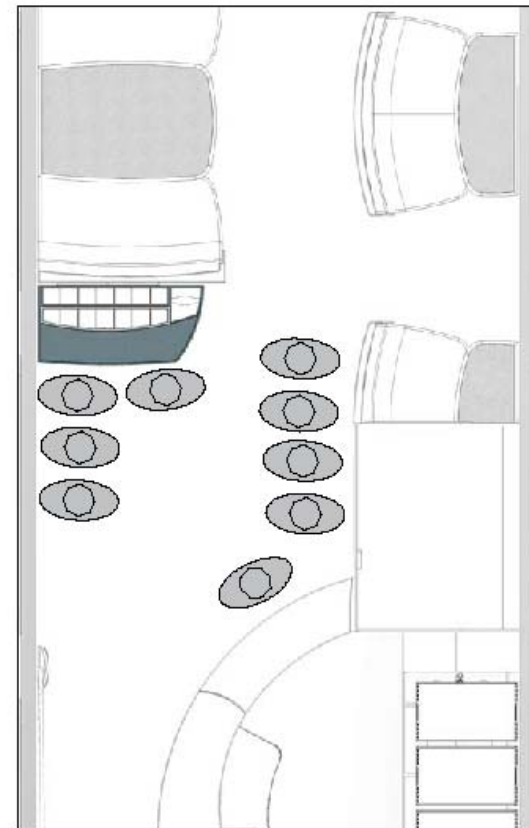
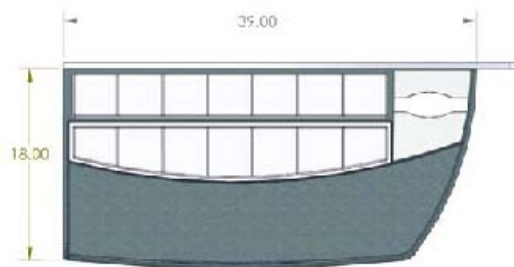
Option 1
6-13-07Industrial Design
Rolling Stock Engineering

Figure 14-7: Condiment Station Conceptual Drawing

* End of Chapter 14 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 15 **Water and Waste System**

Table of Contents

15.0	Water and Waste System	15-2
15.1	Overview	15-2
15.2	General Requirements.....	15-2
15.2.1	Water System Features.....	15-2
15.2.2	Waste System Features	15-3
15.2.3	FDA Compliance.....	15-3
15.3	Water System.....	15-4
15.3.1	Water Tank	15-4
15.3.2	Water Fill, Vent and Drain System.....	15-4
15.3.3	Pressurization System	15-4
15.3.4	Distribution and Piping	15-5
15.3.5	Pressure Regulators	15-5
15.3.6	Backflow Preventers/Vacuum Breakers.....	15-5
15.3.7	Sink, Faucet and Drain	15-5
15.3.8	Water Heaters	15-5
15.3.9	Water Cooler and Alcove	15-6
15.3.10	Toilet Flush Water	15-6
15.3.11	Waste Tank Rinse Water.....	15-6
15.3.12	Galley Water.....	15-6
15.4	Waste System.....	15-6
15.4.1	Operation	15-7
15.4.2	Toilet Bowl with Flush Control	15-7
15.4.3	Waste Tank and Vacuum System	15-9
15.4.4	Waste Tank Draining and Rinsing	15-10
15.4.5	Vent	15-11
15.4.6	Sink drains	15-11
15.4.7	Piping.....	15-11
15.4.8	Indicators.....	15-12
15.5	Freeze Protection.....	15-12
15.5.1	Blanket Heaters.....	15-13
15.5.2	Heat Tape	15-13
15.5.3	Automatic Drain Valves	15-13

15.0 Water and Waste System

15.1 Overview

A pressurized fresh water system shall be provided on each car to supply potable water for drinking, hand washing, toilet flushing and Café car galley requirements. Storage for 200 gal of potable water shall be located in the A/F-end equipment room of coach and cab/baggage cars, and 300 gal on café/lounge cars. A re-circulating chiller shall provide chilled potable water to two dispensing stations, one on each level of all cars.

A vacuum type waste retention system shall be provided on each car. The waste tank, drain lines and associated components shall be located in the B-end equipment room. Gray water from toilet room and galley hand washing sinks shall be captured and pumped to the waste retention tank.

No waste water shall be permitted to drain to ground, including gray water from hand washing sinks. Only fresh water from the following sources shall be permitted to drain to ground:

- Condensate from Heating, Ventilation and Air Conditioning (HVAC) and chiller units
- Drain from potable water chillers
- Melt water from ice storage bins
- Carbody drains from door tracks and equipment rooms
- Fresh water from water supply system when drained manually or by freeze protection devices

All car types shall have an Accessible Toilet Room (ATR) on the lower level. Coaches and cab/baggage cars shall also have a Unisex Toilet Room (UTR) on the upper level.

The water and waste systems shall be protected from damage due to freezing through the use of heat tape, blanket heaters, automatic drain valves (water system only) and insulation.

See Chapter 14, Food Service, for galley water system requirements.

15.2 General Requirements

15.2.1 Water System Features

A potable water supply system shall be provided on each car to supply water for drinking, washing, cleaning and waste disposal. The fresh water shall be supplied from one or more storage tanks located in the A/F-end equipment room. These water tanks shall be filled from a water fill valve located on each side of the car at the A/F-end.

The basic features of the water system include:

- 200 gal fresh water storage in coach and cab/baggage cars, 300 gal in café/lounge cars (one or more tanks)
- Water fill, vent and drain system
- Pressurization system
- Distribution and piping
- Pressure regulators
- Backflow or vacuum preventers
- Sinks, faucets and drains
- Water heaters (or flash heaters)

- Water cooler and alcove
- Fresh water for toilet bowl rinse during flush
- Fresh water for waste retention tank rinse during draining
- Galley water: sinks and coffee maker

15.2.2 Waste System Features

A waste system shall provide flush toilets in each toilet room. The waste system shall be a vacuum system with sufficient capacity to collect and retain a minimum of 250 gal of passenger waste, in a single tank, for discharge at a dumping facility. Waste incineration is not permitted. The waste system shall be designed with a minimum service life of 30 years, a minimum overhaul cycle of eight years and a minimum maintenance cycle of one year. Overhauling of waste system components may be included in the maintenance cycle. Recommended waste system components included in maintenance cycle is to be approved by the Customer. The waste system and all its components shall be designed for fail-safe operation and protection of passengers, service personnel and equipment.

The waste tank shall be located in the B-end equipment room, and shall have waste discharge drain lines and valves located adjacent to the tank on each side of the car.

The waste system shall be designed to operate normally at all elevations from 200 ft below to 9200 ft above sea level, and under all environmental and operational conditions identified in Amtrak Specification 963.

Toilet flushing shall be inhibited due to: lack of adequate water, air pressure, vacuum or electric power; waste tank full or waste drain valve open.

The basic features of the waste system include:

- Toilet bowl with flush control
- 250 gal usable waste tank capacity
- Vacuum source and control
- Waste tank vent
- System status indicators
- Waste tank drain and rinse
- Piping

15.2.3 FDA Compliance

The Contractor shall arrange for an FDA inspection of the design and installation of the water and waste system on each car to certify that it meets all requirements. Documentation of compliance shall be included in each vehicle's history book. **CDRL**

Water from hand washing faucets shall be dispensed at a temperature between 100°F and 108°F, in accordance with FDA/PHS requirements. All water heaters and flash heaters shall maintain water temperature in accordance with FDA/PHS regulations.

FDA-approved backflow preventers shall be located as necessary to prevent contamination of the fresh water system from the waste system. Backflow preventers shall be easily accessible for inspection and maintenance.

The Contractor shall thoroughly clean and sanitize the fresh water system on each vehicle prior to release from the Contractor's facility, to remove dirt, debris, solder, adhesive, cleaning agents or other contaminants from the manufacturing process. All filters in the fresh water system shall be renewed after the sanitization process and before release of the vehicle.

15.3 Water System

15.3.1 Water Tank

Storage for 200 gal of potable water shall be provided on coach and cab/baggage cars, and 300 gal on café/lounge cars, in one or more stainless steel tanks located in the A/F-end equipment room. Water tanks shall include internal baffle plates to minimize wave action produced by train motion. Water storage tanks shall comply with the latest edition of the ASME Boiler and Pressure Vessel Code sections IX and X.

Tanks shall be equipped with a manual drain valve for use in tank sanitizing as required by the FDA. Manual drain valves shall be readily accessible within the equipment room and shall drain to ground.

15.3.2 Water Fill, Vent and Drain System

A water fill point shall be provided on each side of the car. The fill point and three-way valve shall be enclosed in a stainless steel box inset into the equipment room and equipped with a weather-tight cover. The water fill box cover shall be spring loaded to be held securely in the closed position, with a strut or latch to hold the cover in the open position during water filling. The water fill point shall be a nozzle (Equipment Hydraulique Rainville p/n H-G15-001X or equivalent) enclosed in a metal shroud (Clements National p/n MRA-H-ALST-V109 or equivalent) and be painted medium blue.

A three-way valve (NYAB p/n 705504 N-9723 or equivalent) shall be provided on each side of the car that will cut off pressurization air and vent the water tanks when placed in the FILL position. This will allow the tank to be filled via a check valve located immediately behind the fill nozzle. The three-way valve shall be enclosed behind sheet metal, serviceable from the front, with only the operating handle exposed. When venting the tanks, vented air shall blow downwards to the ground and away from maintenance personnel operating the valve.

When the valve is placed in the WATER position, the vent will be closed and air pressure applied to the water in the tanks. Valves and piping shall be sized for a maximum fill time of 15 minutes, including the time necessary to vent the tank.

Water fill point piping and valves shall be insulated and equipped with heat tape for freeze protection. All hardware used in the water fill system shall be corrosion resistant and rated for use in a wet environment.

15.3.3 Pressurization System

The water supply system shall be pressurized through the use of auxiliary air, provided from the main reservoir through a governor and regulator valve. Air pressure for water rising shall be set for 45 ± 2 psig. The system shall be designed such that water shall not flow back into the auxiliary air system under any circumstances.

A desiccant air filter shall be provided on the main reservoir air supply line to remove contaminants from water raising air (see Chapter 7).

Potable water shall be provided through a pressure reduction valve at 20 ± 2 psig for hand washing sinks in toilet rooms, potable water drinking fountains and café galley sinks.

Water for toilet bowl rinse shall be provided at 28 ± 2 psig. Waste tank rinse water shall be unregulated.

15.3.4 Distribution and Piping

Distribution piping shall be type-K copper. Easily accessible ball cock type isolation valves shall be provided for each of the following (located upstream of pressure regulators, backflow preventers, etc):

- Main water supply (at water tanks)
- Sinks (combined hot and cold water feed at faucet)
- Water chiller
- Toilet flush (one for each toilet)
- Waste tank rinse
- Galley sinks and coffee maker
- Water heaters

Easily accessible manual drain valves shall be provided to allow draining water from the car as well as to service equipment.

Engraved color coded laminated plastic tags, attached to piping, will be provided to identify all water and air pressure regulators, water and waste cutout cocks, and drain cocks.

15.3.5 Pressure Regulators

Pressure regulators, complete with integral gauge shall be supplied to maintain the water pressures identified herein. Regulators shall be adjustable and have a locking ring or other locking device to prevent unintended changes to pressure settings.

15.3.6 Backflow Preventers/Vacuum Breakers

The potable water system shall be isolated from toilet flush water and toilet waste tank rinse water through the use of FDA-approved backflow preventers or vacuum breakers. Backflow preventers/vacuum breakers shall be located for easy access and replacement.

15.3.7 Sink, Faucet and Drain

Each toilet room shall be equipped with a sink, faucet and drain. All sinks shall be stainless steel. All gray water discharge from the sinks shall be captured and sent to the waste tank. Minimum drain line internal diameter shall be 1.5 in. Drain water may not be used as flush water for toilets.

Sink faucets shall utilize an automatic start-stop feature, such as infrared or proximity sensor, that will permit hands-free use of the faucet. The sensor may be mounted in the counter surface or the faucet. Faucets shall be regulated to have a flow rate of no more than 0.5 gpm, in order to maintain FDA-compliant water temperature.

15.3.8 Water Heaters

Each restroom shall be equipped with a standard one-gallon, 120VAC, 1250 W (minimum), vertical unit. Hot water temperature in the tank shall be maintained in accordance with PHS recommendations, and shall be mixed with cold water at the toilet room faucet to maintain hand washing water temperature between 100°F and 108°F at a flow rate of 0.5 gpm, in accordance with FDA/PHS regulations. The water heaters shall include the following features: immersion heater, factory installed thermostatic control and low water protection. The tank relief valve shall be set at 75 psig. The water feed piping to the heater shall be from the bottom to allow gravity draining from the local freeze protection valve. The water heater shall be easily accessible and removable without disturbing any other equipment. Water heaters shall conform to ASME Boiler and Pressure Vessel Code sections IX and X.

For galley water heater, refer to Chapter 14.

15.3.8.1 Instant-Flow Water Heaters (Flash Heaters)

An in-line instant-flow water heater (flash heater) may be provided as an alternate to a standard water heater. The flash heater shall meet temperature requirements of the water heater, and must be able to increase water temperature from an ambient temperature of no more than 50°F to the FDA required 100°F to 108°F at a flow rate of no less than 0.5 gpm.

The flash heaters shall be flow activated and shall operate at 120VAC. Flash heaters shall be easily accessible for replacement or maintenance.

15.3.9 Water Cooler and Alcove

Each drinking water station shall consist of a stainless steel alcove equipped with a chilled water dispenser and drain. The drain shall be .50 in. copper piping and shall drain to ground under the car. A kazoo shall be installed on the end of the drain under the car.

Water coolers shall be capable of producing at least 10 gal of chilled water per hour to spigots at designated locations on the upper and lower levels of all cars. The water cooler shall be capable of chilling water from 80°F to 50°F within 10 minutes. The chilled water shall be re-circulated to provide chilled water on demand.

Water coolers shall operate from 120VAC and shall use a non-ozone-depleting refrigerant meeting 40CFR Part 82. The water cooler shall have an FDA-approved particulate and bacteria filter on the supply line to the spigot.

Water shall be dispensed at a rate no greater than 0.5 gpm, or by gravity, to minimize spraying.

15.3.10 Toilet Flush Water

Toilet flush water shall be provided to the toilet bowl assembly through a cutout cock, pressure regulator and backflow preventer.

15.3.11 Waste Tank Rinse Water

Waste tank rinse water shall be provided to the waste tank through a cutout cock and backflow preventer. Waste tank rinse water shall be at the same pressure as the water raising system.

15.3.12 Galley Water

Potable water shall be provided to the galley of the café/lounge cars for hand washing, food preparation and coffee makers. See Chapter 14 for details.

15.4 Waste System

A waste system shall be provided on each car. The system shall have a useful waste storage capacity of at least 250 gal. The waste system shall be comprised of vacuum toilets, constant-vacuum waste transfer system, a central waste collection tank, two external waste valve stations, indicator panels and associated piping and controls,

Safety, reliability and ease of servicing and maintenance shall be major design considerations. The system shall be designed and tested to operate at all elevations from 200 ft below to 9200 ft above sea level, in accordance with Amtrak Specification 963.

Pump motors shall operate from 480VAC, 3-phase, 60 Hz head end power. All controls, solenoid valves, relays and circuitry, and antifreeze protection shall operate from 120VAC, 60 Hz. All transducers and indicator devices shall operate from 74VDC.

The equipment shall be designed for a minimum service life of 30 years, a minimum overhaul cycle of eight years and a minimum maintenance and level sensor calibration cycle of no less than one year.

The system shall consist of the assemblies listed below:

- Vacuum toilet
- Waste collection tank
- Waste valve stations
- Waste system indicator panels

The system shall have no adjustments and automatically recover from loss of power, air or water pressure when restored. The system shall have a manual reset pushbutton provided on the status panel to reset the system after a lockout, such as resulting from a toilet with a failed open vacuum flush valve. Cycling the 74VDC circuit breaker shall also reset the system.

Gray water from hand washing sinks shall be collected and stored in the waste tank. Gray water may be transferred from sinks to waste tank by the use of pumps or vacuum draw. Gray water shall not drain to ground.

15.4.1 Operation

A flush cycle shall be initiated by operating a flush actuating pushbutton located adjacent to the raised toilet lid in the UTR. The ATR will have two flush pushbuttons, one located on each side of the toilet, per ADA requirements. See Chapter 9 for details of the toilet room layouts. The flush function at all other toilets in the car will be disabled during the flush cycle. The vacuum blower shall automatically come on at the beginning of the cycle. Pressurized rinse water shall be sprayed into the toilet bowl before waste is evacuated. Toilet operation shall be disabled when: there is inadequate water, vacuum, air pressure or 480VAC; the waste tank is full; or when the waste tank drain line is open.

The waste shall be drawn, by vacuum, from each toilet in the car and transported through a 2 in. diameter waste line to a holding tank for discharge at a collection facility. The holding tank shall be continuously under vacuum, regulated by blower operation and maintained by an air-tight check valve between the tank and vacuum blower.

Indicators shall show the volume of waste collected in the retention tank and system status. The vacuum blower and toilet flushing shall be disabled whenever waste volume collected exceeds usable tank capacity.

A waste discharge valve shall be located on each side of the car near the B-end truck to drain the waste collection tank. Waste may be drained from the retention tank by gravity or vacuum assistance from the servicing facility. When the waste discharge valve is opened: vacuum blower operation will be disabled; the waste retention tank will be vented; the interior of the retention tank will be rinsed with wayside water; and wastes will be drained from the retention tank to the servicing facility. Draining the waste tank shall not require more than one person. Servicing time for draining the tank shall not exceed five minutes. The waste tank must be able to be drained without requiring 480VAC power or air pressure to be present on the car. An external rinse water hookup shall be provided if rinse water is required for draining.

15.4.2 Toilet Bowl with Flush Control

Each toilet room of each car shall be equipped with a toilet stand and shroud.

The toilet assembly shall be a self-contained, free standing unit consisting of a bowl with spray ring, rinse valve, drain valve, electronic flush control module, isolation valve, and supporting frame. The assembly shall be mounted on a stainless steel pan, to contain flooding should the outlet become blocked.

A flush pushbutton shall be provided to initiate the flush cycle. Pressurized rinse water shall be sprayed into the toilet bowl before waste is evacuated. Force required to activate the flush pushbutton shall be within ADA requirements.

Pressurized rinse water, 7 oz to 8 oz per flush, shall be sprayed into the toilet bowl before waste is evacuated. It shall be provided from the car water system via a dedicated local cutout cock, backflow preventer and pressure regulator.

Compressed air from the main reservoir shall be provided via a cutout cock and pressure regulator to operate the toilet flush valve.

The toilet assembly shall be mounted so as to be easily accessible and removable for service and maintenance. The shroud shall be secured with captive fasteners so as to be easily removed and installed. Likewise, valves shall be easily accessible, without tools, for operation from inside the car.

15.4.2.1 Toilet Bowl

The toilet bowl shall be stainless steel with a non-stick coating (such as Teflon), applied inside to prevent waste matter and mineral deposits from adhering. Bowl surfaces shall curve in a continuous fashion and shall be free of recesses and inaccessible areas. The sides of the bowl shall be steep and sloped toward the vacuum vent inlet to allow waste to accumulate for evacuation. To prevent blockage of the sewage system, the outlet of the bowl shall be a maximum 1.75 in. in diameter and shall be the most restrictive point in the piping system. The bowl and spray ring shall be easily and completely cleaned with ordinary cleansing agents and tools.

15.4.2.2 Overflow Pan

A pan shall form part of the interior bathroom assembly. The floor pan of the modules shall be FRP with a stainless steel overflow pan under the toilet bowl. The purpose is to prevent fluids from wicking beneath the toilet room flooring, both for hygiene and also to prevent degradation of the subflooring materials. This overflow pan shall be watertight and have raised edges of at least 2 in. in height. The pan's exposed edges shall be folded for safety and to provide stiffness. The floor pan shall be installed over, and attached to, the subfloor of the car. Attachment points shall be on the sides, rather than the bottom surface, and be watertight.

A drain tube shall penetrate the floor of the pan to allow spilled fluids to drain to ground. The drain shall be flush with the bottom of the pan, and shall extend through to the underside of the car. It shall be sealed to make the joint waterproof and shall also be sealed with an appropriate material to prevent flame propagation from underfloor flame sources. A split rubber hose (kazoo) shall be attached to the bottom end of the drain tube to prevent dust and debris from being blown up the tube.

15.4.2.3 Flush Valve

The flush valve shall be either pneumatically operated (60-120 psig), or vacuum operated (3-12 in. of Hg), and be a self-contained unit which provides a zero-leakage seal at the bowl outlet after operation. Operation shall be initiated through a solenoid valve. The flush valve shall seal within 0.1 seconds from a full open position. The zero-leakage seal shall be maintained under 15 in. Hg of vacuum. The valve shall be constructed entirely of stainless steel with the exception of seals and actuator. All surfaces that are subject to wear shall be designed to be self-lubricating with no maintenance required. Seals shall be easily replaced with standard tools.

The flush valve shall pass a Customer approved proof-of-design test, which shall be included in the vehicle's proof-of-design test plan, with a minimum of 300,000 cycles of operation. See Chapter 19.

15.4.2.4 Rinse Valve

The rinse valve shall control rinse water flow into the bowl. The valve shall be designed to maximize water pressure for water flow and orifice size when activated and provide a positive zero-leak seal when closed.

15.4.2.5 Electronic Flush Control

The electronic flush control unit shall control all toilet operations and activate the blower when the flush cycle is initiated. All electrical connections between the car and toilet assembly shall be made through a multi-pin connector. The electronic module shall plug into a card socket. The flush cycle shall be initiated at each toilet by a flush pushbutton. The flush cycle shall be delayed whenever another flush cycle on another toilet on the car is in progress. The control unit will provide the following timing functions:

- Blower ON signal from flush initiation;
- 1.0-1.5 second RINSE activated 0.5-0.7 seconds from flush initiation; and
- 3.0-3.5 second DRAIN activated 1.0-1.5 seconds from flush initiation.

15.4.2.6 Flush Pushbutton

At least one clearly labeled flush pushbutton shall be provided in the UTR, and two flush buttons in the ATR to initiate the flush cycle.

15.4.2.7 Cut Out Valve

A rinse water and air cut out valve shall be provided for each toilet assembly. Cut out valves shall be easily accessible, without tools, for operation en route from inside the car. Pipe flanges and couplers shall be provided to allow easy and quick removal of the toilet assembly by maintenance personnel.

15.4.2.8 Vacuum Isolation Valve

A slide type waste line vacuum isolation valve shall be provided on the toilet assembly with actuator handle accessible from the front of the toilet at floor level.

15.4.3 Waste Tank and Vacuum System

The waste tank assembly shall be designed as a self-contained unit suitable for mounting in an equipment room. The assembly shall consist of the retention tank, vacuum blower, level measuring system, tank drainage, freeze protection, electronic controls and debris shields.

Pump motors shall operate from 480VAC, 3-phase, 60 Hz HEP. All controls, solenoid valves, relays and circuitry, and antifreeze protection shall operate from 120VAC, 60 Hz. All transducers and indicator devices shall operate from 74VDC.

15.4.3.1 Retention Tank

The Waste Collection Tank assembly shall be a self-contained pallet-type unit intended for mounting in the car equipment room. The assembly shall consist of the retention tank, vacuum blower, check valve, vacuum relief valves, level indicators, level-measuring system, rinse valve, freeze protection and electrical control panel. Equipment location in the equipment room shall allow the unit to be easily serviced in place for most repairs, including replacing the vacuum blower. Design shall have the vacuum blower and associated check valve located on the exposed side to the tank when it is mounted in the equipment room, to allow these components to be easily serviced. In addition, it shall be easy to remove the unit from the car for preventative maintenance and overhaul. This includes not having to move or remove any equipment not directly related to the waste system.

Usable retention tank capacity shall be a minimum 250 gal.

The waste holding tank will be made of carbon steel. The interior and exterior surfaces will be coated with a corrosion resistant epoxy powder finish. This coating shall provide a tank life in excess of 30 years.

Self-cleaning sight glasses at the FULL, 2/3 and EMPTY levels shall be provided as a visual check of the waste level. A removable clean-out cover large enough to permit the interior of the tank to be cleaned and inspected shall be provided. A water separator located inside the tank shall prevent water and waste from being ingested into the vacuum blower. A 28 ± 2 psig rinse shall automatically apply fresh rinse water at a rate of 3 to 6 gpm to the sides of the tank during the drain cycle. The rinse valve shall be mechanically opened by the tank discharge actuator.

15.4.3.2 Central Control Panel

The control system for the overall waste system shall be incorporated onto the waste tank unit, enclosed in a weather-tight electrical cabinet. The central control panel shall consist of vacuum blower control and protection functions, level measuring, status panel interface, vacuum switches, transformer, AC and DC circuit breakers, tank draining functions and safety switch. All conduit connections to the control box shall be liquid-tight and shall use waterproof fittings and hardware. All electrical connections between the car and tank assembly shall be made through multi-pin connectors. The electronic module shall plug into a card socket.

15.4.3.3 Vacuum Blower and Control

The waste collection system shall be a constant vacuum type, with the vacuum obtained from an electrically operated blower operating on 480VAC. The vacuum blower will come on at the beginning of the flush cycle and will cycle on as needed to maintain the required vacuum.

The vacuum blower shall be capable of producing a differential pressure of at least 12 in. of Hg and a flow rate of at least 200 Standard Cubic Feet per Minute (SCFM). Tank vacuum shall be maintained at 6-10 in. of Hg through operation of the blower and an air-tight check valve between the tank and blower. The vacuum blower shall cycle on when the system differential pressure falls below 6 in. of Hg and cycle OFF when the differential pressure rises above 10 in. of Hg. A 19 to 21 second time-out function shall prevent continuous vacuum blower operation at high altitudes. Any toilet FLUSH signal shall start the blower and restart the time-out function. The blower shall remain off whenever the tank is full, or during the tank drain cycle.

15.4.3.4 Tank Level Measuring System

A load-cell tank level measuring system shall be provided to monitor the level of waste inside the retention tank. An input shall be provided to the status panel inside the car to indicate when the tank is empty, 2/3 full, and full. An input shall be provided to the vacuum blower control whenever the tank is full, which then sets the toilet room light to OUT OF SERVICE and displays TANK FULL on the system status panel.

The sensors, measurement system and TANK EMPTY indicator lights shall operate from the car 74VDC power source and shall draw no more than 1 amp of current at nominal voltage. For the level measuring system, the tank shall be considered "empty" when it contains less than 5 gal of waste.

15.4.4 Waste Tank Draining and Rinsing

Tank drainage shall be through a 4 in. stainless steel or epoxy-coated malleable-iron discharge line. A 4 in. inside diameter full port ball-type waste discharge valve, fitted with an Andrews quick disconnect fitting for interface with the servicing facility shall be provided on each side of the car. Tank drainage shall be controlled by a manually operated drain valve. When

operated, the drain valve shall: vent the tank, open the tank rinse valve, deactivate the vacuum blower and drain the tank.

A waterproof waste valve station, enclosing the discharge valve and associated items shall be provided beneath the car on each side of the B-end. All sheet metal and related hardware shall be 304 stainless steel to inhibit corrosion. Heat tape shall be applied to the valve and piping with the use of aluminum heat transfer tape, and the surrounding space well insulated with a durable waterproof, thermal insulation. The valve operating handle shall be robust, painted yellow and oriented so as to shield it from damage caused by debris impact. The valve closed position is with the handle oriented vertically, pointing downward. To open the valve, the handle shall be rotated 90 degrees towards the side of the car (away from the center of the car). To close the valve, the handle shall be rotated 90 degrees downward. Waste may be drained from the retention tank by gravity or vacuum assistance from the servicing facility. When the waste discharge valve is opened: vacuum blower operation will be disabled; the waste retention tank will be vented; the interior of the retention tank will be rinsed with on-board water; and waste will be drained from the retention tank to the servicing facility. It may be possible to drain the tank without requiring 480VAC power or compressed air on the car.

Time to drain a full tank using a gravity system shall not exceed five minutes. The tank shall be considered empty when less than five gallons of waste remains in the tank. Accumulated deposits shall not exceed 2% of tank volume over one year.

15.4.5 Vent

The vent from the waste tank blower shall be routed up to the roof level, terminating at a louvered vent placed immediately below the roof line and on the opposite side from the HVAC fresh air intake to prevent ingestion of waste exhaust vapors by the HVAC system. The vent line shall run to a carbon filter located in an accessible box allowing for easy filter replacement. A moisture drain shall be installed at the bottom of any vertical runs to permit the draining of accumulated water.

15.4.6 Sink drains

Gray water from hand washing sinks in toilet rooms and galleys shall be captured and transferred to the waste tank for storage and discharge at maintenance facilities. Gray water shall not drain to ground. Gray water may be transferred from sinks to waste tank by pumps or vacuum draw. Level sensing and water transfer equipment must be capable of maintaining function while coated with soap scum. Sink tanks, pumps, vacuum valves and manual drains shall be located in an easily accessible position for maintainability.

15.4.7 Piping

Water and air piping to the waste system shall be type-K copper tubing. The waste line between toilets and the waste tank shall be 2-in. (i.d.) non-metallic pipe that conforms to Amtrak Specification 759. There shall be no sharp bends or moisture traps in the pipe routing.

All fresh water and waste piping shall have accessible drain ports for draining of the system manually to prevent water freezing in the pipes. There shall be no low points in the water supply or waste system that cannot be drained. Waste piping must not be drained to the ground. The waste system must be dry flushed to produce an empty piping situation. Waste in the retention tank must then be dumped using the normal procedure.

15.4.8 Indicators

The status of the waste system shall be monitored continuously and displayed on indicator panels as described below. The power source for the indicator panels shall be 74VDC so that the system status is displayed when there is no HEP.

A TANK EMPTY light (black front with green letters) shall be installed on the waste tank assembly adjacent to each of the drain valves. The indicator shall be visible by maintenance personnel so they will know when the tank is empty so that the discharge line may be disconnected.

15.4.8.1 Status Panel

A status panel shall be installed inside the electric locker, and on the waste tank control box in the equipment room, to provide a visual indication of system status. The panel shall be black front with letter color specified below. A PUSH TO TEST button shall be provided to test the lights and reset the system.

The following indications shall be provided:

Label	Indicator	Function
TOILET SYSTEM	WHITE	System Identifier (Goes on together with any indicator below.)
POWER OFF	RED	HEP OFF to the waste system.
LOW AIR	RED	Less than 60 psig of air pressure.
LOW WATER	YELLOW	Less than 15 psig of water pressure.
LOW VACUUM	RED	Differential vacuum pressure is less than 3 inches of Hg, except when flush valve is open for toilet flush cycle.
FAULT	RED	Waste system failure detected.
TANK FULL	RED	Retention tank is full.
2/3 FULL	YELLOW	Retention tank is 2/3 full.
TANK EMPTY	GREEN	Retention tank is empty.

The white TOILET SYSTEM indicator lights shall be lit when any other indicator is on. Low vacuum function shall be disabled when the flush valve is open for the flush cycle.

A yellow LED indicator light shall be included on the system status panel on the electrical locker wall in the vestibule. This indicator shall be on continuously when the system is powered and operating normally, flashing when the system has a fault, and off when the system is not powered. See Chapter 11 for details.

An LED TOILET OUT OF SERVICE indicator shall be provided outside each restroom to indicate to passengers that the restroom is out of service when the toilet system is not functioning. See Chapter 9 for details.

15.5 Freeze Protection

The water and waste system shall be freeze-protected to enable the car to be left off power indefinitely in subfreezing temperatures with no damage resulting to any component of the system under any condition.

Freeze protection consists of three separate functions:

- Thermal insulation
- Protective heat, which keeps various equipment warm in cold weather
- Automatic drain valves, which drain water from car piping and tanks should a prolonged loss of heat occur

The water and waste tank enclosures shall be thermally insulated to allow the protective heat to keep the tanks from freezing at ambient temperatures down to -40°F. The installations shall be designed to remain waterproof and retain the insulation quality for the life of the equipment.

Protective heat shall be installed on fresh water and waste storage equipment and piping within the equipment room to maintain temperatures above freezing during these low ambient conditions.

15.5.1 Blanket Heaters

Blanket heaters, operating on 120VAC, may be employed for heating the water and waste tanks. Attached directly to the bottom of the respective tank, each of these heaters shall include two integral thermostats, one to activate the heat when the tank temperature falls below approximately 40°F and opening at approximately 55°F, and a second, providing a high limit function.

15.5.2 Heat Tape

Self-limiting heat tape, 120VAC, nominally 8 W per foot, shall be applied in areas subject to freezing temperatures, such as:

- Water piping
- Waste piping
- Water-fill housings
- Waste drain piping and valves

The heat tape shall be installed in a way to permit pipes and fittings to be disassembled for maintenance and repairs without removing the entire protective system.

The freeze protection thermostat will activate the heat tapes via a freeze protection contactor when the ambient outside temperature falls below 40°F.

15.5.3 Automatic Drain Valves

Air-sensing automatic drain valves with heater shall be used to protect the fresh water system from freezing should a loss of power and heat occurs. These valves include a heater on the sensing element to rapidly warm the element when HEP is applied to the car to allow the valve to close quickly after a power outage in cold weather. This allows a car to be watered shortly after power is applied rather than waiting for the piping to be warmed by the car heating system.

These valves shall be located at low points throughout the water system piping to allow all car water to drain automatically should the car lose power and the ambient air temperature fall below 38°F at the valve. No water shall be trapped in low points of the system. Vacuum relief valves are also required to allow the draining to occur. Potable and non-potable water shall use separate valves. Fresh water shall only be drained from the car when ambient outside temperatures are below 38°F and the car has no HEP or layover power.

The waste system shall not use automatic drain valves. All waste water shall be retained on the car under freezing conditions.

* End of Chapter 15 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 16

Cab and Train Controls

Table of Contents

16.0	Cab and Train Controls	16-4
16.1	Overview	16-4
16.2	General Requirements.....	16-4
16.2.1	Cab Area General Arrangement	16-4
16.3	Cab Design and Layout	16-5
16.4	Cab Equipment.....	16-6
16.4.1	Engineer's Side of Cab	16-6
16.4.2	Assistant's Side of Cab	16-6
16.4.3	Both Sides of Cab	16-6
16.4.4	Secure Cabinet behind Engineer's Cab	16-7
16.4.5	Secure Cabinet behind Assistant's Cab.....	16-7
16.4.6	Exterior Cab Equipment.....	16-7
16.5	Engineer's Desktop Console	16-8
16.5.1	Desktop Console Arrangement.....	16-8
16.5.2	Control Components.....	16-8
16.5.3	Engineer's Console Equipment	16-9
16.6	Engineer's Right Side Instrument Panel	16-11
16.6.1	Air Gauges	16-11
16.6.2	Speedometer.....	16-11
16.6.3	Loadmeter	16-11
16.7	Engineer's Left Side Auxiliary Console.....	16-12
16.7.1	Cab Radio/PA Handset.....	16-12
16.7.2	Headlight Selector Switch.....	16-12
16.7.3	Positive Train Control (PTC) Display Panel	16-13
16.7.4	Windshield Wiper Control.....	16-13
16.7.5	Alerter Reset Indicator Light	16-13
16.7.6	Car Number Plate.....	16-13
16.8	Overhead Indicator Panel.....	16-13
16.8.1	Indicator Lights	16-13
16.8.2	Alerter Control Head and Test Button.....	16-14
16.8.3	Headlight and Crossing Light Indicator.....	16-14
16.9	Right Side Overhead Circuit Breaker and Control Panel.....	16-15
16.9.1	Circuit Breaker Panel	16-15
16.9.2	Control Panel	16-16
16.10	Audible Alarms	16-16
16.11	Assistant's Cab Area	16-16
16.11.1	Desktop Console.....	16-17
16.11.2	Right Auxiliary Console	16-17
16.11.3	Left Auxiliary Console.....	16-17

16.12	Locomotive Control 27-Point MU Trainline Operation	16-17
16.12.1	Trainline Circuit Protection	16-17
16.12.2	Trainline Functions	16-18
16.12.3	Throttle/Dynamic Brake Control and Reverser	16-18
16.12.4	Power Knockout Functions	16-19
16.13	Brake Control System	16-19
16.13.1	Features	16-19
16.13.2	Brake Operation	16-20
16.13.3	Parking Brake	16-21
16.14	Communication Equipment	16-21
16.14.1	Two Way Radio	16-21
16.14.2	Conductor Signal	16-22
16.14.3	Public Address System	16-22
16.15	Event Recorder and Alerter	16-22
16.15.1	Event Recorder	16-22
16.15.2	Alerter System	16-25
16.16	Positive Train Control (PTC)	16-26
16.17	Train Communication Data System	16-26
16.17.1	Forward-Facing Audio/Video Camera	16-27
16.18	Cab Glazing and Accessories	16-27
16.18.1	Windshields	16-27
16.18.2	Side Windows	16-27
16.18.3	Sun Shade	16-28
16.18.4	Windshield Wipers	16-28
16.18.5	Mirrors/Wind Deflectors	16-28
16.19	Seating	16-28
16.20	Miscellaneous Cab Appointments	16-29
16.20.1	Trash Containers	16-29
16.20.2	FRA Inspection Card and MAP Form Holders	16-29
16.20.3	Coat Hooks	16-29
16.20.4	Crew Storage Locker	16-29
16.20.5	Track Warrant Holder	16-29
16.20.6	Fusee Holder	16-29
16.20.7	Fire Extinguisher and First Aid Kit	16-29
16.20.8	Arm Rest	16-30
16.20.9	Cup Holders	16-30
16.20.10	Crew Refrigerator	16-30
16.20.11	Convenience Outlets	16-30
16.21	Cab Doors	16-30
16.21.1	Cab End Frame Door	16-31
16.21.2	Engineer's Compartment Door	16-31
16.21.3	Assistant's Compartment Door	16-31
16.21.4	Equipment Lockers behind Cab	16-32

Table of Contents**16-3**

16.22	Cab Interior Lights	16-32
16.22.1	Cab Ceiling Lights	16-32
16.22.2	Reading Lights.....	16-32
16.22.3	Gauge Lights	16-33
16.23	Exterior Operating Lights	16-33
16.23.1	Headlights	16-33
16.23.2	Crossing Lights	16-33
16.23.3	Marker Lights	16-33
16.23.4	Car Number Board	16-33
16.24	Air Horn and Bell	16-33
16.24.1	Air Horn	16-34
16.24.2	Bell.....	16-34
16.25	Other Exterior Equipment	16-34
16.25.1	Pilot.....	16-34
16.25.2	Blue Flag Holder.....	16-35
16.25.3	Conspicuity Decals	16-35
16.26	Environmental and Ergonomics	16-35
16.26.1	Cab Interior Sound Levels	16-35
16.26.2	Heating, Ventilation and Air Conditioning.....	16-36
16.26.3	Crew Safety	16-37
16.27	Cab Arrangement Mockup.....	16-37

16.0 Cab and Train Controls

16.1 Overview

This chapter describes the design and functionality of the cab area of the cab/baggage car, including locomotive control equipment, instruments and gauges for systems necessary for the safe and efficient operation of the train from the engineer's cab and ancillary equipment for crew comfort and safety.

16.2 General Requirements

The cab/baggage car shall include a cab control compartment that spans the full width of the upper level of the F-end of the car (opposite end from the B-end). The cab control compartment shall include a desk-type engineer's console on the right side and desk-type assistant's work station on the left. The cab control compartment shall provide the engineer with all necessary functions and indications to safely and efficiently control the locomotive, and other train functions, from the cab end of the train through the use of the 27-pin Multiple Unit (MU) and Communication (COMM) trainlines.

The cab shall be configured to permit the cab compartment to be closed off from the passenger seating area when the cab car is at the end of the train, and to permit the engineer's side and assistant's side compartments to be closed off separately to provide a passageway to the end frame door so the car may be used as a mid-train coach.

The cab shall be equipped with forward-facing FRA Type I compliant windshields on the right and left end sheets and the end frame door between the collision posts, and FRA Type II compliant drop-sash side windows in the engineer's and assistant's compartments.

The operating controls and cab features shall include, but are not limited to those listed in the following paragraphs and shall be in full compliance with all applicable FRA requirements.

16.2.1 Cab Area General Arrangement

Refer to Figure 16-1, Figure 16-2 and Figure 16-3 for the cab area conceptual arrangement. The cab shall be arranged so that the engineer and assistant have easy access to all controls and switches, clear visibility to all indicators and labels, and sufficient view forward and to the sides to safely operate the train and perform all duties as required. Primary train controls and instruments will be ergonomically arranged on a panoramic desk-type console. The interior of the cab shall present a clean, efficient appearance and shall be free of sharp edges, protrusions, pinch points and safety hazards.

The cab arrangement shall allow the cab car to be used as a coach car in any position in a train, with a passageway to the adjacent car seating areas. Cab compartment doors, which can be maintained in either of two positions, will be provided to isolate the cab from the passenger area, allowing configuring the vehicle as a full width cab or creating a passage through the cab area to the end frame door for mid-train use. When the doors are configured for pass-through, the engineer's and assistant's sides of the cab are each isolated from the passengers, and from each other.

16.3 Cab Design and Layout

Cab layout will be designed and manufactured so that all devices and equipment are integrated (built-in and flush mounted) into the console, walls, ceiling and floors to give an integrated appearance. Ergonomics, safety, maintainability and commonality with other bi-level equipment as specified shall be major considerations in cab design. The design shall group controls and instruments for function, maintenance and ease of cleaning. Electrical and control enclosures shall be designed to be dust-resistant and drip-proof, and shall be water-tight to avoid damage or failure from spilled liquids, windshield condensate or leaks.

The cab equipment layout and console configuration shall be designed to accommodate engineers and assistants from the 5th percentile female to the 95th percentile male. The layout of the cab shall consider the engineer's relationship to the console and the windshield, and shall permit the engineer and assistant to have a continuous unobstructed field of view from 30 degrees above horizontal to a point on the tracks no more than 40 ft from the end of car. The cab layout shall also be arranged so as to provide the engineer with an effective field of view to the right and left of the direction of travel, including an unobstructed view of the rear-view mirror mounted on the left side of the car. Obstructions to the field of view caused by required structural members shall be minimized.

The Contractor shall demonstrate the ergonomic design of the cab for the full percentile range of engineers and assistants as specified. Documentation as provided during the cab area design review regarding the ergonomics of the cab shall include:

- Seat travel forward and rearward
- Engineer and assistant access into and out of cab seats
- Leg and knee room under the cab console for full range of seat positions
- Visibility forward, up and down, and side-to-side through front windshield
- Visibility through left- and right-side windows including view to mirrors
- Access to all controls and visibility of all gauges and indicators
- Range of motion to get into and out of crew seats
- Visibility and access to all indicators and controls

Primary console operating features shall be positioned to be accessible and functional from the engineer's optimal seating position with all required controls and display instrumentation mounted within the operating crew console desk. Normal operation shall not require awkward and unnatural positioning, extension or excessive motion on the part of the engineer. Switches and controls on the engineer's console shall be kept to a minimum. Gauges and instruments shall be internally illuminated and shall be positioned to avoid glare and reflection.

The console and instrument panels shall be designed to provide access to all controls, switches and indicators for routine maintenance. Instruments (such as the speedometer, air gauges, loadmeter, etc.) shall be easily replaceable from the cab interior, without requiring the removal of major panels and assemblies. Captive hardware will be used to secure all removable and/or hinged panels.

Secondary controls, switches and features that are not used in the performance of operation of the cab shall be located outside of the cab area.

16.4 Cab Equipment

The cab shall be fitted with all necessary appointments, indicators and controls, including but not limited to, the following items or devices.

16.4.1 Engineer's Side of Cab

- Engineer's desktop console
- Right side instrument panel
- Left auxiliary control panel
- Overhead indicator panel
- Side overhead circuit breaker and control panel
- Rear wall audible alarm panel
- Engineer's seat
- Trash container
- Door to close off cab when not in use
- Overhead heat thermostat

16.4.2 Assistant's Side of Cab

- Assistant's desktop console
- Right side instrument panel
- Assistant's seat
- Assistant's emergency brake valve
- Door to close off area when cab not in use
- Holders for FRA inspection card and Maintenance Analysis Program (MAP) form
- Forward-facing digital video camera

16.4.3 Both Sides of Cab

- FRA Type I windshields with integral electric defogger
- Windshield sunshades
- Forced air defroster
- Windshield wipers
- Tinted-glass drop sash side windows (FRA Type II)
- 74 Volts Direct Current (VDC) receptacle
- 120 Volt Alternating Current (VAC) receptacle
- Cup holders
- Coat hooks (two per side)

- Adjustable louvers for Heating, Ventilation and Air Conditioning (HVAC)
- Overhead heater
- Ceiling light with switch
- Reading light with switch
- Dimmer switch for instrument lights
- Car number plate
- Track warrant holder with clip

16.4.4 Secure Cabinet behind Engineer's Cab

- Upper cabinet (lockable and sealable inner door):
 - Positive Train Control (PTC) components and memory module
 - Train Communication Data (TCD) and forward-facing camera system components
 - Event recorder system components
 - Event recorder download module
- Lower cabinet (open behind cabinet door):
 - Emergency equipment (fusee holder, fire extinguisher, first aid kit, snap lights, tool storage)

16.4.5 Secure Cabinet behind Assistant's Cab

- Upper cabinet (open behind cabinet door):
 - Storage area for crew belongings
- Lower cabinet (open behind cabinet door):
 - Crew refrigerator

16.4.6 Exterior Cab Equipment

- Wind deflector/mirror (both sides of cab)
- Blue flag bracket (Engineer's side)
- Headlights
- Crossing lights
- Marker lights
- Horn
- Bell
- Pilot/Plow
- Cab radio antenna (recessed area on roof over Assistant's side)
- PTC antennae (recessed area on roof over Assistant's side)
- Illuminated car number boards
- Retro-reflective conspicuity decals

16.5 Engineer's Desktop Console

The engineer's desktop control console shall consist of a working desktop surface with major controls for train operation, and a cabinet underneath the desktop console to provide access to the wiring, piping, instrument mounting fasteners and other components mounted on or under the console.

16.5.1 Desktop Console Arrangement

The desktop console shall be designed and arranged to provide a comfortable operating area that is easy to clean and maintain. The desktop surface shall be angled down (towards the engineer) at least 10 degrees from horizontal. The control console shall be designed so that liquids spilled on the surface will not damage or interfere with operation of components or wiring, and shall have a finish that can be cleaned with a soap solution in water.

The desktop console operating surface shall be constructed of stainless steel, and shall be powder-coated with low-gloss black paint. The console cabinet shall be constructed of integrally colored fiberglass-reinforced polyester resin, or other Customer-approved material, to match adjacent cab lining materials.

The master throttle controller and brake controller shall mount directly to the desktop console, and shall be fastened to the console frame. Other desktop equipment and controls shall be fastened to mounting plates that are attached to the desktop surface. All control mounting panels shall be fastened to the console or cabinet surfaces with captive threaded fasteners. All hardware shall be attached with machine screws to either tapping plates or captive nuts. The console desk surface shall be removable for replacement or overhaul.

The console shall be designed and shaped in such a manner to permit the engineer to open and lean out of the cab side windows to inspect the train. The console will extend to the bottom of the windshield, and will have no hard-to-maintain areas where debris and dirt may collect.

16.5.2 Control Components

All switches, controls, buttons and indicators used on the control panels shall be rugged, high-quality components that are readily available from commercial sources. The number of different types of device shall be kept to a minimum, and individual functional designations shall not be marked on the device, except for the air brake gauges that may be marked on the face or cover of the gauges. Designations shall be attached to, or be part of, the console.

For commonality of train control equipment, switches and controls shall be provided as specified. A listing of the type and description of all switches in the cab area is shown in Table 16-1.

All controls and indicators shall be identified by signage as defined by Amtrak signage guidelines. Multi-position controls shall have all positions identified. Customer-approved adhesive-bonded tags will be permitted for labeling.

16.5.3 Engineer's Console Equipment

Main engineer controls and equipment on the desktop console shall include:

- Master controller
 - Throttle/dynamic brake controller
 - Reverser with removable handle
- Brake controller
 - Automatic brake handle
 - Parking brake handle
 - Brake cutout valve
- Horn push button
- Bell push button
- Locomotive sand control push button
- Alerter reset push button
- Track warrant holder with spring clip

16.5.3.1 Master Controller

An ElectroMotive Diesel (EMD) desk-type, single-lever throttle/dynamic brake control (EMD p/n 10592830) shall be provided. Traction power increases with handle motion toward the engineer and dynamic braking increases with handle moving away from the engineer. A gate or guard will be provided to separate traction from dynamic braking. The throttle handle will be interlocked with the reverser.

- Throttle handle cannot be moved from IDLE when reverser handle has been removed.
- Reverser handle cannot be removed if throttle is in any position other than IDLE.

A separate reverser handle will incorporate FORWARD, REVERSE and NEUTRAL positions.

A holder will be provided for the reverser handle when removed from the reverser.

16.5.3.2 Brake Controller

The console will be equipped with a conventional 30CDW desk-mounted air brake controller (Wabtec p/n 593290-1001) incorporating the automatic brake handle and parking brake control handle. It shall also incorporate the brake cutoff valve.

Automatic brake handle movement shall be continuously variable between the minimum application and full service positions; however, detents shall be provided for the following positions: RELEASE, MINIMUM REDUCTION, SUPPRESSION, FULL SERVICE, HANDLE OFF and EMERGENCY.

The parking brake shall apply and release the air brakes on the cab car only. Application of the parking brake shall be equivalent to a full service brake application. The parking brake shall not include a function to bail-off the locomotive brakes via trainline.

Both brake control handles shall be non-removable.

The brake valve shall include a three position cutoff pilot valve, with positions labeled as:

- PASSENGER
- FREIGHT
- OUT

Means for a brake pipe pressure regulating valve adjustment will be provided near the brake controller.

Air brake system noise shall not be introduced into the cab. All air brake system exhaust shall be vented to the underside of the car.

Refer to Chapter 7 for further details of the air brake system.

16.5.3.3 Horn push button

A two-position push button shall be mounted on the desktop console for control of the horn. The button shall be blue mushroom-head style, and shall have positions for low volume (partially depressed) and high volume (fully depressed). Cutler-Hammer p/n 10250ED1309-5.

16.5.3.4 Bell push button

A twin-control push button shall be mounted on the desktop console for control of the bell. Button assembly shall be yellow. Top button shall be labeled ON and bottom button shall be OFF. Cutler-Hammer p/n E30CED6.

16.5.3.5 Locomotive sand control push button

A blue collar-type push button shall be mounted on the desktop console for control of the locomotive sanding function. Cutler-Hammer p/n 10250ED1309-2.

16.5.3.6 Alerter reset

A yellow mushroom-head style push button shall be mounted on the desktop console for reset of the alerter. Cutler-Hammer p/n 10250ED1309-4.

16.5.3.7 Track warrant holder with spring clip

Working space shall be provided on the desktop console for a track warrant holder. The holder shall consist of a spring clip and a flat area where track warrants and other operating papers can be secured for easy access and viewing.

16.6 Engineer's Right Side Instrument Panel

The Engineer's right side instrument panel shall include:

- Duplex air gauges
- Speedometer
- Locomotive loadmeter

16.6.1 Air Gauges

The following air brake pressures will be displayed on two duplex 4.5 in. gauges with black lettering on a white background as follows:

Left or bottom gauge:

- Main reservoir (red needle)
- Equalizing reservoir (black needle)

Right or top gauge:

- Brake cylinder (red needle)
- Brake pipe (black needle)

Label for needles shall be located on the gauge cover.

The gauges shall be internally illuminated and shall permit the replacement of internal bulbs from within the cab area without requiring the removal of the gauge. All gauges will be equipped with Salem test fittings for calibration checks. The fittings may be located under the gauge front cover so they are hidden from the operating crew, but must be easily accessed from the engineer's console area.

16.6.2 Speedometer

An analog speedometer shall be provided on both engineer's and assistant's sides of the cab, with display range of 0 to 120 mph. The speedometer may employ a mechanical movement or solid-state simulation. Unit face will be black, with white lettering, and shall include a digital display.

The speedometer motion shall be smooth, continuous movement that shall accurately depict vehicle speed in real time (less than 1 second delay). The speedometer shall have a resolution of at least 1 mph. The display and readout shall not flicker between values. The speedometer shall be internally illuminated.

16.6.3 Loadmeter

A remote locomotive loadmeter (EMD p/n 10620135) shall be provided which will be compatible with the 27-point MU trainline and locomotive sending units. The loadmeter shall be internally illuminated.

16.7 Engineer's Left Side Auxiliary Console

The Engineer's left side auxiliary console shall include:

- Cab radio/PA handset and keypad
- Headlight selector switch and control panel
- PTC display panel
- Windshield wiper control switch
- Alerter acknowledgement light (duplicate to alerter status panel)
- Car number plate

16.7.1 Cab Radio/PA Handset

A handset shall be provided for use with the cab radio and the train's Public Address (PA)/intercom system. The handset control panel shall have a selector switch that allows the engineer to choose whether the handset works with the radio, PA (train), PA (cab car only) or intercom (trainline). There shall be a push-to-talk button on the inside of the handset. The handset shall be Amtrak standard locomotive handset (EMD p/n 10623456), and shall connect to the PA control panel via multi-pin connector.

The handset shall rest in a cradle when not in use.

16.7.2 Headlight Selector Switch

A four-position headlight selector switch shall be provided (Electro Switch Corp p/n 101405A-S). The positions shall control the headlights as follows:

- Top (12 o'clock): Headlights dim and crossing lights on
- Right (3 o'clock): Headlights dim and crossing lights off
- Bottom (6 o'clock): headlights high and crossing lights on
- Left (9 o'clock): Headlights and crossing lights off

Placing the switch in the right (3 o'clock) position shall cause the crossing lights to be extinguished, even if they are flashing as a result of the horn being blown. Blowing the horn while the switch is in this position shall cause the crossing lights to illuminate and flash for the established duration, then re-extinguish.

Placing the headlight selector switch in the OFF position shall cause the headlights and crossing lights to extinguish and stay extinguished.

If the marker light switch in the electrical locker is set to F-END, then the marker lights shall come on when the headlight switch is in the OFF position, and be extinguished when the headlight selector switch is in any other position.

16.7.3 Positive Train Control (PTC) Display Panel

The display screen for the PTC system shall be located on the left side auxiliary console, and shall be oriented so that the screen is clearly and easily viewed by the engineer when seated, without glare or reflection from instruments, controls or lights, and without requiring excessive or unsafe diversion of the engineer's view forward from the cab. All controls related to the function of the display screen; including brightness control, shall be located in the immediate vicinity of the screen and be easily accessed.

The PTC display screen shall not hinder access to, or view of, other controls.

The display panel shall be removable from within the cab without requiring the removal of other controls or components.

16.7.4 Windshield Wiper Control

A switch to control the windshield wipers shall be located on the left side auxiliary console, adjacent to the headlight selector switch. The windshield wiper control shall be a rotary switch with variable speed control and intermittent operation, and shall control wipers on both sides of cab. The windshield wipers shall automatically park to one side when turned off.

16.7.5 Alerter Reset Indicator Light

A red Light Emitting Diode (LED) light shall be located on the left auxiliary console to give the engineer a visual indication that the alerter requires resetting or acknowledgement. This light shall be in parallel with the indicator light on the alerter control head on the overhead indicator panel, and shall be clearly visible to the engineer under all lighting conditions. The alerter "request for acknowledgement" indicator light shall be appropriately labeled as to its function.

16.7.6 Car Number Plate

A metal or polycarbonate plate with the car's road number and reporting marks shall be located on the left auxiliary console. Numerals shall be no less than 1 in. tall, and shall have a high contrast with the background in order to be readable in low lighting conditions.

16.8 Overhead Indicator Panel

The overhead indicator panel shall be mounted on the cab wall above the engineer's console and forward-facing windshield. The panel shall be mounted so that all indicators are easily seen and recognized by the engineer while seated.

16.8.1 Indicator Lights

LED indicator lights shall be of a "push to test lamp" style button, with the lettering for each indicator etched into the lens so that it will not wear off from lamp testing. Lamps shall be replaced by removing the indicator faceplate from the cab. Lamp lenses shall be secured into the lens housing so that they will not fall out when the housing is removed. The console shall have labels adjacent to each lamp under the housings to aid troubleshooting indicators when the housing is off, and prevent the wrong housing from being installed over an indicator unit.

The indicator lights to be provided are shown in the following table.

Light Group	Condition	Indicator Lights
Operating Status	MU power on	Green
	PCS open	Red
	Sanding (loco)	White
	Wheel slip (loco)	White
	Dynamic brake warning	Amber
	Loco Alarm: failure	Red
Safety Equipment Status	Automatic Train Stop (ATS) penalty*	Red
	ATS cutout*	Red
	Alerter cutout	Red
	Overspeed (cab signal)*	Red
	Overspeed cutout	Red
	Spare	Red
Cab Car Status	Heated windshield on	Amber
	HEP on	Blue
	HEP off	Red
	No battery charge	Red
	Spare	Red
	Spare	Amber
Train Status	Brakes applied	Amber
	Brakes released	Green
	Car doors closed	Green
	Car door summary bypass on	Red
	Hot journal	Red
	Spare	Red

* If so equipped

16.8.2 Alerter Control Head and Test Button

The control head and test button for the alerter shall be mounted on the overhead indicator panel. Another alerter acknowledgement request light, in parallel with the light on the alerter control panel, shall be mounted on the left side auxiliary console.

16.8.3 Headlight and Crossing Light Indicator

The overhead indicator panel shall be equipped with a visual indicator that displays the status of the headlights, crossing lights and marker lights that are mounted on the F-end of the cab/baggage car. The indicator shall graphically represent the end of the car, and shall have LEDs that are illuminated whenever the respective light is illuminated on the exterior of the car. The LED shall only be illuminated when the exterior light is also illuminated, and shall not illuminate if the exterior light is off, burned out or disconnected.

16.9 Right Side Overhead Circuit Breaker and Control Panel

Low voltage circuit breakers and auxiliary cab equipment control switches shall be mounted on a panel on the upper console on the right hand side in the cab, accessible to the seated engineer. All circuits and devices will be clearly labeled by name and position. A label shall be included which provides instructions for switch and circuit breaker positions for lead and cutout operation in push-pull service.

16.9.1 Circuit Breaker Panel

Circuit breakers and switches shall include at a minimum:

- Locomotive control/MU trainline power (trainlines 4 and 13)
- Dynamic brake cutout
- Engine run switch
- Generator field switch
- Door summary circuit bypass (sealed switch)
- Heated windshield
- Windshield defogger
- Cab heat
- Car number boards
- Crossing Lights (VDC)
- Headlights (VDC)
- Radio
- Indicator and gauge lights
- Event Recorder/Alerter/Speedometer (sealed)
- PTC (sealed)
- Forward-facing video system (sealed)
- 74VDC Receptacle
- 120VAC receptacle
- Refrigerator
- Spare

Other circuit breakers may be needed. The Contractor shall submit a list of circuit breakers and the panel layout for review and approval by the Customer.

16.9.2 Control Panel

The right side overhead control panel shall include at a minimum:

- Windshield defogger switch
- Windshield defroster switch
- Instrument light dimmer switch
- Cab ceiling light switch
- Reading light switch (white reading light)
- Reading light switch (red reading light)
- Locomotive alarm silence push button
- Emergency locomotive shutdown push button
- Locomotive fault reset push button

16.10 Audible Alarms

All required audible alarms and signals shall be electronic and shall be provided in the cab, located so as to be clearly audible to the engineer and assistant, and be readily accessible for maintenance. Audible signals requiring different actions shall have different sounds as specified below. Audible signals shall be no louder than necessary to be clearly audible in the cab under worst case conditions such as passing another train in a tunnel. The final levels shall be determined during acceptance testing. The alarm panel shall be located at the top of the rear wall of the engineer's cab.

The audible alarms and signals shall include, but not be limited to:

16.10.1.1 Audible Alarm Panel

- Loco alarm (Sonalert) 2.9 kilohertz (kHz) intermittent fast pulse tone
- Conductor signal (Buzzer) 4.5 kHz continuous tone
- Wheel slip/brake warning (Sonalert) 1.9 kHz continuous tone

16.10.1.2 Alerter Panel

- Alerter audible alarm (yelp)
- Overspeed (whistle under engineer's console)

16.11 Assistant's Cab Area

The assistant's side of the cab shall include the following controls and indicators. Unless otherwise specified, all controls and indicators used on both Engineer's and assistant's side cabs shall be identical components.

16.11.1 Desktop Console

- Bell push button (ON/OFF)
- Horn push-button (3 position)
- B-3-B emergency brake valve
- Track warrant holder with spring clip

16.11.2 Right Auxiliary Console

- Reading light switch
- Ceiling light switch
- Windshield wiper control
- Speedometer
- Cab reading light dimmer

16.11.3 Left Auxiliary Console

- Radio handset, control panel and handset storage cradle
- Radio keypad
- Car number plate

16.12 Locomotive Control 27-Point MU Trainline Operation

The cab/baggage car shall be capable of operating the train in push-pull mode with a locomotive equipped for operation using APTA standard 27-point MU trainlines. During push-pull operation, the MU controls and communications will be interfaced using the existing trainline protocol (see Chapter 13).

16.12.1 Trainline Circuit Protection

The 74VDC control power for the MU functions will be provided from the locomotive via the #13 and #4 pins. A two-pole, 15-amp circuit breaker shall be provided between the #13 and #4 trainlines and the cab MU electrical equipment, and shall be labeled LOCOMOTIVE CONTROL. This will serve two functions:

1. To protect cab equipment from faults in the outgoing MU trainline system.
2. To provide on/off switch function to activate or deactivate the cab for changing ends.

A green MU POWER ON pilot light will be provided on the load side of this circuit breaker to provide the engineer an indication that MU trainline power is available.

16.12.2 Trainline Functions

MU trainline functions will conform to APTA Standard RP-E-017-99 (see Chapter 13). All MU trainlines shall provide APTA standard locomotive control functions, except as listed below.

16.12.2.1 Locomotive Alarm Silence

MU trainline #2 provides a circuit to provide a locomotive fault alarm in the cab area of the cab/baggage car. Locomotive faults which cause this alarm include:

- Prime mover (traction engine) shutdown
- HEP engine shutdown
- HEP loss (local and/or trainline)

The ALARM SILENCE push button is to be provided to allow the engineer to silence the locomotive alarm. This will be via a self-latching relay so that if the locomotive fault clears, the cab alarm is automatically restored to normal condition, and will respond to a new alarm.

16.12.2.2 Emergency Locomotive Shutdown

Pressing the EMERGENCY LOCOMOTIVE SHUTDOWN button causes the following:

- Shuts off power feed to throttle/dynamic brake commands; and
- Energizes the MU trainline #3 (only), which shuts down all diesel engines in the locomotive (prime mover and HEP engine).

This button shall be latching in both positions - push to activate, and pull to reset.

16.12.2.3 Remote Locomotive Loadmeter

MU trainlines #18 and #19 provide a current loop to operate the remote locomotive loadmeter in the cab area of the cab/baggage car.

16.12.2.4 Trainline Ground/Electronic Air Brake (EAB) Alarm Silence

A push button will be provided to apply 74VDC to MU trainline #26 to reset the locomotive. The push button shall be labeled TRAINLINE GROUND/EAB ALARM SILENCE.

16.12.3 Throttle/Dynamic Brake Control and Reverser

An EMD desk-type, single-lever throttle/dynamic brake control will be provided. This controller regulates the traction current generated by the locomotive via trainline commands, per APTA Recommended Practice RP-E-017-99. Traction power increases with handle motion toward the engineer and dynamic braking increases with handle moving away from the engineer. A gate or guard will be provided to separate traction from dynamic braking. This handle will be suitably interlocked with the reverser. The reverser will incorporate forward, reverse and neutral positions.

The master controller incorporates a dynamic brake zone of movement that will cause only dynamic brake operation. Use of the dynamic brake controller will activate the dynamic brakes

on the locomotive but will not make an air brake application. Use of the automatic brake valve (trainline air brakes) will automatically activate the blended brakes on any locomotive so equipped, which combine air braking and dynamic braking. These functions shall conform to APTA Recommended Practice RP-E-006-99.

16.12.4 Power Knockout Functions

Power Knock/Out (PKO) will occur in response to emergency or penalty brake applications. The MU propulsion control system will receive the PKO signal from the brake system and immediately remove traction power by deenergizing the GF, A, B, C, and D valve control trainlines, and also lighting the PCS OPEN indicator on the console.

16.13 Brake Control System

The cab/baggage car shall be capable of controlling the operation of the train in push-pull mode with a standard locomotive equipped with 26L type air brake equipment. The cab/baggage car shall be designed to interface with locomotives equipped with pneumatic, dynamic and blended brake systems. Blended brakes operate in response to brake pipe pressure reduction (there is no electrical trainline function). This function shall conform to APTA Recommended Practice RP-E-014-99.

16.13.1 Features

The cab/baggage car shall be equipped with 26L brake equipment. It will include the following features:

- A 30CDW desk type air brake controller, which shall include:
 - Automatic brake control
 - Parking brake control
 - A 3-position cutoff pilot valve, with Passenger (PASS), Freight (FRT) and Out (OUT) positions.
 - In the FRT position the system shall provide for gradual application and direct release of the trainline brakes. Once applied, brake cylinder pressure is maintained until the automatic brake handle is placed in the RELEASE position.
 - In the PASS position the system shall provide for gradual application and gradual release of the trainline brakes. Once applied, brake cylinder pressure may be reduced by increasing the brake pipe pressure until the automatic brake handle is placed in the RELEASE position.
 - In the OUT position the automatic brake valve operation is blocked.
 - When the pilot valve is in the cutout position, the following brake interfaces are inoperative:
 - Alerter
 - Overspeed
 - Parking brake
 - ATS/Cab signal (if so equipped)

- A brake pipe pressure regulating valve adjustment mechanism located near the brake controller. Normal setting is 110 psig. The feed valve shall be delivered adjusted to normal setting and sealed.
- B-3-B Emergency brake valves in assistant's side of the cab and in the passenger seating areas.
- Separate magnet valve interfaces will be provided as follows:
 - Alerter (suppressible penalty)
 - Overspeed (alerter, not cab signal) (suppressible penalty)
 - PTC interface (non-suppressible penalty)
- Air gauges for Main Reservoir (MAIN RES), Equalizing Reservoir (EQ RES), Brake Pipe (BRK PIPE) and Brake Cylinder (BRK CYL) pressure.

16.13.2 Brake Operation

The Engineer's desktop console will be equipped with a desk-mounted air brake controller, incorporating the automatic brake handle and parking brake control handle as well as the brake valve cutoff device. The automatic brake handle will control the application and release of the air brakes on the entire train, including the locomotive. It will also initiate blended braking, on locomotives so equipped, through brake pipe pressure reduction.

Braking effort shall be continuously variable between the minimum application and full service positions; however, detents shall be provided for the following positions: RELEASE, MINIMUM REDUCTION, SUPPRESSION, FULL SERVICE, HANDLE OFF and EMERGENCY. Both automatic and parking brake control handles will be non-removable.

An equalizing reservoir cut off valve shall be provided and coordinated with the brake valve operation in the FREIGHT position such that the system shall stop the brake valve from increasing the pressure in the equalizing reservoir except with the brake valve handle in the RELEASE position. The equalizing reservoir cut off valve may be separate from the brake valve.

Penalty brake application will be at the full service rate. The braking system shall provide electrical interlocking to remove traction power (power knockout/PKO) in the event of a penalty or emergency brake command. Procedure for recovery of both an emergency brake application and a penalty brake application shall be as follows:

16.13.2.1 Process for traction recovery from emergency:

1. Place automatic brake handle in emergency position;
2. Reset source of emergency application if initiated from other than cab (such as broken air line or B-3-B valve);
3. Wait 60 seconds from application of emergency;
4. Place throttle in idle or dynamic brake setup positions;
5. Move automatic brake handle to release position; and
6. Move throttle to power or dynamic brake position.

16.13.2.2 Process for traction recovery from penalty:

1. Place automatic brake handle in suppression position;
2. Move throttle to idle or dynamic brake setup position;
3. Satisfy requirements of system that initiated penalty (e.g. acknowledge alerter);
4. Move automatic brake handle to release position; and
5. Move throttle to power or dynamic brake position

These procedures shall be described in the operating manual for the cab/baggage cars.

16.13.3 Parking Brake

The parking brake handle provides the ability to make a brake application of the air brakes on the cab car, regardless of the state of the automatic brake. This will allow the train brakes to be released while the brakes on the cab car hold the train stationary. The parking brake will be either applied or released; it is not modulated. When the automatic brake valve is cutout, parking brake function is disabled, causing the cab/baggage car's brakes to respond to brake pipe pressure in the normal way. This shall occur regardless of parking brake handle position when the pilot valve is cutout.

16.14 Communication Equipment

The cab shall incorporate an integrated communication system that combines functions for the cab radio, public address and intercom systems into one handset in each cab compartment for use by the engineer and assistant. A selector switch on the handset panel shall allow the engineer or assistant to choose the function of the handset – radio, PA (cab car only), PA (train) and intercom. This selector switch shall provide a visible indication of the function selected.

The handset shall have a push-to-talk (PTT) switch, and shall plug into a receptacle on the faceplate of the handset panel. A cradle shall be provided for handset storage when not in use.

The cab area PA/Intercom interface shall provide a connection to the car's public address/intercom system.

The cab radio shall be a separate unit and shall not have an interactive function with the PA/Intercom unit.

16.14.1 Two Way Radio

The cab will be equipped with an Amtrak standard 2-way radio. The radio will be located at the engineer's console. A press-to-talk handset and holder will be provided for the engineer and the assistant positions. The radio case and the antenna shall be securely grounded to the carbody to ensure an excellent standing wave ratio.

A 160-162 Mhz railroad-band roof-mounted cab radio antenna shall be installed on a flat mounting plate on the centerline of the roof over the cab compartment. All mounting and conduit holes shall be fully watertight. Removal and installation of the antenna shall be possible from the roof of the car without requiring access to the underside of the roof.

Installation of the radio antenna shall be within the clearance requirements of Amtrak Bi-Level Clearance Drawing B-066-00050, Rev A.

16.14.2 Conductor Signal

The cab will be equipped with a conductor signal buzzer, (communication trainline #22 74VDC). This buzzer shall alert the engineer and/or assistant to an incoming request to communicate by intercom.

16.14.3 Public Address System

The Radio/PA/Intercom function control panel shall provide an interface to the car-borne public address/intercom system. Function of this panel shall be similar to the PA/Intercom control panel used at the Conductor's PA control station, except for the cab radio interface. See Chapter 12 for details of the PA system.

16.15 Event Recorder and Alerter

16.15.1 Event Recorder

An event recorder/alserter system shall be provided. It shall be Wabtec Train Trax model TTX-REC-M5.

The event recorder, including memory and download modules, shall be designed and installed in accordance with 49CFR Section 229.135. Memory modules shall be painted orange for easy identification following an accident. These components shall be located in the secure top portion of the cabinet behind the Engineer's cab.

The parameters to be recorded, and the rate of scan for those parameters, shall be provided to the Customer for review. Time, date, car number and distance traveled shall also be recorded.

At a minimum, the system shall record the following parameters:

No.	Type	Description
1	Digital	Brake Cylinder Pressure 15 psig (bench mark)
2	Digital	Alerter Reset (use of alerter reset button)
3	Digital	Brake Pipe Charging Cut-off (Port 53) (lead/trail)
4	Digital	Operator Initiated Emergency
5	Digital	Bell Use (Air Signal)
6	Digital	Horn Use (Full Volume Horn Blast, Air Signal)
7	Digital	Self Test of Alerter
8	Digital	Alerter Control Override (Electric Cutout)
9	Digital	ATS Enabled (combination electronic & pneumatic)*
10	Digital	Generator Field Excitation
11	Digital	Throttle Valve "A"
12	Digital	Throttle Valve "B"
13	Digital	Throttle Valve "C"
14	Digital	Throttle Valve "D"
15	Digital	Direction of Travel - Forward
16	Digital	Direction of Travel - Reverse
17	Digital	Dynamic Brake Setup
18	Digital	Sand Magnet Valve (locomotive sander only)
19	Digital	Penalty Brake (Output to Alerter Magnet Valve)
20	Digital	Headlight Switch – Headlights On (high or dim)/Off
21	Digital	Crossing Lights On/Off
22	Digital	Horn Sequencer Foot Switch Use
23	Digital	HEP ON/OFF
24	Digital	Door Closed Summary Circuit (Doors Closed/Not Closed)
25	Digital	Holding Brake Pressure (HBPS) (Parking Brake Applied)
26	Digital	PCS Open
27	Digital	ATS Acknowledge*
28	Digital	ATS Request for Acknowledgement*
29	Digital	High Horn
30	Digital	Low Horn
31	Digital	Cab Signal High Overspeed Select (ATS is cutin)*
32	Digital	Door Closed Summary Circuit Status (Normal/Bypass)
33	Digital	Not Used
A1	Analog	Brake Pipe Pressure
A2	Analog	Brake Cylinder Pressure
A3	Analog	Headlights High/Dim/Off
A4	Analog	Crossing Lights On/Flashing/Off
A4	Analog	Not Used
A5	Analog	Cab Signal
A6	Analog	Not Used
A7	Analog	Not Used
F1	Freq.	Speed (1 mph increments)
F2	Freq.	Not Used
F3	Freq.	Not Used
F4	Freq.	Not Used

* If so Equipped

The memory module shall be crash-hardened, tamper resistant and waterproof. The system shall retain data during extended loss of power to the system, shall provide physical protection during vehicle catastrophic occurrences, be flame resistant and contain constraints against accidental or deliberate data erasure or over-writing. The system shall retain, at a minimum, the last 60 hours of data collected in normal railroad operation.

Train operating data will also be provided to the non-removable memory module to record operational performance data. Minimum scan rate occurs as a result of a change. Data retained will cover a period of at least 60 hours in normal railroad operation. Recorded data will be capable of convenient down-load on demand to a compatible Windows-based computer and a removable memory storage device. The credit card memory device will be the primary means of download. The list of recorded inputs is to be submitted for Customer approval.

16.15.1.1 Speed signal

A single speed signal will be used for speedometer and event recorder. Axle #1 shall be used. The installation of speed sensor and truck wiring shall be similar to that described for the wheel slide system (see Chapter 7). End-of-axle drive type speed pickups shall not be used. Design of the system will minimize pickup and wiring vulnerability to damage from wayside debris. This speed signal may also be used for the PTC system.

16.15.1.2 Overspeed

The speedometer will include an overspeed function, with 83 mph setting for 79 mph territory. Overspeed shall be provided for operations above 79 mph if the PTC system is disabled. Should the car with the active cab exceed the allowed speed, the overspeed indicator will flash, and after a time delay of 3-5 seconds, a penalty brake application will occur, with power knockout. To recover brake control, the brake controller must be brought to suppression position and the train brought down below overspeed. After the PCS light goes out, the brakes can then be released. It is not necessary to stop the train. Overspeed will be dormant when the brake valve is cutout.

It shall be possible to do a self-test on the overspeed when the car is stationary. Terminals to inject a speed signal into the unit without disconnecting any wiring will be provided. Adjustment for wheel size shall be done easily.

If the overspeed fails, it shall be possible to cut it out through the use of a sealed cutout cock, handle coded white in color, co-located with the alerter and ATS cutout cocks. Actuation of the cutout will provide an indication on the engineer's overhead indicator panel.

16.15.1.3 Data download

Recorded data shall be capable of convenient download on demand to a standard Windows-based laptop computer through the use of a cable with a Universal Serial Bus (USB) 2.0 connector on one end.

Data shall also be downloaded through the use of commercially available portable memory modules [Personal Computer Memory Card International Association (PCMCIA), flash memory or USB memory module] inserted into a memory module reader located in the vicinity of the event recorder.

All event recorder data shall include the car number and the date and time of download. Data shall be downloadable at any time including during operation.

16.15.1.4 Deliverables

The Contractor shall supply the following prior to acceptance of the first cab/baggage car to support the event recorder system:

- Three copies of required event recorder software, needed for retrieving and manipulating the event recorder data, shall be provided. Instructions for using the software will be provided. Software packages will incorporate both methods to down-load data and will be compatible with commercially available series microprocessors and Windows software. There will be no additional cost or use restrictions associated with this software.
- One memory module is to be provided with each cab/baggage car.
- Ten download cables shall be provided.

CDRL

16.15.2 Alerter System

An alerter function shall be provided by the event recorder system.

The engineer's activities shall be monitored over time intervals that decrease in duration as train speed increases. Lack of recorded activity for certain functions during this period shall result in a continuous audio alarm, a continuous visual alarm, and, if unacknowledged, a penalty brake application with power knockout.

To recover from a penalty brake application, the brake controller must be moved to the suppression position, the alerter must be reset by normal reset actions, wait for the PCS light to go out, and then release the brakes. It shall not be necessary to stop the train.

An alerter reset is generated every time the engineer:

- Changes throttle setting;
- Initiates dynamic brake setup;
- Changes reverser position;
- Makes an automatic brake adjustment of more than 5 psi;
- Changes the position of the headlight selector switch;
- Blows the horn; or
- Presses the alerter reset push button.

Alerter reset interval shall decrease as speed increases. This interval shall be adjustable and shall be set per Customer requirements.

The alerter shall become dormant if the pilot valve on the 30CDW brake controller is cut out.

It shall be possible to do a self-test of the system while the car is stationary.

If the alerter system fails, it shall be possible to cut it out through the use of a sealed switch or through the use of a sealed cutout cock, handle yellow in color, co-located with the overspeed

and PTC cutout cocks. Activation of the cutout will provide an indication on the engineer's console indicator panel.

Alerter magnet valves shall be Graham-White, or approved equivalent.

Event recorder system and alerter specifications shall be provided to the Customer for approval during design review. **DR**

16.16 Positive Train Control (PTC)

Each cab/baggage car shall be equipped with Positive Train Control (PTC). The PTC system shall conform to all applicable Amtrak, AAR, APTA and FRA standards and regulations, and be fully functional with PTC systems in use or planned for use on the host railroads over which Amtrak trains operate. The system shall meet all requirements for being a vital system as determined by the host railroads.

The PTC system shall be Wabtec's Electronic Train Management System (ETMS) or approved equivalent.

The video display screen for the PTC system shall be mounted on the left side auxiliary console in the engineer's cab, at a height and orientation that maximizes the engineer's ability to clearly see the display without glare or reflection, and without requiring that the engineer's vision be distracted from the view forward to the tracks. A brightness control shall be provided.

The PTC ancillary equipment (processor, radio equipment and hardened memory) shall be located in the secure cabinet behind the engineer's cab, adjacent to the event recorder equipment. The equipment shall be oriented and installed to facilitate removal and reinstallation, downloading/uploading of data using a laptop computer, and troubleshooting.

Antennae shall be mounted on the car for train-to-wayside communication and GPS. The antenna shall be installed in a location that maximizes communication between the train and the wayside equipment, and shall conform to the clearance requirements of Amtrak Bi-Level Clearance Drawing B-066-00050, Rev A.

The system shall be programmed with all required data in order for the cars to be fully functional on the operational territory as specified by the Customer.

PTC system design, including brake system interface and system isolation procedures, shall be evaluated during design review. **DR**

16.17 Train Communication Data System

The cab/baggage car shall be equipped with Amtrak's Train Communications Data (TCD) system as applies to cab control cars. This system provides train data communications to a central data processing center for purposes of train status monitoring, location, speed, video camera access and other operational and mechanical information.

System requirements include communication and Global Positioning System (GPS) antennae (mounted on the roof), data processor and memory module, digital video camera and recording

system, color touch screen in engineer's cab, and associated cables and hardware. These components shall be located in the secure cabinet behind the engineer's cab, except as noted.

The Contractor shall demonstrate the system's functionality and connectivity with Amtrak's TCD system through real-time tests while in service. See Chapter 19.

16.17.1 Forward-Facing Audio/Video Camera

The cab compartment shall be equipped with a forward-facing digital audio/video camera and recording system. The system shall be fully compliant with Amtrak's train communication data system.

The video camera shall be mounted behind the windshield in the assistant's area, in a location that shall not obstruct the view of the assistant. Location of the camera shall be subject to Customer approval.

The audio/video recording system components (except the camera) shall be installed in the same secure locker as the event recorder. The audio/video cable connecting the camera to the recording system shall be routed in a dedicated conduit. A separate sealable 74VDC circuit breaker shall be provided in the circuit breaker panel in the cab compartment for the recording system.

16.18 Cab Glazing and Accessories

Forward-facing windshields and side-facing drop-sash windows shall be provided in the engineer's and assistant's cab compartments. The end frame door shall be equipped with Type I glazing in the upper portion of the door panel. All glass used in the construction of cab windshields and windows shall be laminated safety glass meeting FRA 49CFR Part 223 requirements.

16.18.1 Windshields

The windshields in the engineer's and assistant's cabs shall be electrically heated and incorporate a spall shield that shall be factory laminated to the inner surface of the glass panel. Windshields shall not be tinted. Windshields shall be FRA Type I compliant in conformance with 49CFR Part 223.

16.18.2 Side Windows

The side windows on each side of each cab shall be FRA Type II compliant, tinted, and shall be a drop sash design, complete with latch. The window shall be air and water-tight when latched closed, and shall drop down to open and rise up to close and latch. The windows shall be effectively weather stripped, reinforced for rough usage and designed to eliminate rattles. The sash and sash housing shall be sealed and constructed so that all collected water drains to the outside of the car. Windows shall be easily replaceable.

The sash shall be designed to move freely in either direction (up or down). The sash design shall allow the moving portion to maintain any desired opening during normal operating conditions; it shall also permit a crew member to lean out of the window and view the station platform in either direction. The entire window unit will be removable as a single assembly. The latch shall not require the use of a key or tool to open the window, and shall not require

more than 20 lbs of force to raise and latch the sash closed.

16.18.3 Sun Shade

An adjustable roll-down, tinted, translucent sun shade shall be provided in each of the cab areas for the engineer and assistant. The shades shall be designed such that the engineer or assistant can limit sunlight coming through either windshield (but not the end frame door) while maintaining adequate forward visibility for safe train operation. The sun shade shall be adjustable over the full height of the windshields. Vibration and normal vehicle motions shall not cause the shades to change adjusted position.

16.18.4 Windshield Wipers

Electric windshield wipers shall be provided for each windshield. At least 80% of the width and 60% of the height of the total windshield area shall be swept over a complete cycle. Total sweep of the wipers shall be demonstrated to the Customer. The windshield wipers shall be functional at all vehicle speeds and all weather conditions.

The wiper drive units shall provide variable speeds of operation and shall return the wiper blades to a PARK position at extreme inward position of their sweep in the OFF position. Drive units shall be electrically operated. The wiper mechanism shall operate smoothly without hesitation throughout its cycle under all conditions. Wiper operating mechanisms and drive units shall be easily accessible for repair and replacement. The operating mechanisms shall be enclosed. The windshield wiper motor assembly (with blade attached) shall be accessible and replaceable from inside the cab.

16.18.5 Mirrors/Wind Deflectors

Retractable type wind deflectors with full-length mirrors, Prime Manufacturing SC-875-28, will be installed on both sides of the cab in front of the side windows to provide the engineer with a view towards the rear of the train. Left side mirror must be capable of allowing either the engineer or the assistant to see down the left side of the train in the mirror. Mirrors shall be capable of folding against the side of the car when not in use, and shall not lose adjustment or position while in use under all operating conditions. Mirrors must conform to Amtrak Bi-Level Clearance Drawing B-066-00050, Rev A.

16.19 Seating

Operator and assistant cab seats shall be in the cab area. The cab seat shall have perforated vinyl or cloth seat covering. The seat shall either have moveable armrests or shall swivel to allow convenient access to the seat. The seat and mounting shall meet APTA Standard SS-C&S-011-99 requirements.

The seats shall be located in such a manner as not to obstruct normal train operation or emergency egress.

Seat location, range of motion and adjustment, visibility forward and side to side, and relationship to console and controls shall be simulated electronically and demonstrated through the cab area mockup.

DR

16.20 Miscellaneous Cab Appointments

16.20.1 Trash Containers

A removable stainless steel trash container shall be provided in the cab within reach of the engineer when seated. It shall be designed to be leak-proof and easily cleaned, and shall be secured to its mounting surface to prevent rattling. The trash container shall be designed to accommodate commercially available trash container liners.

16.20.2 FRA Inspection Card and MAP Form Holders

The rear wall of the assistant's cab shall be equipped with the following inspection card and form holders:

- Multiple card holder, Power Parts p/n 17672.
- Single card holder, Power Parts p/n 17673.

16.20.3 Coat Hooks

Four spring retracted coat hooks will be provided in the cab area (two in the engineer's cab and two in the assistant's cab), high on the rear cab wall, for hanging crew coats.

16.20.4 Crew Storage Locker

A secure area shall be provided for crew belongings in the top half of the secure cabinet behind the assistant's cab. The area shall be large enough to hold a large briefcase (sample case), and an overnight bag measuring 10 in. wide by 17 in. long by 22 in. deep.

16.20.5 Track Warrant Holder

The engineer's and assistant's consoles shall each be equipped with a track warrant holder that includes a spring-loaded clip at the top to secure the operating paperwork (similar to a clip board).

16.20.6 Fusee Holder

A fusee holder shall be provided in the lower half of the secured cabinet behind the engineer's cab on the upper level of the F-end of the cab car. See Chapter 17.

16.20.7 Fire Extinguisher and First Aid Kit

A fire extinguisher, first aid kit and package of snap lights shall be provided in the lower half of the secured cabinet behind the engineer's cab on the upper level of the F-end of the cab car. See Chapter 17.

16.20.8 Arm Rest

An armrest shall be molded into the drop sash window liner in the engineer's and assistant's cabs.

16.20.9 Cup Holders

Cup holders shall be mounted on both the engineer's and assistant's side of the cab. The cup holder must be designed and built to withstand use in the railroad environment, and must accommodate a variety of beverage containers. The location and design shall be simulated on the cab mockup, and shall be submitted to the Customer for approval during design review. **DR**

16.20.10 Crew Refrigerator

A locomotive-style, railroad-grade refrigerator for crew storage of water and other provisions shall be provided in the lower half of the secure cabinet behind the assistant's cab. The refrigerator shall operate on 74VDC. Exterior dimensions of the refrigerator shall not exceed 42 in. tall by 15 in. wide. The refrigerator shall be securely mounted to the car floor. The door to the refrigerator shall open to the right (same as the secured cabinet door). Adequate air flow, in accordance with manufacturer's recommendations, shall be provided to vent the hot air discharge back into the HVAC return air.

16.20.11 Convenience Outlets

Standard receptacle convenience outlets, operating on 120VAC and 74VDC, will be located in the engineer console footrest area and the assistant's console footrest area, convenient for equipment servicing. These outlets shall have a spring cover. The 74VDC outlet shall be orange to differentiate it from the 120VAC outlet. Both outlets shall be appropriately labeled to indicate their voltage.

16.21 Cab Doors

The cab area shall be equipped with five doors, as follows:

- A structural end-frame door that closes off the end of the car between the collision posts;
- An engineer's compartment door that closes off the engineer's compartment, and opens to latch parallel to and adjacent to the end frame door;
- A compartment door that closes off the assistant's cab area, and also latches closed at the rear of the cab compartment to separate the cab from the passenger seating area; and
- Two secured locker doors, one on each of the secure equipment lockers located immediately behind the cab area on either side of the center aisle.

16.21.1 Cab End Frame Door

The end frame door shall be of robust construction consistent with leading-end operation of up to the full rated speed of the train, including headwinds. The door shall be equipped with FRA Type-I compliant glazing to provide forward visibility. The door shall be secured and sealed to be water- and air-tight against all weather conditions at all rated speeds, in either direction of travel. The door shall also be designed to resist penetration of solids, liquids and vapors as might be encountered in collisions, such as grade crossing accidents, per the requirements of 49CFR Section 238.209.

The door shall be secured in the CLOSED position with both of the following:

- A robust door latch with the following features:
 - Roller on the plunger
 - Keyed lock, operable from outside and inside the door, keyed to Amtrak standard coach key
- Three wedge-type latches operable from both inside and outside the door

A latch shall be provided to firmly hold the door in the fully open position when the cab/baggage car is in mid-train use. The door shall be hinged on the left side (assistant's side) of the door panel, and swing into the car. A threshold shall be provided at the bottom of the door opening to seal the doorway and drain water to the underside of the car.

16.21.2 Engineer's Compartment Door

The engineer's compartment door shall be of robust construction and will close against the carbody end frame door when the cab is in use, or close off the engineer's compartment when the cab is not in use. The door will be equipped with a rugged positive latch that incorporates a lock keyed to the Amtrak standard coach key. The key will operate from the aisle side of the door (the side of the door facing the aisle when the cab is closed off). The door latch will operate from inside the engineer's compartment via a release handle. The door will be equipped with a clear Lexan window (FRA Type I or II not required for this door) to permit visibility through the glazing on the end frame door.

16.21.3 Assistant's Compartment Door

The assistant's side of the cab will have a door that isolates the cab from the passenger area when the cab is in use. The door will be equipped with a rugged positive latch that incorporates a lock keyed to the Amtrak standard coach key. The key will operate from the aisle/seating area side of the door. The inside of the door will be equipped with a "panic bar" type release which will allow the crew to leave the cab quickly in an emergency. The door latch shall also have a handle on the inside to release the latch and open the door in normal use without requiring the use of the panic bar. The door will be solid (no window) and shall be equipped with a wide-angle viewing port ("peep hole") to permit the engineer to see activity in the passenger seating area.

16.21.4 Equipment Lockers behind Cab

The equipment lockers behind the cab shall have full-height doors that are secured with a standard Amtrak coach key. The doors shall be hinged on the edge toward the cab so that an open locker door will not interfere with the crew opening the cab door and leaving the cab in the event of an emergency. The door behind the engineer's cab shall be equipped with signage identifying the emergency equipment contained therein.

The cabinet door on the engineer's side shall remain locked at all times. There shall be a secure area within this cabinet where the event recorder, PTC control module, and other train data are stored. This secure storage area shall have a tamper-proof door that can be locked with a padlock and sealed with a serialized Amtrak-issued seal.

The latch on the assistant's side cabinet door shall be capable of being locked or unlocked. A handle shall be used to open this door.

16.22 Cab Interior Lights

16.22.1 Cab Ceiling Lights

Each side of the cab interior shall be equipped with a flush-mounted dust-proof ceiling light. The ceiling lights shall be powered by the 74VDC power supply. The ceiling lights shall provide adequate lighting for the safe and efficient operation of the cab equipment under low-light conditions.

The cab console shall be illuminated for daytime and nighttime operation without causing any reflections or glare on the windshield. The fixtures shall be suitably placed in the ceiling to illuminate the engineer's console and the general cab area. The illumination intensity measured on the engineer's controls shall be 20 foot-candles and 15 foot-candles at the floor. Lighting shall meet the requirements of Chapter 11, in both cab and pass-through configurations.

The cab ceiling light at the engineer seat shall be controlled from a two-position (ON/OFF) switch on the engineer's console and likewise for the assistant on his console. A separately controlled, dimmable reading light for lighting the console shall be provided each for the engineer and assistant.

The operative complete cab lighting arrangement shall be included and reviewed in the cab mockup.

DR

16.22.2 Reading Lights

The Engineer's and assistant's consoles shall each be equipped with a white reading light. In addition, the engineer's console will have a red reading light. Light shall be directed over the minimal area necessary to clearly read operating instructions at night, but shall be designed and oriented to provide the Engineer and assistant with adequate light levels for reading of track warrants and other operating papers. A dimmer switch shall be provided for the white reading light for each location. All reading lights shall include a gimbal mount to permit swiveling.

16.22.3 Gauge Lights

Instrument and gauge lights shall identify all controls and their functions during night operation without additional cab lighting being on. Gauge lights shall be replaceable from within the cab without requiring the removal of the instrument from the panel.

16.23 Exterior Operating Lights

16.23.1 Headlights

Two headlights, 200W, PAR56, 30VDC, shall be provided on the F-end, in a twin-beam fixture. Each headlight shall be 200,000 candela minimum, with performance measured to demonstrate compliance with FRA 49CFR Section 229.125. Geometry of the headlight/crossing light installation and headlight/crossing light illumination pattern shall be subject to Customer and FRA review. Headlight fixtures shall be installed so that the arrow on headlight bulbs always points up. Replacement of headlight bulbs shall be possible without requiring the use of tools. Lenses shall be held in a hinged frame that is secured with a knurled hand-tightened knob.

16.23.2 Crossing Lights

Two crossing lights shall be mounted on the F-end in conformance with the requirements of FRA 49CFR Section 229.125. Each crossing light shall be 200,000 candela minimum. Two lamps, 350 W, PAR56, 75VDC, will be provided on the F-end. Crossing lights shall flash alternately in response to the horn being blown, as controlled by the event recorder system, and shall continue to flash for 30 seconds after the horn is blown. Crossing light fixtures shall be installed so that the arrow on crossing light bulbs always points up.

16.23.3 Marker Lights

Two red incandescent marker lamps shall be provided on the F-end, on either side of the diaphragm and below the cab windshields. See Chapter 11 for details.

16.23.4 Car Number Board

Lighted signs shall be provided on the F-end of the car to display the car's road number. Number boards shall be illuminated by white LEDs. Numerals shall be a minimum of 4 in. tall, Helvetica, white numerals on a black background. Car number shall be specified by the Customer (see Chapter 23).

The number boards and housing shall be watertight and shall provide access to the LEDs for replacement.

16.24 Air Horn and Bell

The F-end of the cab car shall be equipped with an Amtrak standard 5-chime horn and an air-actuated warning bell, configured to operate as described below. The horn and bell will be located at the F-end of the car. The horn will be in an alcove directly above the F-end coupler so sound emanates toward the front. The bell will be under the F-end underframe, located

rearward as much as possible to prevent damage from road debris and grade crossing accidents.

16.24.1 Air Horn

The horn will be an Amtrak standard five-chime Nathan K5LA air horn, with all flutes facing forward.

The horn will have two controls for actuation:

1. A push button that allows two-level horn control to modulate the sound as required. Pressing the button half way will produce reduced horn volume, while pressing the button all the way will produce full horn volume. The assistant engineer shall also have a horn control push-button.
2. A foot pedal to activate repeating cycles of preprogrammed horn blasts for approaching public crossings at grade, per the horn use requirements of 49CFR Section 222.21. Total duration of the sequence shall be 15 to 20 seconds. The automatic horn sequences shall consist of two long blasts followed by one short blast and a third long blast. The horn shall sound this sequence once, and then stop. Pressing the pedal or console-mounted horn push button during the sequence shall terminate the sequence. The pedal function shall be inoperative below 5 mph.

When the horn is actuated at full volume, the bell shall also sound and continue to sound for 30 seconds or until reset with the bell button.

The horn sound level at full volume shall be 96 dBa, minimum, at a distance of 100 ft forward of the cab and meet FRA requirement 49CFR Section 229.129. The Contractor shall demonstrate through testing that the horn sound distribution meets these requirements.

Control valves and supply piping shall be sized to handle the required air flow, and an accessible cutout cock shall also be provided as close to the horn as possible. The horn shall also be quick-acting so that there is no delay in the build-up to full volume when activated.

16.24.2 Bell

A 12 in. pneumatic bell with ringer shall be located under the end underframe at the F-end of the cab car. It shall be shock-mount isolated from the carbody and shall be equipped with its own cutout cock. The bell shall be located back from the end sheet of the car as practical to avoid damage from road debris and grade crossing accidents.

16.25 Other Exterior Equipment

16.25.1 Pilot

The F-end of the cab/baggage car shall be equipped with a plow pilot to deflect snow and debris, and to prevent objects from being rolled under the car. The pilot shall meet the requirements of 49CFR Section 229.123 and Amtrak Bi-Level Clearance Drawing B-066-00050, Rev A.

The pilot shall be designed and manufactured in accordance with Amtrak Drawing D 034-00014. The pilot shall be constructed of low alloy, high tensile steel properly coated for corrosion resistance and painted to match the end sheet of the car.

The pilot shall not interfere with, or affect the condition or performance of, the coupler, draft gear, uncoupling lever, air hoses, electrical cables and receptacles or undercar equipment, and shall not create a safety hazard for crews working between or under cars.

The pilot shall be installed on the end sheet of the F-end of the cab/baggage car so that the clearance above top of rail shall be 6 in. maximum and 3 in. minimum with all new parts on car at load value AW0. Clearance shall be adjustable.

The pilot shall be attached to the carbody by mechanical fasteners. The connection between the pilot and the carbody end sheet shall be designed and constructed to facilitate installation and removal and to permit interchangeability among cars. The portions of the carbody to which the pilot is attached shall be substantially stronger than the pilot, so that if the pilot is overloaded from impact, damage to the portions of the car to which it is attached will be minimized. Longitudinal struts shall be provided to carry the longitudinal loads from the pilot into the carbody, and their inboard ends shall be attached to the bottom of the draft sill.

16.25.2 Blue Flag Holder

A holder for a blue flag shall be provided on the car exterior adjacent to the engineer's side window. It shall be capable of holding a standard Amtrak blue flag, and shall be mounted in a location so that a seated engineer will be able to see the blue flag from the cab, and maintenance crews will be able to see the blue flag from any location along the engineer's side of the train. The blue flag and holder shall not interfere with the operation of the drop sash window or mirror.

16.25.3 Conspicuity Decals

The F-end of the cab car shall be affixed with retro-reflective conspicuity decals to increase visibility of the car while at night. Colors and design of the conspicuity graphics shall be consistent with the graphics on the car exterior, and shall be submitted to the Customer for approval.

16.26 Environmental and Ergonomics

16.26.1 Cab Interior Sound Levels

The cab shall be well insulated and employ additional sound absorbing techniques to obtain the lowest practical sound levels.

Under normal operating conditions, the cab noise level shall be in compliance with the interior sound level requirements of 49CFR Section 229.121.

When the train is stationary, with doors and windows closed and the climate control system operating normally, the noise level in the cab shall not exceed 75 dBa.

Sound levels in the cab shall not exceed 85 dBa under normal operating conditions when the horn (at maximum volume) and bell are being used simultaneously.

Normal operating conditions shall be defined as operation at all speeds up to top-rated speed, with the cab/baggage car in leading position, doors and windows closed, and all motorized cab equipment is operating (wipers, defroster, etc.).

Unless otherwise noted, cab interior sound levels shall be tested at the location of the seated engineer's head (ear level for 95th percentile male and 5th percentile female).

All equipment installed in the cab shall be designed to reduce or eliminate rattling, vibration and noise transmission, especially that of the horn. The operating cab shall incorporate sound and vibration engineering techniques, proper dampening and/or gaskets, to prevent rattling and vibrational noise.

The contractor shall use the appropriate construction materials for attenuation and abatement of noise emissions. Insulating materials or coatings shall meet all Federal requirements for smoke and toxicity. Confined materials shall be non-hygroscopic and of a type which does not settle or gradually lose noise attenuation properties over the service life of the car.

16.26.2 Heating, Ventilation and Air Conditioning

16.26.2.1 Climate Control

The cab shall be provided with a quiet, forced-air supply from the car's main HVAC system. Full climate control with air supply through individual fully adjustable diffusers for each of the seat locations shall be provided. Care shall be taken to avoid drafts blowing directly onto seated crewmembers. The arrangement of this system shall be part of the cab mock-up review. See Chapter 10. **DR**

The cab will be equipped to provide a comfortable cab climate regardless of ambient conditions, train operations, or the number of cab occupants.

Cab climate control equipment shall include:

- Conditioned air from car's main HVAC system;
- Local overhead heater and thermostat; and
- Forced-air defroster for each windshield.

16.26.2.2 Performance

In addition to meeting 49CFR Section 229.119, cab temperature requirements, the HVAC system shall:

- Supply a minimum of 100 cfm conditioned air, equally distributed to both sides of cab;
- Maintain the relative humidity inside the cab at a level not greater than 50% at design load and not greater than 55% at loads less than design, when HVAC system is operating normally;
- Maintain a cab temperature of 76°F or less at all ambient outside temperatures up to and including 120°F;
- Maintain a cab temperature of no less than 70°F at -30°F ambient outside temperature, by using local overhead heat only;

- Maintain air duct and heater grill temperature of 140°F or less under all conditions; and
- Maintain a temperature gradient throughout the cab that is no greater than 5°F, except within 6 in. of the floor.

16.26.2.3 Controls

The local overhead heat shall be controlled independently of the HVAC unit with crew-adjusted thermostat control.

16.26.2.4 Air distribution

The cab shall have durable individually adjustable diffusers with manual direction and volume, infinite adjustment between maximum and minimum air volume and direction, for each seat location. The diffusers shall not create drafts on the cab occupants.

16.26.3 Crew Safety

The cab area shall be free from sharp edges and corners, pinch points and safety hazards. The cab design shall conform to all applicable FRA, OSHA and APTA standards regarding safety, signage, emergency equipment, occupational and environmental conditions and comfort.

16.27 Cab Arrangement Mockup

A cab area interior mock-up shall be provided by the Contractor at its facility for Customer's review and approval. This mockup shall be constructed at the Continuing Design Review phase of the design review process, so that input from the mockup evaluation may be incorporated into the design prior to final design review. See Chapter 3. **DR**

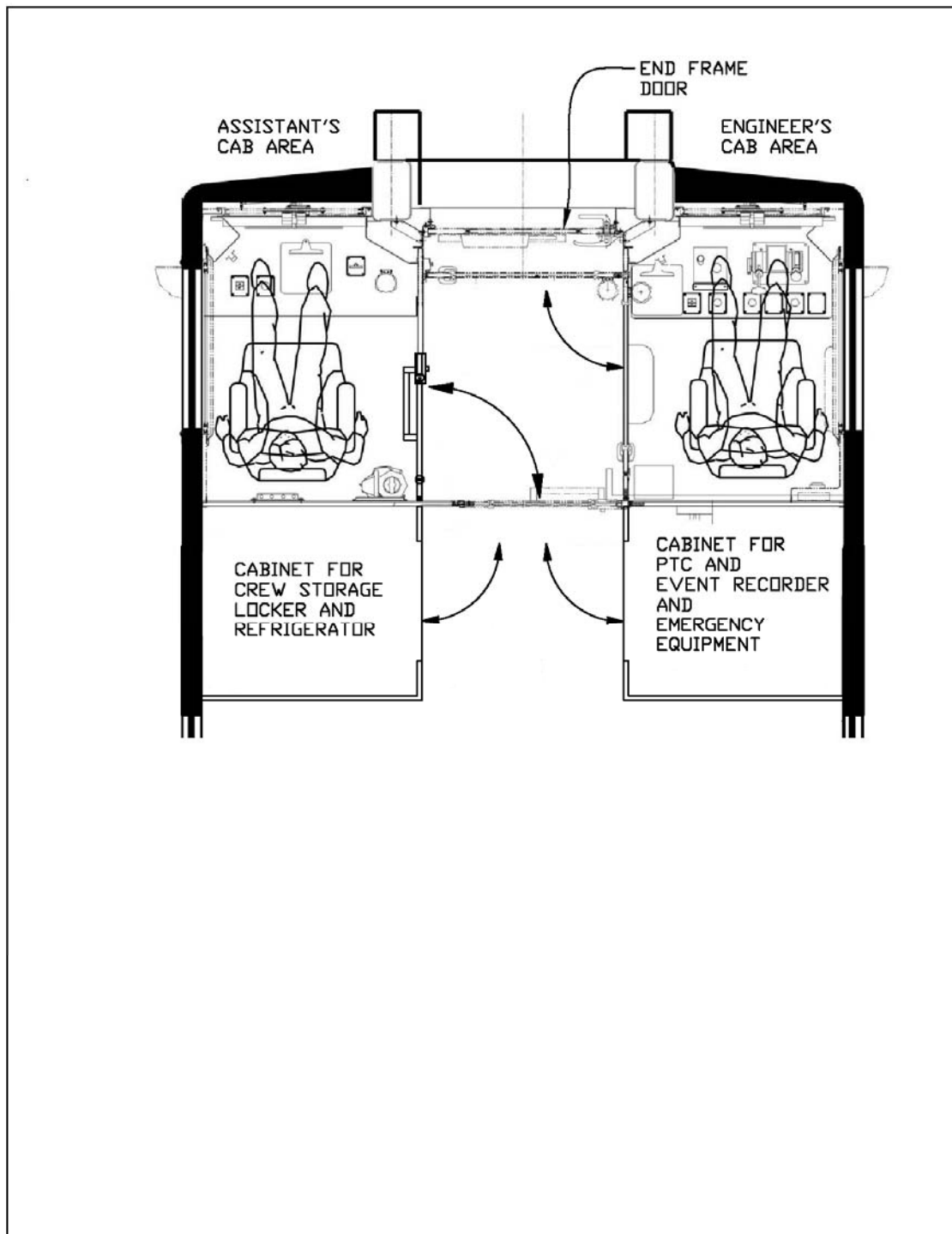


Figure 16-1: Cab Arrangement

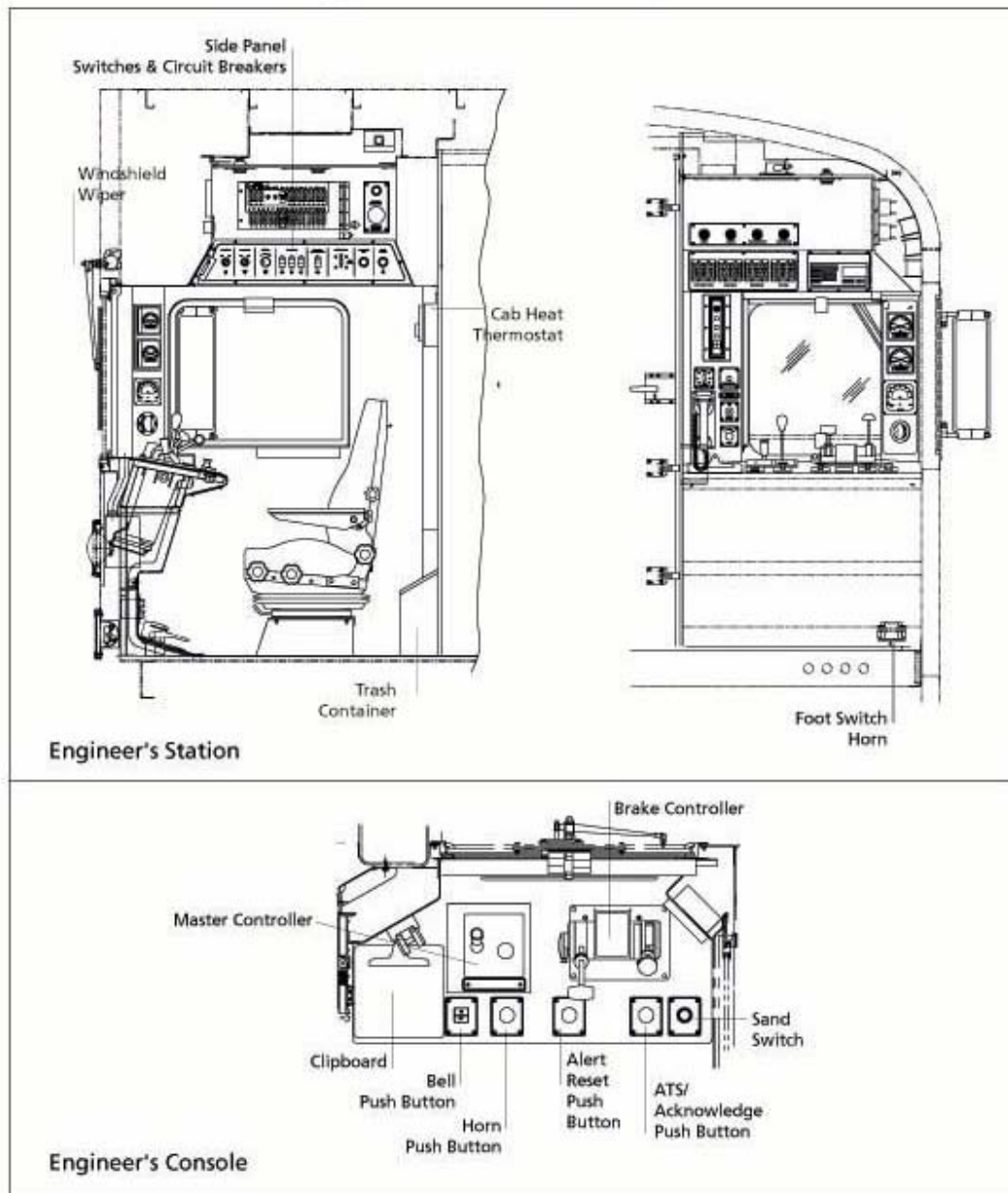


Figure 16-2: Engineer's Cab Compartment Concept

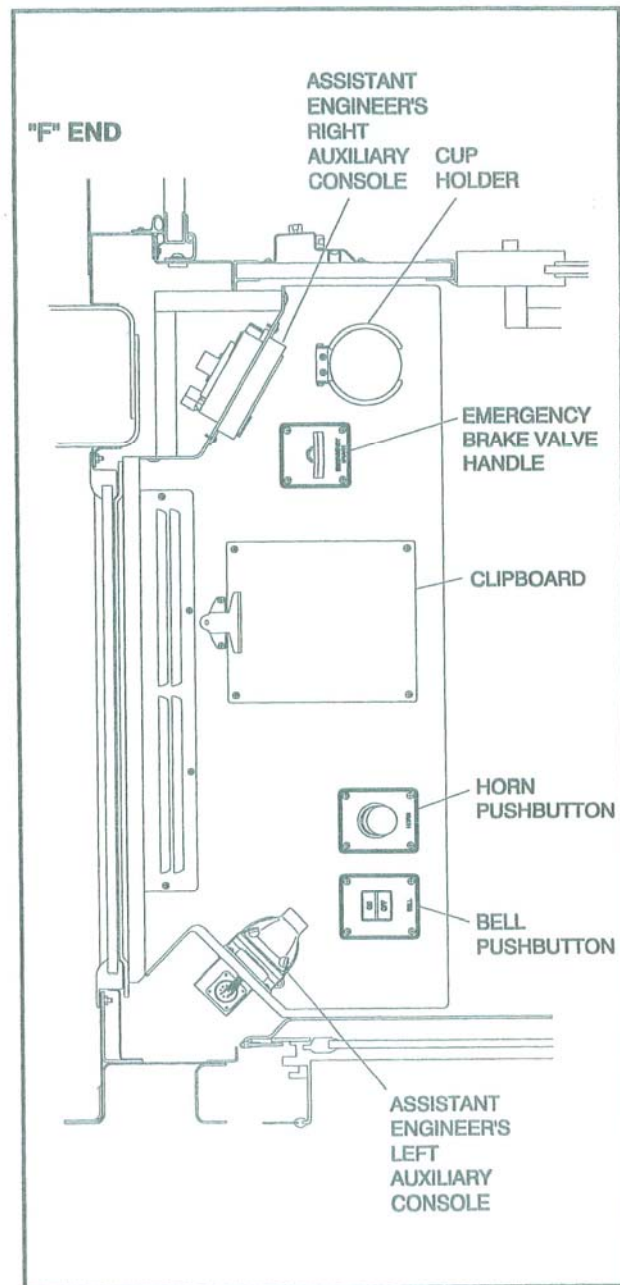


Figure 16-3: Assistant's Cab Compartment Concept

Table 16-1: Controls and Switches (other than throttle, reverser and brake)

Location	Switch Function	Switch Type/color
Desktop	Alerter Reset	Yellow, mushroom- style push button (Cutler-Hammer 10250ED1309-4)
	Horn	Blue, mushroom-style push button, 3 position (Off, Low, High) (Cutler-Hammer 10250ED1309-5)
	Bell Control	Yellow, square, two button, push button (On, Off buttons) (Cutler-Hammer E30CED6)
	Sand	Blue collar type push button (Cutler-Hammer 10250ED1309-2)
Floor (foot space)	Horn Automatic Sequence	Pedal (yellow) (Square-D AW-13)
Left Auxiliary Console	Headlight Selector	4-position rotary (Electro Switch Corp 101405A-S)
	Cab Reading Light Dimmer	Rotary dimmer switch with off detent
	Windshield Wiper	Rotary switch with variable speed
Right Side Overhead Console	Defogger	Rotary (On/Off) (Cutler-Hammer 10250ED1309-6)
	Defroster	Rotary (On/Off) (Cutler-Hammer 10250ED1309-9)
	Console Light Dimmer	Rotary Switch (Angstrohm Precision 5ES443.1)
	Cab Ceiling Light	Rocker Switch (NKK SW3821D/328)
	White Reading Light	Rocker (NKK SW3821D/328)
	Red Reading Light	Rocker (NKK SW3821D/328)
	Intercar End Door Light	Rocker (NKK SW3821D/328)
	Locomotive alarm Silence	Red Collar type Push button (Cutler-Hammer 10250ED1309-8)
	TL GRD/EAB Loco Fault Reset	Black Collar type Push button (Cutler-Hammer 10250T23B)
	Emergency Locomotive Shutdown	Push button, Red jumbo mushroom type. Two position – push to activate, pull to reset (Cutler-Hammer 10250ED1309-7)

* End of Chapter 16 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 17 **Emergency Equipment**

Table of Contents

17.0	Emergency Equipment.....	17-2
17.1	Overview	17-2
17.2	General Requirements.....	17-2
17.3	Emergency Equipment Lockers	17-2
17.3.1	Emergency Tools	17-2
17.3.2	Fire Extinguisher.....	17-3
17.3.3	First Aid Kit.....	17-3
17.3.4	Snap Lights	17-3
17.4	Automatic Electronic Defibrillator (AED).....	17-3
17.5	Seat-Back Safety Information Card	17-3

17.0 Emergency Equipment

17.1 Overview

The upper and lower level of each rail car shall be equipped with emergency equipment per the requirements of 49CFR Section 239.101. Emergency equipment provided shall include fire extinguishers, pry bars, sledge hammers, first aid kits, chemiluminescent snap lights and seat-back passenger safety information cards. Additionally, a storage container for an Automatic External Defibrillator (AED) shall be provided in the lower level galley of the café/lounge car, per Amtrak AED standards.

17.2 General Requirements

Emergency equipment as provided shall meet all applicable regulations, standards and specifications. Equipment provided shall be located and installed in a manner that facilitates identification and access of the emergency equipment when needed by passengers and crewmembers without the use of keys or tools, unless otherwise specified. Emergency equipment shall be located as to be available to passengers in the range from the 5th percentile female to the 95th percentile male, and in accordance with applicable ADA regulations. All emergency equipment shall be new and shall be qualified for use for a minimum of one year after delivery of the car. Each car shall be shipped with a full complement of emergency equipment unless otherwise specified by Customer.

17.3 Emergency Equipment Lockers

An emergency equipment locker shall be provided on each level of each car; in the lower-level B-end vestibule and at the upper-level B-end passageway. The location of each locker shall be in compliance with all applicable ADA requirements. The design and layout of the emergency equipment locker shall be in accordance with Amtrak Drawing E-140-2959. Each emergency equipment locker shall be recessed into the wall and shall have a clear Lexan front panel. The panel shall be hinged with a stainless steel piano hinge and secured with a paddle latch. The paddle latch shall have a tamper-seal hasp. The Lexan panel shall be mounted in an equipment locker door equipped with a pencil-lock release so crewmembers can access the emergency equipment without breaking the seal.

Each locker shall be marked with emergency equipment signage that is compliant with federal emergency signage standards and compatible with Amtrak standard signage per Amtrak Specification 697 for the safety equipment contained therein.

At a minimum, each emergency equipment locker shall be designed to include emergency tools, a fire extinguisher, a first aid kit and snap lights. The equipment shall be securely attached to the interior of the locker and shall not be loose within the locker, but shall be easily removed in the event of an emergency.

17.3.1 Emergency Tools

Each emergency equipment locker shall include the following emergency tools:

- A 6 lb sledge hammer with an 18 in. ash handle
- An 18 in. pry bar

The tools shall be installed in a manner that will prevent vibration and rattling and be readily available for emergency use.

17.3.2 Fire Extinguisher

The extinguisher shall be securely mounted in a manner that will prevent vibration and rattling and allow their prompt removal in case of fire. The installation shall conform to the requirements of NFPA Specification No. 10. The fire extinguisher shall be clearly marked with instructions in accordance with NFPA Specification No. 10.

A dry-chemical, 10-pound fire extinguisher, UL rated 2A-40 type B/C shall be included in the emergency equipment locker on both levels of each car.

A fire extinguisher, identical to those specified above, shall also be mounted in the emergency equipment locker behind the cab area of the cab/baggage car. See Chapter 16.

A dry-chemical, 2.5 lb fire extinguisher, UL rated 1A-10 type B/C shall be included in each galley area of the café/lounge car. See Chapter 14.

Fire extinguishers shall have all required certifications prior to shipment of the car.

17.3.3 First Aid Kit

A first aid kit, compliant with the requirements of 49CFR Section 239.101, Pac-Kit p/n 6311AMT, shall be included in each emergency equipment locker.

First aid kits, identical to those specified above, shall be located in the emergency equipment locker behind the cab area of the cab/baggage car (see Chapter 16), and in the upper galley area of the café/lounge car (see Chapter 14).

17.3.4 Snap Lights

Each emergency equipment locker shall include one package (quantity 10) of 6 in. yellow 12-hour chemiluminescent snap-lights, Cyalume p/n 9-01360. Snap lights shall also be provided in the upper level galley of the café/lounge car.

17.4 Automatic Electronic Defibrillator (AED)

A storage container for a Customer-provided Automatic Electronic Defibrillator (AED) shall be provided in a location accessible to crewmembers in the lower level service galley of the café/lounge car, in accordance with Amtrak AED installation specification. The container shall be a minimum of 9 in. wide by 20.5 in. deep, and shall provide no less than 19 in. of vertical storage clearance. If the AED is to be lifted vertically out of the holder, a minimum clearance of 24 in. must be provided above the top of the holder. The container shall securely retain the AED under all regulated accelerations. Appropriate signage shall identify the location of the AED unit. Details of location and installation of the defibrillator shall be submitted for Customer review and approval (see Chapter 14).

17.5 Seat-Back Safety Information Card

The Contractor shall develop the artwork for a seat-back safety information card illustrating the type, location and use of all safety features, emergency equipment, emergency signage and emergency exit pathways for each car type. This safety card shall be designed in the format of Amtrak's "Passenger Safety Instructions" and shall include a clear Braille overlay. Artwork is to be provided for Customer review and approval.

Electronic artwork, suitable for printing, shall be provided to the Customer prior to the delivery of the first vehicle.

CDRL

The Contractor shall be responsible for the printing and delivery of the first 5000 copies of the seat-back safety card prior to the delivery of the first vehicle. Seat-back safety cards shall be shipped to a location to be determined by Customer.

CDRL

* End of Chapter 17 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 18

Materials and Workmanship

Table of Contents

18.0	Materials and Workmanship	18-6
18.1	Overview	18-6
18.2	General Requirements.....	18-6
18.2.1	Applicability	18-6
18.2.2	Marking and Storage	18-6
18.2.3	Prohibited Materials	18-7
18.2.4	Material Reporting Requirements	18-7
18.3	Joining and Fastening.....	18-7
18.3.1	Joint Fitting	18-8
18.3.2	Metal-to-Metal Connections.....	18-8
18.3.3	Wood-to-Metal Connections.....	18-8
18.3.4	Wood-to-Wood Connections.....	18-8
18.4	Fasteners	18-8
18.4.1	Threaded Fasteners	18-9
18.4.2	Metric Fasteners.....	18-9
18.4.3	Structural Fasteners	18-10
18.4.4	Decorative and Appearance Fasteners	18-10
18.4.5	Torquing.....	18-11
18.4.6	Washers and Lock Washers.....	18-11
18.4.7	Rivets and Lock Pins	18-11
18.4.8	Plating of Fasteners	18-12
18.4.9	Rivet and Bolt Holes	18-12
18.5	Stainless Steel.....	18-12
18.5.1	Chemical Composition.....	18-12
18.5.2	Mill Reports.....	18-12
18.5.3	Design Stresses	18-13
18.5.4	Testing	18-13
18.5.5	Flatness Tolerance.....	18-13
18.5.6	Finishing Methods.....	18-13
18.6	Low-Alloy High-Tensile Steel	18-13
18.6.1	Design Stress	18-14
18.7	Steel Castings	18-14
18.7.1	Heat Treating	18-14
18.7.2	Castings	18-14
18.7.3	Couplers and Drawbars.....	18-15
18.7.4	Axles	18-15
18.7.5	Wheels	18-15
18.8	Aluminum.....	18-15
18.8.1	Fabrication and Fastening.....	18-16

18.8.2	Gauge.....	18-16
18.9	Elastomers.....	18-16
18.9.1	Tests	18-17
18.9.2	Life Expectancy	18-18
18.9.3	Metal Parts	18-18
18.9.4	Bonding.....	18-18
18.9.5	Truck Parts	18-18
18.9.6	Glazing Strips.....	18-18
18.10	Glazing Materials	18-18
18.10.1	Flatness	18-19
18.10.2	Dimensional Tolerance	18-19
18.10.3	Overlap Tolerance.....	18-20
18.10.4	Color	18-20
18.10.5	Haze	18-20
18.10.6	Specks and Scratches.....	18-20
18.10.7	Bond Separation.....	18-20
18.10.8	Marking.....	18-20
18.10.9	Shipping.....	18-21
18.11	Rubber Floor Covering	18-21
18.11.1	Thin Skinned Blister.....	18-21
18.11.2	Thick Skinned Blister	18-21
18.11.3	Lumps.....	18-22
18.11.4	Holes	18-22
18.11.5	Thin Area	18-22
18.11.6	Color and Marbling Distribution	18-22
18.12	Lumber and Paneling	18-22
18.12.1	Lumber	18-22
18.12.2	Plymetal	18-23
18.12.3	Plywood	18-23
18.12.4	Honeycomb Panels	18-23
18.12.5	Melamine-Faced Aluminum	18-24
18.12.6	Melamine Panels	18-24
18.12.7	Phenolic Composite Floor Panels	18-24
18.13	Seat Cushion and Fabric.....	18-26
18.13.1	Cushion Material.....	18-26
18.13.2	Seat Fabric	18-26
18.14	Carpet and Wainscot.....	18-26
18.14.1	Carpet	18-26
18.14.2	Wainscot Fabric.....	18-27
18.14.3	Counter Surfaces.....	18-27
18.14.4	Decorative Countertops	18-27
18.14.5	Stainless Steel Countertops	18-27
18.15	Welding and Brazing	18-27

18.15.1 Responsibility	18-27
18.15.2 Test Welds	18-28
18.15.3 Cleaning	18-28
18.15.4 Support	18-29
18.15.5 Welding Rod	18-29
18.15.6 Control	18-29
18.15.7 Penetration	18-29
18.15.8 Warpage	18-29
18.15.9 Intermittent Weld Spacing	18-29
18.15.10 Fusion Welding	18-30
18.15.11 Resistance Welding	18-30
18.15.12 Special Welding	18-30
18.15.13 Toughness of Welded Assemblies	18-31
18.15.14 Torch Brazing	18-31
18.15.15 Torch Soldering	18-31
18.16 Exterior Marking Films and Graphics	18-31
18.16.1 Physical Properties	18-32
18.17 Paints and Coatings	18-32
18.17.1 Materials and General Requirements	18-32
18.17.2 Paint Process Documentation	18-32
18.17.3 Painting Restrictions	18-33
18.18 Insulation	18-34
18.18.1 Acoustical Insulation	18-34
18.18.2 Thermal Insulation	18-34
18.19 Flammability and Smoke Emissions	18-35
18.19.1 Electrical Fire Safety	18-36
18.19.2 Combustible Content	18-36
18.19.3 Toxicity	18-36
18.20 Piping	18-37
18.20.1 Air Brake Piping and Fittings	18-37
18.20.2 Air Conditioning and Refrigeration System Piping and Fittings	18-38
18.20.3 Soldering of Piping and Fittings	18-38
18.20.4 Water Piping and Fittings	18-38
18.20.5 Sewage Piping and Fittings	18-39
18.21 Fiberglass-Reinforced Plastic	18-39
18.21.1 Resin	18-40
18.21.2 Reinforcement	18-40
18.21.3 Gel Coat	18-40
18.21.4 Additives	18-40
18.21.5 Strength Requirements	18-40
18.22 Thermoplastic Sheet	18-41
18.22.1 Quality	18-41
18.22.2 Strength Requirements	18-41

18.23	Air Filters.....	18-41
18.23.1	HVAC and Equipment Ventilation Filters.....	18-41
18.23.2	High Pressure Air Filters	18-42
18.24	Wire and Cable	18-42
18.24.1	Wiring - General.....	18-43
18.24.2	Data Communications Wiring.....	18-43
18.24.3	Wire Handling	18-44
18.24.4	Wire Harness.....	18-45
18.24.5	Circuit Separation	18-45
18.24.6	Wire and Cable Runs.....	18-46
18.24.7	Undercar	18-48
18.24.8	Exterior of Roof	18-48
18.24.9	Under Floor	18-48
18.24.10	Interior.....	18-49
18.24.11	Cable Cleating and Support.....	18-49
18.24.12	Wire Securement and Termination	18-49
18.24.13	Marking.....	18-51
18.24.14	Cable and Wire Identification.....	18-51
18.24.15	Pulling Compound.....	18-52
18.24.16	Solder.....	18-52
18.24.17	Tape	18-52
18.25	Wire and Cable Connections	18-53
18.25.1	Terminal Boards and Terminal Points.....	18-53
18.25.2	Wire Terminations	18-54
18.25.3	Power Cable Terminations	18-55
18.25.4	Cable Connectors	18-55
18.25.5	Quick-Disconnect Terminals	18-56
18.25.6	Grounding/ Bonding Connections	18-56
18.25.7	Wire Splicing	18-56
18.26	Conduit.....	18-56
18.26.1	Types	18-56
18.26.2	Size and Fill	18-57
18.26.3	Installation.....	18-57
18.26.4	Conduit Fittings and Junction Boxes.....	18-57
18.27	Electrical and Electronic Designs	18-58
18.27.1	Reliability Standards	18-58
18.27.2	Ability to Repair.....	18-59
18.27.3	Hardware	18-59
18.27.4	Wiring	18-59
18.27.5	Optical Fibers.....	18-59
18.28	Electrical Devices and Hardware	18-59
18.28.1	Contactors and Relays.....	18-59
18.28.2	Switches.....	18-60

Table of Contents**18-5**

18.28.3	Circuit Breakers	18-61
18.28.4	Fuses	18-62
18.28.5	Bus Bars	18-62
18.28.6	Capacitors and Resistors	18-62
18.28.7	Transformers and Inductors	18-63
18.28.8	Switch, Circuit Breaker and Fuse Panels	18-63
18.28.9	Battery Backup Circuits	18-64
18.29	Semiconductor Standards	18-64
18.29.1	Rating	18-64
18.29.2	Availability and JEDEC Registration	18-65
18.29.3	Burn-in	18-65
18.30	Printed Circuit Board Standards	18-66
18.30.1	Marking.....	18-66
18.30.2	Component Mounting.....	18-67
18.30.3	IC and Device Sockets	18-67
18.30.4	Conformal Coating	18-67
18.30.5	Keying	18-67
18.30.6	Circuit Board Connectors	18-67
18.30.7	Testing	18-68
18.30.8	Plated-Through Holes	18-68
18.30.9	Extenders	18-69
18.31	Microprocessor-Based Systems	18-69
18.31.1	Software	18-69
18.31.2	Isolation and Interfacing.....	18-70
18.31.3	Software Documentation	18-70
18.32	Auxiliary AC Motors	18-71
18.33	Recyclable Materials.....	18-71

18.0 Materials and Workmanship

18.1 Overview

This chapter defines the requirements for materials and workmanship that shall apply to the design and manufacture of systems and subsystems for assembly into the Customer's passenger vehicles. This chapter shall apply to all phases of the project. It shall be the responsibility of the Contractor to inform his suppliers of the requirements of this section as well as enforce them.

18.2 General Requirements

18.2.1 Applicability

This section defines the requirements for all material and workmanship which shall apply to the design and manufacture of the vehicles, and all systems, subsystems and components contained therein, that are to be built to this specification. All materials and methods of assembly shall be in conformance with the applicable requirements of this section, and all applicable standards, specifications and references. Those references, standards and specifications listed constitute a partial listing; the Contractor shall be responsible for identifying and complying with all applicable regulations, industry standards and material specifications whether listed herein or not. The revision of these references that are current at time of issuance of Notice To Proceed (NTP) shall apply.

18.2.2 Marking and Storage

All materials intended for use on these vehicles shall be marked or stored so as to be readily identifiable, and shall be adequately protected during handling and storage.

All stored material subject to corrosion shall be protected by waterproof covers, coatings or packaging.

Equipment covers, cable entrances and openings shall be closed to prevent ingress of water or dirt.

All dated material shall have the expiration date clearly marked. Expired material or material expiring within one year of car acceptance shall not be used.

Material or components, which require maintenance during storage, shall be properly maintained per the component(s) manufacturer's instructions. The Contractor shall document such maintenance, and provide these records as requested by Customer.

Rejected material shall be clearly marked and stored in an area specifically designated for that purpose.

18.2.3 Prohibited Materials

The following materials shall not be used in the construction of the vehicle:

- Polyvinyl Chloride (PVC)
- Asbestos
- Lead in brake shoes
- Un-encapsulated urethane foam
- Chlorinated Fluorocarbons (CFCs) that may cause environmental degradation or handling hazards
- Materials that, in their normal installed state, emit products that are known to be toxic or irritants

18.2.4 Material Reporting Requirements

Whenever a commercial material is not covered by a specification or standard, the Contractor shall identify the material by the commercial trademark, name and address of the Supplier. The Contractor shall submit a description and the technical data specifications of the material composition for approval at the design review.

The Contractor shall keep on file a Material Safety Data Sheet (MSDS) for all chemical materials (paints, solvents, adhesives, etc.) used in the manufacture, maintenance, operation or repair of the vehicles, and shall provide a copy of each MSDS in the appropriate maintenance manual.

The Contractor shall keep a running list of all materials used in the vehicle. The Contractor shall submit this list along with material certifications and material property test reports to the Customer as part of the material certification test requirements. See Chapter 19.

The Contractor shall maintain records that trace all materials to their manufacturers and production specifications and methodologies.

18.3 Joining and Fastening

Certain combinations of materials require particular care in joining to avoid the possibility of corrosion. Isolating and moisture-proofing materials, appropriate to the materials being joined, shall be used at all times where these combinations exist.

The Contractor shall submit joining and fastening data, specifications and standards for all types and methods of fastening and joining used to the Customer for review and approval at the design review.

The Contractor shall submit to the Customer a dissimilar metals report, identifying all locations where dissimilar metals or metals and wood are joined, and describing the methods used for mitigating galvanic or chemical corrosion at those locations. These methods shall be subject to review and approval by the Customer.

18.3.1 Joint Fitting

Joints shall be properly fitted, whether exposed or concealed. When not otherwise specified in drawings or specifications, gaps between joints shall be held to a dimension not greater than 10% of the thinner material being joined, or 0.002 in., whichever is greater. Gaps shall be uniform in width. The edges of panels shall have a smooth, finished appearance.

Where excessive gaps (greater than those permitted by approved drawings or standards) are found to exist at the facing surfaces of structural bolted or riveted connections, metal shims of the same material as that of the deficient part may be used, but only with the written permission of the Customer. Shims, if used, shall be permanently fastened to one of the base parts being joined. The use of epoxy or other plastic filler at such locations is prohibited.

18.3.2 Metal-to-Metal Connections

Where metals contact each other, the contact surfaces shall be free of dirt, grease, rust and scale. Unless specified otherwise, the contact surfaces shall be coated with a metal-based primer that conforms to GSA Federal Standard TT-P-664D. Metal primer may be omitted for like-stainless steel to like-stainless steel joints.

18.3.3 Wood-to-Metal Connections

Where wood and ferrous metal surfaces are placed together, the wood shall be coated with aluminum paint conforming to GSA Federal Standard TT-P-38E, and the metal shall be coated with a primer that conforms to GSA Federal Standard TT-P-664D.

All bolts or rods passing through wood shall be coated with aluminum paint conforming to GSA Federal Standard TT-P-38E.

18.3.4 Wood-to-Wood Connections

Where wood and wood are placed together, both abutting surfaces shall be coated with aluminum paint conforming to GSA Federal Standard TT-P-38E.

18.4 Fasteners

The Contractor and all suppliers are responsible for selecting fastener types, sizes, styles, lengths, materials, grades and finishes that will meet the requirements of this Specification. The Contractor shall minimize the number of different sizes and styles of fasteners used. Whenever a maintenance process requires the removal or application of a fastener, consideration shall be given to the ease of access to such fasteners.

Fasteners used throughout the vehicle shall be inch standard fasteners, except as provided otherwise. All fasteners used on the vehicle shall be specified under one of three categories: electrical and electronic; structural and safety-related; or decorative.

Safety-related fasteners include, but are not limited to, those applied to trucks, bolsters, brake equipment attachment, couplers and attachment of interior components or other fasteners as identified by the Customer. A fastener is safety related if a single fastener failure will create an unsafe condition.

Self-tapping screws and structural Velcro shall not be used without written Customer approval.

18.4.1 Threaded Fasteners

All inch-standard threaded fasteners shall conform to ANSI Standard B1.1 or Industrial Fasteners Institute 1970 Fastener Standards.

Prevailing-torque type locknuts shall be nylon insert type, ESNA or approved equivalent, conforming to IFI Fastener Standards or Military Standard MS-21044. Distorted thread locknuts shall only be used where there is insufficient clearance to install ESNA type locknuts, or where the locknut may be exposed to temperatures above 200°F.

When making connections to heat producing apparatus, thermal expansion of the components shall be taken into consideration for selection of fastener materials. If the joined components are high expansion alloys such as copper or austenitic stainless steel, austenitic stainless steel fasteners shall be used. If the joined components are low expansion materials such as carbon steel or ferritic stainless steel, zinc plated carbon steel fasteners of minimum Grade 5 shall be used.

All screws or bolts used to secure access panels to the interior, undercar, or roof equipment shall be made captive to the panel in which they are used.

When bolts are used to secure apparatus where the bolt head is not accessible, a reusable mechanical locking device shall be used to prevent the bolt head from turning when the nut is being turned. Threaded inserts shall not be permitted without prior written Customer approval.

At least 1.5 screw threads shall be visible beyond all nuts. When used without elastic stop nuts, bolts shall not project more than 1.5 threads plus 0.25 in. for bolts 0.25 in. diameter or less and shall not project more than 8 threads for larger diameter bolts. With elastic lock nuts, bolt threads shall not project more than 0.25 in., regardless of bolt size.

18.4.2 Metric Fasteners

Subject to the Customer approval, specific components, control groups, or individual units that are supplied by a supplier or sub-supplier to the Contractor, may be supplied with metric fasteners meeting ANSI B1.13M (ISO-metric) Standards. All internal fasteners and threaded components of the approved assembly shall have ISO-metric threads. Internally, there shall be no mixing of metric and inch threaded fasteners. External mounting fasteners and threaded connecting components shall have ISO-inch threads to ANSI B1.1 Standards. Each unit, component, or group assembled with or containing ISO-metric threads shall be indelibly identified, in a manner and a conspicuous location approved by the Customer, to signify that the unit was assembled using metric threaded fasteners or components. All repair and maintenance manuals shall be conspicuously marked on each page where metric threaded fasteners were used within the unit. Replacement, repair or maintenance parts supplied under this Specification shall contain all necessary replacement fasteners of the correct size and grade.

Metric fasteners shall be marked as required in *Metric Fastener Standards*, Industrial Fasteners Institute, latest edition.

18.4.3 Structural Fasteners

All structural fasteners shall have documentation identifying manufacturer and purchase specifications available for examination by the Customer at the Contractor's Quality Assurance (QA) department. This documentation shall include the fastener material or grade, and finish including plating material and specifications, when applicable. Whether the purchaser is a subcontractor, supplier or the Contractor, the Contractor shall obtain and hold this documentation for a period of not less than the expiration of the warranty period of the last vehicle accepted.

All safety-related fasteners shall either: a) be manufactured, tested, and distributed in accordance with ASME Standard B18.18.3M, including the requirements of ASME accreditation or b) have a representative sample of each production lot of fasteners tested for conformance to purchase specifications by an independent laboratory accredited by the American Association of Laboratory Accreditation (AALA), or approved equivalent. A production lot is defined as one size of fastener, from one manufacturer, and produced during one continuous production run. Fasteners not meeting this definition of production lot shall be treated as separate lots. Testing shall be performed using sample quantities as proposed by the Contractor and approved by the Customer. Tests conducted shall confirm that fastener material meets specified chemistry and strength requirements. The purchaser shall obtain certified test results from the testing laboratory and the Contractor shall obtain and hold the documents for a period of not less than the expiration of the warranty period of the last vehicle accepted.

All safety-related fasteners that are plated or chemically cleaned shall have certifications showing freedom from hydrogen embrittlement. If non-standard, structural, or safety related fasteners are plated by other than the Original Equipment Manufacturer (OEM); a representative sample of these fasteners shall be tested for hydrogen embrittlement by the Contractor or supplier. If any failures occur the entire lot shall be rejected.

All structural bolts for undercar equipment shall be a minimum Grade 8 and the bolt diameter shall be no less than 0.375 in., regardless of design load. Stronger fasteners shall be used if the application requires. The mounting and attachment bolts for undercar mounted equipment and equipment support structures or brackets shall be sized to the design strengths required. Undercar mounted equipment shall be supported by brackets or other structures and not be supported by bolts in tension or shear. Bolts or screws used for structural connections shall have full size bodies in areas subject to bearing and/or shear loads.

18.4.4 Decorative and Appearance Fasteners

All interior fasteners exposed to view shall be either bright or finished to match the surfaces being joined, and installed such that the fastener head is flush with the mating surface. Bright finished fasteners used for stanchions shall be austenitic grade stainless steel. Bright finished interior fasteners may be either austenitic or plated martensitic stainless steel. Type A sheet metal screws shall not be used.

All exterior fasteners visible to passengers shall be austenitic stainless steel for steel, Low Alloy High Tensile (LAHT) steel and stainless steel car bodies. Exterior aluminum shall be joined by austenitic stainless steel or aluminum alloy fasteners, as appropriate to the design and appearance requirements. Fasteners used on the side sill to attach heavy equipment brackets shall be considered structural fasteners.

All fasteners used to secure access covers or panels to equipment boxes or interior panels shall be made captive to the panel in which they are used. Where access for service is expected more often than every five years, access panels shall be equipped with quarter-turn stainless steel fasteners. Quarter-turn fasteners shall have a minimum shank diameter of 0.25 in. and be of adequate strength.

All decorative and appearance fasteners shall have documentation that identifies the manufacturer, base material, plating or finish if applied and the fastener type. The Contractor or supplier shall maintain this documentation on file for the Customer to review for a period of not less than the expiration of the warranty period of the last vehicle accepted.

18.4.5 Torquing

All safety-related fasteners, including truck and brake equipment bolts and all fasteners exposed to fatigue loads, shall be torqued to a minimum preload equal to 75% of their proof load and "torque striped" after torquing by paint or other approved means. All other fasteners shall be torqued to a value appropriate to the application, so that they do not loosen in service.

Fastener installation torque for standard oiled or waxed bolts with standard or heavy hex nuts may be calculated from Industrial Fasteners Institute, *Fastener Standards*, latest issue, equations using values for "K" of 0.18 for unplated and 0.15 for plated threads. Locknuts shall be torqued in accordance with their manufacturer's recommendations or the Contractor may conduct tests to determine installation torque. For those nuts or bolts requiring "torque striping", the Customer may require bolt torque-tension tests to verify that installed preload is equivalent to 75% of proof loads.

18.4.6 Washers and Lock Washers

Washers shall be used under the heads of all bolts and under all nuts. Where high strength fasteners are applied, washers shall be hardened and comply with IFI Fastener Standards, latest issue.

Helicoidal lock washers, when applied, shall conform to IFI Fastener Standards, latest issue. Helicoidal lock washers shall not be used for fatigue applications where the fastener must be torqued and marked. If applicable, prevailing torque nuts shall be used for these applications.

Other types of washers, including Belleville washers, may only be used for special applications with the Customer's approval.

18.4.7 Rivets and Lock Pins

Rivets and lock pins exposed to passengers or crew shall be austenitic stainless steel or aluminum, as appropriate to the materials being joined. Structural steel rivets shall conform to ASTM A502-03 or ANSI B18.1.2 Standards. Rivets may be hand driven when hot and shall completely fill the rivet holes. Rivets driven cold shall be mechanically driven. Exposed heads shall be concentric with the shank and free from rings, fins, pits and burrs.

Swage-locking (Huckbolt type) fasteners shall conform to Military Specification MIL-P-23469/1B. All rough surfaces of the collar end of these fasteners shall be machined or ground smooth where accessible to passengers, crew or maintenance personnel performing routine maintenance functions.

18.4.8 Plating of Fasteners

All carbon, alloy and martensitic steel fasteners shall be plated with cadmium or zinc, unless specifically waived by the Customer.

Cadmium plating shall conform to GSA Federal Standard QQ-P-416F, Class 2 or 3, Type II.

Zinc plating shall conform to ASTM Standard B633-07, Type II SC2, SC3 or SC4.

18.4.9 Rivet and Bolt Holes

Rivet and bolt holes shall be accurately located and aligned, and, when necessary during assembly, holes shall be reamed round to specified size in position. Bolt hole clearances shall not exceed the Industrial Fasteners Institute's requirements. All removed and replaced rivets shall have the holes reamed to the size required such that the next larger rivet may be driven securely.

18.5 Stainless Steel

Required alloys of stainless steel are indicated throughout this Specification. No other alloys shall be used. Finish shall be as specified. Color and finish of pieces abutting on any surface shall match.

All stainless steel surfaces subject to paint application shall be cleaned and painted in accordance with a Customer approved general paints and corrosion protection process.

Finishing methods: surface finishes shall be uniform and of such texture that the original finish will be maintained through repeated brush washings.

Buffing and polishing of stainless steel, where required, shall be done without the use of any composition-containing iron or iron oxide.

18.5.1 Chemical Composition

Chemical composition and "L" grades of stainless steel alloys used for structural purposes shall conform to ASTM Standard A666 except that the carbon content shall not exceed 0.03% and type 301L may contain up to 0.25% nitrogen.

Chemical composition of stainless steel alloys used for non-structural purposes shall conform to ASTM Standard A666.

The material shall be free from precipitated carbides and from surface imperfections of a magnitude which would prevent its meeting bend requirements.

18.5.2 Mill Reports

It shall be the responsibility of the Contractor to insure that all material for each use shall be of a quality conforming to ASTM Standard A666. Mechanical properties of Low carbon ("L") grades of stainless steel alloys used for structural purposes shall be submitted to the Customer

for approval if they differ from ASTM Standard A666 requirements and submitted with the car history book.

18.5.3 Design Stresses

Stainless steel structures shall be designed so that the sum of the stresses to which any part is subjected under fatigue loading conditions shall not exceed the corresponding allowable stress values that will be selected by the Contractor and approved by the Customer.

In selecting the allowable stresses, the Contractor shall make appropriate consideration for the effects of column, flange and web stability; local discontinuities and other stress concentrations; strength reduction at welded regions; fatigue loadings; etc. Sources for selection of the allowable stress values shall be cited, or fatigue test results shall be submitted for approval of selected values by the Customer.

18.5.4 Testing

Tensile strength shall be determined with a testing machine having a maximum head speed of one-half inch per minute. The bend test shall be made with the axis of the bend parallel to the direction of rolling; after bending, no cracks shall be visible to the naked eye. Gauge (thickness) tolerances of materials shall be in accordance with standard industrial tolerances.

18.5.5 Flatness Tolerance

Coil stock shall meet standard mill flatness tolerances, unless otherwise specified. Sheet stock shall be of stretcher-leveled quality. The camber of the sheet stock shall not exceed 0.25 in. in 8 ft.

18.5.6 Finishing Methods

Unless otherwise specified, all smooth sheets exposed to passengers shall be given a medium-grit finish on the exposed side using a belt or oscillating sander. Grain shall be in a direction to suit the decorative treatment in the interior of the car.

- 80 grit on exterior surfaces
- 180 grit on interior surfaces

18.6 Low-Alloy High-Tensile Steel

LAHT steels shall be more than twice as corrosion resistant to atmospheric exposure as plain carbon steels. It is preferred that LAHT steels used for welded structure meet specified weld- and heat-affected zone toughness requirements without post-weld heat treatment or heat-generated stress relief. As a minimum, LAHT steels shall conform to ASTM Standard A572, ASTM Standard A588, ASTM Standard A606 - Type 4, ASTM Standard A715 - Grade A or 70 and ASTM Standard A710, Grade A, Class III.

Exposed sheet steel shall have a smooth surface free from pitting. Mill test reports for each heat of steel used in the construction of these vehicles shall be retained on file by the Contractor shall be available for inspection by the Customer upon request and submitted with the vehicle history book as requested.

Heat treated parts made of LAHT steel shall be certified. A record of this certification, including hardness test results, shall also be retained on file and available for inspection by the Customer upon request.

18.6.1 Design Stress

Structures of LAHT steel shall be designed so that the sum of the stresses to which any part shall be subjected under fatigue loading conditions shall not exceed the corresponding allowable stress values that shall be selected by the Contractor and approved by the Customer. In selecting the allowable stresses, the Contractor shall consider the effects of column, flange and web stability; local discontinuities and other stress concentrations; strength reduction at welded regions; fatigue loadings; and similar conditions. Sources for selection of allowable stress values shall be cited, or fatigue test results shall be submitted, for approval by the Customer of the selected values. **CDRL**

18.7 Steel Castings

Steel castings shall comply, shall be tested, inspected and accepted in accordance with procedures of the applicable AAR standards.

The quality of steel castings shall be checked in accordance with the requirements of AAR Standard M-201. Any radiographic testing shall be per ASTM using reference radiographs to ASTM Standard E446-98(2004)e1 or E168-06, as may be applicable. The radiographic sensitivity shall be at least 2% (2-2T). Acceptance levels for the radiographic testing shall be submitted to the Customer for review and approval. The surface quality of the steel castings shall be evaluated in accordance with ASTM Standard E802-95 to acceptance level IV. All weld repairs shall meet the requirements of ASTM Standard A488/A488M-07. When castings are found to be unacceptable, they shall be repaired in the original factory of manufacture prior to shipment or by another repair process approved by the Customer.

The Contractor shall prove the quality of castings by either destructive or nondestructive means. Following the establishment of a satisfactory procedure, quality control shall be maintained by testing one or more of each lot at a frequency to be determined by the Customer, the Contractor and the subcontractor. This frequency shall be influenced by the critical requirements of the part.

18.7.1 Heat Treating

All steel castings used in the truck structure shall be made of electric furnace or controlled open hearth steel and shall be heat treated.

Where physical strength is gained by heat treating, a physical test shall be conducted on each treating charge of each heat of castings. Where more than one heat is represented in a treating charge, a physical test shall be conducted on each heat represented in each treating charge.

18.7.2 Castings

Steel castings used in locations not specifically referred to shall be selected by the Contractor or its subcontractor for composition and characteristics best suited to the application but shall be subject to review by the Customer.

18.7.3 Couplers and Drawbars

Cast-steel couplers and drawbars shall conform to AAR Specification M-201, Grade C or better. Maximum allowable compressive stress for cast-steel car body structural elements shall be 50% of the material's yield strength, for the car body subjected to its own weight plus that of the specified absolute maximum loading, and shall be 90% of the material's yield strength for the maximum compression loadings specified at the collision posts and at the coupler anchorage. Maximum allowable tensile stress for such elements shall be 80% of the above maximum allowable compressive stress values.

18.7.4 Axles

Axles should be forged steel conforming to SAE/AISI Standard 4140, normalized, oil-quenched and tempered to give Brinell 220-270, minimum ultimate tensile strength of 100,000 pounds per square inch (psi), elongation of 20% in 2 in. minimum, reduction of area at 50% minimum, yield strength of 80 ksi (1000 psi) minimum.

18.7.5 Wheels

The wheels shall be heat treated, multiple-wear type, 36-inch diameter, Class 'B' curved plate, hub stamped in accordance with AAR Standard M-107/M-208 latest revision, including APTA Standard SS-M-012-99.

18.8 Aluminum

Aluminum alloy mill products shall be identified by designations prescribed by The Aluminum Association and shall conform to specifications contained in the Association's publication *Aluminum Standards and Data*. Aluminum alloy castings shall only be used for trim and for door thresholds. Such castings shall conform to ASTM Standards B26, B85 or B108 for, respectively, sand, die or permanent mold castings. Aluminum alloy forgings shall conform to ASTM Standard B247-02a. Copies of all test reports for sheet, extrusions, and forgings used shall be retained on file by the Contractor, shall be available for inspection by the Customer upon request and submitted with the vehicle history book as requested.

Unpainted aluminum used for interior surfaces exposed to contact by passengers and the crew shall have a clear (natural) anodic coating, with a minimum coating thickness of 0.0004 in. and a minimum coating weight of 21 milligrams per square inch (mg/sq. in.).

All aluminum surfaces of the car body, including not only surfaces in contact with dissimilar metals but also surfaces in contact with aluminum and surfaces not in contact with any materials at all, but excluding exterior uncolored surfaces, shall be cleaned and given one coat of zinc chromate primer.

Aluminum used for heat sinks shall be nickel plated to minimize contact corrosion and surface pitting.

18.8.1 Fabrication and Fastening

The forming of aluminum parts, their joining by bolting, riveting, and welding, and the protection of contact surfaces shall conform to the requirements of the Aluminum Company of America's (ALCOA) Technical Report Number 524 *Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles*, except as specified otherwise.

The specific measures to be taken to prevent risk of contact and resultant possible electrolytic corrosion shall depend upon determination of the most suitable method which shall be adapted to the design involved, and the following instructions are provided for general guidance. These instructions shall not supersede recommendations of the aluminum manufacturer.

Aluminum alloy surfaces shall not be secured to, nor make direct metal-to-metal contact with, the surfaces of copper, brass, bronze, silver, nickel and nickel-plated parts or alloys thereof, lead, tin and ferrous materials. The surfaces of aluminum alloy parts secured to steel parts shall be protected with a one-part polysulphide sealant, zinc chromate paste, or a silicone sealant used as the joint compound. Alternatively, an insulating material shall be non-hygroscopic and, if fibrous, shall be impregnated with bitumen or other water-repellent substance.

Wood shall not be placed in contact with aluminum alloy except with written permission from the Customer.

Some form of surface covering or insulation shall be provided for all bolts, rivets, securing clips and devices to prevent contact with the aluminum alloy, if the bolt or other device does not also consist of a compatible aluminum alloy. Stainless steel and carbon steel fasteners, including washers and nuts, plated in accordance with provisions of this Specification shall be coated with a protective non-chromate paste before installation. Where possible, only the head and unthreaded portion of the shank of the bolt shall be in contact with the aluminum part when secured in place. Suitable bushings may be used in place of the protective non-chromate paste. Rivets driven hot shall be considered to be covered by a protective oxide coating due to the heating; but the method of riveting shall, if possible, always be with the formed rivet head in contact with the aluminum alloy.

18.8.2 Gauge

Aluminum sheet gauge size shall be in accordance with the American or Browne and Sharp Standard Gauge.

18.9 Elastomers

All elastomeric parts shall be of neoprene, or approved equal, unless otherwise specified. The elastomer shall be compounded and cured to perform satisfactorily in the temperature range specified. The elastomers shall have high resistance to ultraviolet and other solar radiation, weather, all Customer car washing fluids, and the longest possible life consistent with other specified characteristics. All elastomeric parts shall be resistant to ozone, oxidation, heat, oil, grease and acid.

All resilient mounts shall be of natural rubber. Synthetic rubber compounds may be substituted for natural rubber only when approved for a specific application.

All elastomeric parts are to be marked with the date of manufacture and shall not have aged more than 12 months when assembled into the vehicle.

18.9.1 Tests

All tests shall be conducted according to the latest revisions of the specified ASTM test procedures, unless otherwise specified. All resilient, natural rubber mounts and elastomeric truck suspension components shall be tested in accordance with the performance requirements for the following and must be provided by the manufacturer: ASTM D2240-05, ASTM D412-06ae2, ASTM D1149-07, ASTM D573, ASTM D395-03 (Method B), ASTM D624-00 (die C) and ASTM D746-07. All joints shall be vulcanized.

The durometer hardness shall be suitable for the construction and conditions specified.

The manufacturer shall provide test equipment and test specimens and shall perform, at its expense, the following tests at an independent testing facility:

- ASTM C1166-06: *Flame Propagation Test*
- ASTM E 662: *Smoke Density Test*

All materials must pass ASTM C1166-06 with a burn length = 4 in. They must also have a smoke density of $D_s(1.5) = 100$ and $D_s(4.0) = 200$ in both the flaming and non-flaming modes when tested according to ASTM E 662. The toxicity of the materials must be specified in SMP 800-C.

Unless otherwise agreed by the Contractor:

- ASTM D412-06ae2 tensile strength shall be 1500 psi (min.)
- ASTM D412-06ae2 elongation for sheet material shall be 300% (min.)
- ASTM D412-06ae2 elongation for extruded material shall be 275% (min.)
- ASTM D573 loss in tensile strength shall be 15% (max.) when subjected to 168 hours at 158°F.
- ASTM D1149-07 shall have no cracks when subjected at 100 parts per hundred million (pphm) at 104°F for 100 hours and a specimen elongation of 20%.

Unless otherwise agreed by, the gas concentrations shall be defined as follows:

Gas	Critical Concentration (*ppm) (max.)
CO	3,500
CO ₂	90,000
NO + NO ₂ (Nox)	100
SO ₂	100
HC1	500
HF	100
HBr	100
HCN	100

* parts per million (ppm)

The test specimens shall be cut out from the extruded material, and at least one tensile strength and elongation test and one accelerated aging test shall be made on the material used

for each order. If the compound or cure, or both, are changed during the production of material for one order, at least one test of each type shall be made for each different batch.

The ozone resistance of the elastomer shall be tested in accordance with ASTM Standard D1149 using an ozone concentration of 100 ppm, an exposure time of 100 hours at 100°F, and a specimen elongation of 20%. The elastomer shall not exhibit any cracks during the test period.

18.9.2 Life Expectancy

For all parts made by vulcanizing an elastomer to metal, any premature failure (less than five years) between metal and the elastomer or in the elastomer, occurring when the parts are used in normal service and according to the provisions of this Specification, shall be considered as having been caused by defect of materials or workmanship.

18.9.3 Metal Parts

Metal parts to which elastomeric material is vulcanized shall be made of SAE 1020 or 1045 hot-rolled steel, except for air brake equipment.

18.9.4 Bonding

The joining of elastomeric pieces shall be conducted by the hot vulcanization process. Bonding of elastomers shall not be allowed unless the Contractor submits the application, bonding procedure, and bonding agent technical data for approval prior to the purchase of any materials.

18.9.5 Truck Parts

Truck bumpers and snubbers shall be made of natural rubber or approved equal. They shall be compounded to be resistant to abrasion, oil, grease and acid.

18.9.6 Glazing Strips

Glazing strips shall be of neoprene conforming to ASTM Standard C542-05, or of Styrene-Butadiene rubber. The compounding of the rubber shall be such as to preclude discoloration or staining of neighboring areas, particularly from water drainage.

Window glazing sections shall be service proven and constructed of high-quality elastomeric compounds containing neoprene subject to approval by the Customer. Glazing strips and other elastomeric extrusions shall be continuous and made from neoprene or other compounds suitable for the purpose and shall be free of major defects of material or workmanship.

18.10 Glazing Materials

All window glass shall be provided with tints, screens, or other solar/thermal limiting measures as required by the Heating, Ventilation and Air Conditioning (HVAC) design. The tints shall not preclude passengers from being seen from outside the car or limit their vision when looking out the bodyside windows.

Glazing used shall meet the following material criteria:

- Windshield glazing shall be a single-glaze, certified FRA Type I clear laminated safety glass, meeting all the applicable requirements of ANSI Standard Z-26.1 and U.S. Code of Federal Regulations, 49CFR Part 223, including Appendix A. The glazing shall incorporate an anti-spall shield on the interior side. The glazing shall be clear tint. The glazing shall be a minimum of 0.560-in. thick. The glazing's maximum solar energy transmittance shall not exceed 70%.
- End door window glazing shall be a single-glaze, certified FRA Type I clear laminated safety glass, meeting all the applicable requirement of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49CFR Part 223, including Appendix A. The glazing shall be clear tint. The glazing shall be 0.560-inch thick. The glazing maximum solar energy transmittance shall not exceed 90%.
- Side door window glazing shall be a single-glaze, certified FRA Type II clear laminated safety glass, meeting all applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations 49CFR Part 223, including Appendix A. The glazing shall be clear tint. The glazing shall be 0.375 inch thick. The glazing's maximum solar energy transmittance shall not exceed 90%.
- Cab car control station sliding window assemblies shall be double-glazed. The outer pane shall be 0.250-inch thick, clear laminated safety glass. The inner pane shall be 0.250-inch thick, clear laminated safety glass. The double-glazed assembly shall have a 0.250-inch thick clear air space separating the inner and outer panes. The double-glazed assembly shall be certified FRA Type II and meet all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49CFR Part 223, including Appendix A. The double-glazed assembly shall be clear tint. The double-glazed assembly's maximum solar energy transmittance shall not exceed 85%.
- Side (non-emergency) window assemblies (emergency and non-emergency) shall be double-glazed. The outer pane shall be 0.250-inch thick, gray-tinted tempered safety glass unless specified otherwise by the Customer. The inner pane shall be 0.375-inch thick, clear tempered safety glass. The double-glazed assembly shall have a 0.375-inch dead air space separating the inner and outer panes. The double-glazed assembly shall be certified FRA Type II and meet all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49CFR Part 223, including Appendix A. The double-glazed assembly shall be a gray tint unless specified otherwise by the Customer. The double-glazed assembly's visible light transmission shall be 24%. The double-glazed assembly's maximum solar energy transmittance shall not exceed 50%.

18.10.1 Flatness

When an individual window of glass is laid on a truly flat surface, such as a surface plate, the glass shall not indicate a bow of more than 0.030 inch per linear foot.

18.10.2 Dimensional Tolerance

The overall dimensions of any window supplied shall not exceed ± 0.060 in. dimensional deviation.

18.10.3 Overlap Tolerance

The overlap of one laminate of the window with respect to the other at an edge shall not exceed 0.03125 in. Corners and burrs shall be ground smooth and all edges shall be treated in accordance with SAE Z26.1, Section 6.

18.10.4 Color

When new, there shall be no more than $\pm 4\%$ variation in the color of individual windows of laminated sheet glass when examined over a white background.

18.10.5 Haze

All the laminates of the safety glass shall be so nearly free from haze that the laminated glass shall have approximately the same clarity as non-laminated plate glass of the same nominal thickness of plate glass.

18.10.6 Specks and Scratches

Occasional specks of foreign material and scratches are permissible, provided such specks do not exceed 0.020 in. in greatest dimension and scratches do not exceed a total of 3 in. in length and neither are within the central three-quarters area of the window. The Customer reserves the right to determine which windows are to be rejected.

The visual inspection criteria for laminated glazing shall be submitted for a Customer approval as part of the glazing design review.

18.10.7 Bond Separation

The bond between two sheets of glass and the membrane shall be of such quality that when the glass is broken by twisting or by direct impact, there will be no separation between the glass sheets. Windows that contain un-bonded areas shall not be used.

18.10.8 Marking

All safety glass shall be marked with proper identification in accordance with FRA 49CFR Part 223 requirements. The window shall be installed so that the identification marking can be read from the inside lower right hand corner.

Each window shall be marked for identification by the supplier in legible letters 0.125 in. to 0.25 in. high in the lower right hand corner as viewed from the inside of the vehicle. This identification shall be no closer than 0.375 in. to the edge. The identification shall give the product name, the manufacturer, the serial number and FRA Type designation. Markings shall be legible and permanent for this application and shall be applied in such a manner so as not to reduce the integrity of the coating. Markings are to be in accordance with 49CFR Part 223. The window shall be installed so that the identification can be read from the inside.

18.10.9 Shipping

The material shall be carefully prepared for shipping and shall be properly protected to prevent damage. If a pressure sensitive masking is used, it shall be easily strippable from the material and not leave a gummy or sticky residue.

18.11 Rubber Floor Covering

The floor covering shall be rubber sheet or approved equal. The covering shall meet ADA visibility and coefficient of friction requirements, with a static coefficient of friction of at least 0.6 on level surfaces and 0.8 on ramps, even when wet. Rubber floor covering shall contain 20% (nominal, by weight of compound) butadiene styrene rubber, shall be non-staining, non-discoloring, and 100% non-oil extended. Only high quality hard clay shall be used as filler. No whitening (limestone) shall be used in the compound. At room temperature, the rubber flooring shall bend around a 0.75 in. (19 mm) diameter mandrel without breaking, cracking, crazing or showing any change in color. The rubber flooring material shall be fully homogeneous throughout, and shall meet the requirements of ASTM F1344-04. Rubber flooring shall conform to the criteria below.

18.11.1 Thin Skinned Blister

A thin skinned blister is a blister, which when finger-pushed, will collapse upon itself. Thin skin blisters of the indicated sizes will be permitted as follows and shall be repaired as indicated:

- Maximum Size - 0.030 in. (0.8 mm) height, 0.80 in.² (5.2 cm²) area with longest dimension of 2 in. (51 mm).
- Maximum Population - 3 blisters in a 12 in. (30.5 cm) by 12 in. (30.5 cm) area, and there shall be only one other blister within 3 ft (0.91 m) of this area.
- Repair Method - using a hypodermic needle, apply just enough Super Bond 420 or Bostik 1685 to bring to a flush surface.

18.11.2 Thick Skinned Blister

A thick skinned blister is a blister, which when finger-pushed, will collapse and then return to its original condition. Thick skin blisters of the indicated sizes will be permitted as follows and shall be repaired as indicated:

- Maximum Size - 0.030 in. (0.8 mm) height, 0.80 in.² (5.2 cm²) area with longest dimension of 2 in. (51 mm).
- Maximum Population - 3 blisters in a 12 in. (30.5 cm) by 12 in. (30.5 cm) area, and there shall be only one other blister within 3 ft (0.91 m) of this area.
- Repair Method - no repair authorized.

18.11.3 Lumps

A lump is a blister without a void, consisting of solid material. Lumps of the indicated sizes will be permitted as follows and shall be repaired as indicated:

- Maximum Size - 0.030 in. (0.8 mm) height, 0.80 in.² (5.2 cm²) area with longest dimension of 2 in. (51 mm).
- Maximum Population - 3 lumps in a 12 in. (30.5 cm) by 12 in. (30.5 cm) area, and there shall be only one other lump within 3 ft (0.91 m) of this area.
- Repair Method - no repair required.

18.11.4 Holes

A hole is a defect, which is 100% through the material. Holes of any size or population will not be permitted nor shall holes be repaired.

18.11.5 Thin Area

A thin area is a defect where the sheet is below thickness locally. Thin areas of the indicated sizes will be permitted as follows and shall be repaired as indicated:

- Maximum Size - 0.030 in. (0.8 mm) deep at the lowest point, 3 in.² (19.4 cm²) area with the longest dimension of 5 in. (127 mm).
- Maximum Population - one thin area in a 40 in. (1 m) by 40 in. (1 m) area, and there shall not be another thin area within 3 ft (0.91 m) of this area.
- Repair Method - rub with #00 steel wool to blend this area into the normal thickness material and then buff to a normal surface finish.

18.11.6 Color and Marbling Distribution

Tolerances for color and marbling variation shall be submitted to the Customer for approval during preliminary design review. If the base coloring is not within 5% between production runs, or the marbling is not consistent over the entire surface, the roll shall be rejected.

18.12 Lumber and Paneling

18.12.1 Lumber

Lumber shall be thoroughly air seasoned or kiln dried before using and shall be dressed on all surfaces to full dimensions and treated to meet the testing requirements of Chapter 19. Lumber shall be straight grained, free from dry rot, knots checks and other defects which may impair its strength and durability or mar its appearance.

Except where specified, the use of wood in the car shall be limited to specifically approved applications.

Melamine shall be pressure bonded to marine grade plywood using industry approved adhesives. No contact bonding of melamine to plywood is permitted.

The term "cored panels" means honeycomb panels bonded to melamine or to metal faced hard-board (similar to Metalcomb, as marketed by Cored Panels, Inc., Farmingdale, New York).

Such panels must comply with United States Department of Agriculture Forest Products Laboratory Report No. 1937, *Shear-Fatigue Properties of Various Sandwich Construction*.

18.12.2 Plymetal

The term "plymetal" as used in this Specification covers metal-faced plywood and shall conform to the following requirements:

Test Conditions	Minimum Metal to Wood Average Shear Value (or 80% Wood Failure)
Dry shear	250 lbf/in. ² (1.7 MPa*)
Boil shear, 3 hour boil, tested wet at room temperature	150 lbf/in. ² (1 MPa)
Soak shear, 48 hour soak wet at room temperature	150 lbf/in. ² (1 MPa)
Creep or cold flow, under static load for 48 hour, at room temperature	250 lbf/in. ² (1.7 MPa)

* Megapascal

Plymetal that is faced with melamine shall have the melamine bonded to the metal sheet in accordance with this Specification, and the melamine-faced metal sheet shall then be laminated to the plywood core in accordance with this section.

18.12.3 Plywood

All plywood shall be manufactured to conform to the requirements of Grade - Structural I of the National Bureau of Standards Voluntary Product Standard (American Plywood Association) PS 1-85, and then stored under cover. All plywood panels shall be formed from one piece and shall be sealed with two coats of epoxy paint on all edges and cutouts as soon as possible after fabrication. All exposed edges of the panels; joints between panels, fastener heads and openings of panels used in areas accessible to moisture shall be waterproofed and sealed in accordance with MIL-P-8053, paragraph 3.4, prior to installation in the car.

18.12.4 Honeycomb Panels

The term "honeycomb panels" as used in this Specification refers to an assembly of honeycomb material bonded to melamine-faced metal panels or to metal panels. Aluminum honeycomb material shall be commercial-grade meeting the requirements of MIL-C-7438G. Bonding shall be sufficient to develop the full strength of the honeycomb material. Stainless steel honeycomb panels shall be constructed in accordance with the requirements of MIL-A- 9067C. The adhesive bond strength of the honeycomb core to the stainless steel face shall not be less than 15 lb/in. (2.68 kg/cm) climbing drum strength when tested in accordance with SAE-AMS-STD-401. The adhesive bond strength of the integral stainless frame to stainless steel face shall not be less than 30 lb/in (13.6 kg/2.5 cm) climbing drum strength when tested in accordance with SAE-AMS-STD-401. Stainless steel honeycomb panels shall be tested in accordance with SAE-AMS-STD-401 to demonstrate the following requirements. Test results shall be subject to Customer review and approval.

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- Core shear yield at 200°F (93°C) 250 lbf/in.² [1.72 Megapascal (MPa)]

- Flatwise tension at 200°F (93°C) 250 lbf/in.² (1.72 MPa)
- Beam flexure at 200°F (93°C) 75,000 lbf/in.² (517.13 MPa)
- Core shear fatigue at R.T. 150 lbf/in.² @ 106 cycles (1.03 MPa)
- Flatwise tension at R.T. 250 lbf/in.² @ 106 cycles (1.72 MPa)
- Beam flexure at R.T. 50,000 lbf/in.² @ 106 cycles (344.75 MPa)

Honeycomb panels meet the relevant flammability and smoke emission requirements. Results shall be subject to Customer review and approval. No other honeycomb materials will be permitted.

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18.12.5 Melamine-Faced Aluminum

Melamine-faced aluminum panels shall be constructed by laminating melamine to aluminum sheets as follows: The melamine impregnated papers shall be directly molded to the aluminum sheets at temperatures of no less than 270°F (132°C) and pressure no less than 1000 psi (6.9 MPa). The surface characteristics, after manufacture, shall be no less than that required of type GP (General Purpose) in the NEMA Standards Publication No. LD-3-2005, or latest revision. The melamine and the required binder sheets shall be 0.020 ± 0.005 in. (0.51 ± 0.13 mm) thick. The aluminum sheets shall not be less than 0.025 in. (0.64 mm) in thickness when used as a facing on plywood. The aluminum sheets shall not be less than 0.081 in. (2.1 mm) in thickness when not laminated to a substrate such as plywood. Aluminum sheets shall be properly cleaned by etching, sanding or other approved process to insure full, permanent, acceptable adhesion.

The use of any adhesives to bond the melamine sheets to the aluminum backing will not be acceptable. The bond between the melamine and aluminum sheets shall, as a minimum, meet the following requirements:

ASTM D952 Internal Bond	2,600 lbf/in. ² (17.9 MPa)
ASTM D790 Flexural Strength - (S)	with grain: 26,500 lbf/ in. ² (183 MPa) crossgrain: 25,300 lbf/ in. ² (174 MPa)
ASTM D790 Modulus of Elasticity - (E)	with grain: 2.8 x 10 ⁶ lbf/ in. ² (19.3 GPa) crossgrain: 3.1 x 10 ⁶ lbf/ in. ² (21.4 GPa)
ASTM D638-08	Tensile strength with grain: 22,300 lbf/ in. ² (154 MPa) crossgrain: 20,300 lbf/ in. ² (140 MPa)

18.12.6 Melamine Panels

Unbacked melamine panels may be used in the vehicle interior. The panels shall be a minimum of 0.125 ± 0.005 in. (3.2 ± 0.1 mm) thick. The surface characteristics shall be no less than that required of type GP (General Purpose) in the NEMA Standards Publication No. LD-3-2005, or latest revision. Sidewall panels shall be of unbalanced melamine. However, ceiling panels located under air ducts must be balanced melamine to prevent warpage from duct condensation.

18.12.7 Phenolic Composite Floor Panels

Phenolic composite floor panels shall be designed to withstand the following physical requirements with no visible or audible indications of delamination of the panel skin from the core and permanent deformation of the top surface shall be less than 0.010 in. (0.25 mm) unless otherwise specified. There shall be no puncture or damage to fibers of the top surface.

There shall be no separation of any internal core from the top or bottom skin. There shall be no fracture of the balsa core.

- Indentation Resistance – The floor panel shall withstand a concentrated load of 300 lbs (136 kg) applied to a test dowel that has an overall 0.375-sq in.² (242 sq mm²) surface area, with a 0.0625-in. (1.6 mm) radius on bottom edge of test dowel.
- Static Load Test - Average Loading – A representative sample section of the flooring (without rubber floor covering attached) shall be supported on beams spaced at the maximum spacing used on the car using production bonding and fastening techniques. A uniformly distributed load in accordance with the crush loading requirements of Section 2 shall be applied to both sides of the joint (butt and/or shiplap). There shall be less than 0.088-in. (2.2 mm) deflection.
- Static Load Test – Maximum Loading – Using the identical floor panel-mounting configuration as described above, a uniformly distributed load of 200 lb/ft² (976 kg/m²) shall be applied to both sides of the joint (butt or shiplap).
- Small Area Static Load Test – Using the identical floor panel mounting configuration as described above, a 300 lb (136 kg) load shall be applied to a 1.0 in. (25.4 mm) by 3.0 in. (76 mm) contact area directly over the midspan, 6 in. (152 mm) from the outer car body sidewall edge. The footprint shall be machined flat within 0.010 in. (0.24 mm) and the edges shall have a radius of not more than 0.125 in. (3.17 mm). There shall be less than 0.200 in. (5.08 mm) deflection as a result of the load applied.
- Small Object Impact Test - Using the identical floor panel mounting configuration as described above, a 16 lb (7.26 kg) standard bowling ball shall be raised directly over the mid-span, 24 in. (610 mm) from the edge of the panel and dropped from height of 60 in. (1500 mm). Permanent deformation of the top surface shall be less than 0.0625 in. (1.587 mm).
- Large Object Impact Test - Using the identical floor panel mounting configuration as described above, a 150 lb (68 kg) load shall be dropped upon a 3.0 in. (76 mm) by 8.0 in. (200 mm) contact “footprint” pad located directly over the midspan, 24 in. (610 mm) from the edge of the panel and dropped from a height of 12 in. (305 mm). The “footprint” pad shall have a rubber pad on the downside surface with a Shore D 70 minimum, at a 1.00 in. (25.4 mm) thickness machined flat within 0.060 in. (1.524 mm) with edges having a radius of not more than 0.030 in. (0.762 mm). Permanent deformation of the top surface shall be less than 0.030 in. (0.762 mm). Some damage to the top phenolic composite skin will be allowed.
- Rolling Load Test - Using the identical floor panel mounting configuration as described above, a fourwheeled cart with a load of 200 lbs (91 kg) per wheel shall be rolled on the panels laterally, longitudinally and in a circular path 24 in. (610 mm) radius. The wheels shall be 3 in. (75 mm) in diameter, 1 in. (25.4 mm) wide with a 0.125 in. (3 mm) radius on each edge with a Shore A durometer of 80.
- Flammability and Smoke Emission Tests – Floor panels meet the relevant flammability and smoke emission requirements.

18.13 Seat Cushion and Fabric

18.13.1 Cushion Material

The bottom seat cushion shall be molded polyurethane foam. It shall meet Amtrak Specification 967. Indentation Force Deflection (IFD) measured at 25% compression of 50 ± 5 lbs, 3.5 +/-0.4 lbs/cubic ft. density with a support factor of 2.1 min.

The back cushion shall be molded polyurethane foam meeting Amtrak Specification 967.

IFD measured at 25% compression of 33 ± 3 lbs, 3.1 ± 0.3 lbs/cubic ft. density with a support factor of 2.1 min.

18.13.2 Seat Fabric

18.13.2.1 Primary Fabric

Content	90% Wool/10% Nylon
Weight	15.0 oz/sy (+/- 10%)
Backing Material	GoreTex
Width	54 in.
Ends per Inch	88.8
Picks per Inch	55.0

18.13.2.2 Companion Fabric

Content	90% Wool/10% Nylon
Weight	16.4 oz/sy (+/- 10%)
Width	54 in.
Ends per Inch	88.8
Picks per Inch	55.0

18.13.2.3 Armrest Material

Supplier	Uniroyal Engineered Products, or approved equivalent
Content	100% Naugahyde

18.14 Carpet and Wainscot

18.14.1 Carpet

The carpet shall be tufted, 100% solution dyed nylon with a gauge of 1/10, 11 SPI, a minimum of 34 oz/yd², and a pile thickness of 0.250 in. maximum. The primary backing shall consist of woven polypropylene. The carpet will have a stain resistant chemical applied.

The carpet will have a secondary, moisture resistant backing applied that will not delaminate. The thickness shall be nominally 0.09375 in. with a density of 18 lb/ft³, and a weight of 30 oz/yd². The compression resistance shall be 5 lb/in.

18.14.2 Wainscot Fabric

End per Inch	45.4
Picks per Inch	32.0
Weight	24.0 oz/sy (+/- 10%)

18.14.3 Counter Surfaces

All counter surfaces shall be made from Customer approved materials. All countertop material shall be made from FDA and NSF approved non-porous material.

18.14.4 Decorative Countertops

Decorative countertops shall be made from 100% acrylic based material. The material shall be not less than 0.5 in. thick, solid, non-porous and fully sealed. Material shall naturally resist damage from heat, mold, mildew and stains. Material shall be assembled with non-porous, waterproof seams.

18.14.5 Stainless Steel Countertops

All countertops shall be made from type 304 stainless steel with a thickness of at least 14 gauge. Stainless steel countertops shall have a brushed satin finish. All seams shall be finished to match the counters brushed satin finish. Counters shall be built in a manner that doesn't flex, deform, rattle or "oil can".

18.15 Welding and Brazing**18.15.1 Responsibility**

The Contractor shall be responsible for the quality of all welding and brazing, whether done by Contractor's employees or a subcontractor. All welders employed in the making of welds on structures or products built under this Specification shall have been tested and qualified to determine their ability to operate the welding equipment to be used in making the types of welds required hereunder and to produce satisfactory welds therewith.

All steel welding practices shall be according to requirements of AWS Standard D1.1, *Structural Welding Code – Steel*; AWS Standard D1.2, *Structural Welding Code – Aluminum*; AWS Standard D1.3, *Structural Welding Code – Sheet Steel*, AWS Standard D1.6, *Structural Welding Code – Stainless Steel*, and the AWS Handbook. AWS Standard D1.1 shall apply to steel of 1/8-in. and greater thickness, and AWS Standard D1.3 shall apply to steel less than 0.125 in. thickness. Requirements for dynamically loaded structures shall be applied. Cast steel welding shall be according to ASTM Standard A 488/488M, *Steel Castings, Welding, Qualification of Procedures and Personnel*. Resistance welding shall be in accordance with AWS Standard D17.2/17.2M, *Specification for Resistance Welding in Aerospace Applications*. Laser welding, if used, shall comply with AWS Standard C7.2, *Recommended Practices for Laser Beam Welding, Cutting, and Drilling*.

Aluminum welding as covered by this section shall conform to Aluminum Company of America's Technical Report Number 524 *Specification Covering Use of Aluminum in Passenger*

Carrying Railway Vehicles and AWS Standard D1.2/D1.2M *Structural Welding Code, Aluminum*. Requirements for dynamically loaded structures shall apply.

All welding practices not specifically covered in this section shall be in accordance with the applicable requirements and recommendations of the American Welding Society (AWS), as contained in the *Structural Welding Code- Steel* (AWS Standard D1.1/D1.1M), *Structural Welding Code- Sheet Steel* (AWS Standard D1.3/D1.3M), *Specification for Resistance Welding in Aerospace Applications* (AWS Standard D17.2/D17.2M), and the *AWS Welding Handbook*. Should the Contractor propose an alternate standard, it shall be subject to the Customer's approval. Requirements and recommendations of the AWS for new bridges shall have precedence over those for new buildings.

All Welding Procedure Specifications (WPS) shall be fully qualified by the Contractor, accompanied by Procedure Qualification Records (PQR) containing welding test results, and subject to approval by the Customer and a Certified Welding Inspector. Prequalified WPS, or WPS purchased from AWS, shall be qualified by the Contractor before application to production. The use of WPS qualified per AWS Standard B2.1 shall not be permitted in their original form. WPS and PQR originally qualified per AWS Standard B2.1 may be rewritten to conform to the requirements of the applicable structural welding code and used within the limitations of that code.

Welders shall make only those welds for which they have been qualified according to the requirements of the applicable AWS code, ASME Section IX, ASTM A 488/488M, or other approved qualifying procedures. Records of welder qualification tests shall be made available for review.

18.15.2 Test Welds

The Customer shall have the right to require an operator to make test welds to determine his/her ability to produce satisfactory welds of any given type. The Customer shall also have the right to require the making of test welds to settle any question that shall arise as to the suitability of any welding method or procedure used during production. The recommendations of the AWS shall be followed in the making of tests and the settlement of other questions that may arise hereunder regarding welding practice.

Weld heat-affected zones (HAZ) and weld metal shall be limited to maximum allowable stress values in ASME Section VIII, Table UHA-23, for UNS S20100 stainless steel and Table UW-12 rating of welds.

Fatigue allowable stresses shall not exceed the lesser of fatigue limits in AWS Standard D1.1, Section 2.20.6, or 50% of the joint strength level calculated from ASME maximum allowable stress values. Higher values shall only be used if qualified by Contractor tests

18.15.3 Cleaning

Prior to welding, parts to be joined shall be properly cleaned of coatings and films such as rust, oxide, mill scale, oil, grease, corrosion products, and other foreign materials. Cleaning materials and processes shall be in accordance with applicable parts of Section 2, MIL-HDBK-132, *Protective Finishes*. Finished welds shall present a clean appearance.

18.15.4 Support

All parts which shall be joined by welding shall be adequately supported during welding by tables, jigs or fixtures.

18.15.5 Welding Rod

All welding rod, wire, electrodes or filler metal; shall be chosen by the Contractor or subcontractor with respect to manufacturer, type and size necessary to achieve the highest quality work. The Contractor shall have full responsibility for the character of the work produced. It shall be purchased in packages of convenient size, which shall be marked with the Manufacturer's name and the specification, diameter, and net weight of the material.

The material shall be stored in accordance with recommendations of the AWS *Structural Welding Code* so as to protect it from damage, and so that it shall be easily identified. Material shall be issued and handled in such a way as to prevent it from being mixed with that of another specification.

The ferrite number for austenitic stainless steel welds shall be between WRC4 and WRC10, or as proposed by the Contractor and approved by the Customer.

In case a question arises regarding the suitability of welding rod, wire, electrodes or filler metal, the provisions of AWS Standard D1.1/D1.1M shall govern.

18.15.6 Control

Current, voltage, distance, flame and other variables shall be so controlled as to give a smooth weld, free of gas pockets, oxide inclusions, variations in width and thickness, wandering and spattering.

18.15.7 Penetration

Penetration of weld metal into the bottoms of angles and vees and fusion, shall be complete. Weld metal shall run into the base metal at the finished surface of the weld in a smooth curve approximately tangent to the surfaces of the base metal so as to avoid sudden change of section and resultant concentration of stress. Undercutting shall not exceed 10% of the thickness of the thinnest element, or 0.030 in., whichever is less.

18.15.8 Warpage

The method of depositing weld metal shall be chosen so as to minimize warpage and locked-up stresses. Tack welding, skip welding, offset welding and other comparable procedures shall be used for this purpose.

18.15.9 Intermittent Weld Spacing

Intermittent fusion-weld spacing pitch shall not exceed 5 in. for 2-in. (minimum) weld lengths, such that a minimum weld length of 40% of the overall joint length is achieved.

18.15.10 Fusion Welding

Manual fusion welding by the gas process may only be used on sheets more than 0.09375 in. in thickness. Any other application of this process must be approved by the Customer.

18.15.11 Resistance Welding

Resistance welding shall be in accordance with AWS Standard D17.2/D17.2M Class B for structural applications and Class C for non-structural applications. Stainless steel parts shall be joined, insofar as possible, by resistance welding. This procedure shall employ accurate control of current, time, electrode size and shape, and tip force, to produce uniform welds of specified strength which shall not be subject to surface corrosion. Resistance welds in materials other than austenitic stainless steel shall be arranged to avoid tension or "peeling" forces on the welds under any anticipated loading condition.

Sample resistance welds in all materials shall be made with calculated settings of current, time and tip pressure, static (pull) tested and, in the case of austenitic stainless steel elements, chisel tested to verify adequacy; and a record shall be made which includes the settings and ultimate shear strength. (A chisel test shall be made by inserting a chisel between two resistance-welded plates to verify that a weld nugget shall be pulled out of one of the plates). Sample welds shall be made and tested at the beginning of each shift and, in addition, whenever there shall be a change in any of the following:

- Operator
- Material, material thickness, or combination of thicknesses
- Electrodes
- Settings

Spacing of resistance and spot welds shall be appropriate to the design. Spacing shall not exceed 2 in. plus twice the weld nugget diameter for any structural application, including car body side sheets. For any corrugation application, if the pitch of the corrugation nodes does not allow the above weld spacing, there shall be two spot welds between each node.

Surface indentation shall not exceed 20% of material thickness (t) or 0.01 in., whichever is greater. However, for exterior resistance-welded areas exposed to passenger view, indentation shall not exceed 10% of material thickness or 0.005 in., whichever is greater. For exposed welds, the Contractor shall vary welding parameters and conditions within their acceptable ranges to minimize indentations. Surface burn and discoloration shall be removed by chemical cleaning, or an approved equal method, and sanding or polishing to match the surrounding surface.

18.15.12 Special Welding

Procedures for structural welding of stainless steel to HSLA, or other combinations of metals or conditions not covered by AWS specifications or codes, shall be submitted for approval.

Austenitic stainless steel electrodes or wire shall be used to join carbon or HSLA steels to stainless steels.

For the application of welding processes not addressed in other parts of this specification, the Contractor shall submit equipment qualifications, procedure qualification records, and welding

procedure specifications either conforming to identified industry standards or consistent with the approach of AWS Standard D17.2/17.2M, *Specification for Resistance Welding in Aerospace Applications*.

Standards that may apply to selected processes include:

- AWS Standard D17.3/D17.3M, *Specification for Friction Stir Welding of Aluminum Alloys for Aerospace Applications*.
- ANSI/AWS Standard C7.2, *Recommended Practices for Laser Beam Welding, Cutting, and Drilling*.
- ANSI/AWS Standard C7.4/C7.4M, *Process Specification and Operator for Laser Beam Welding*.
- ISO/DIS Standard 15609-4, *Specification and Qualification of Welding Procedures for Metallic Materials - Welding Procedure Specification - Part 4: Laser Beam Welding*.

Galvanized steel shall not be welded to stainless steel. Brazing shall not be used to join stainless steel to either stainless steel or to any other metals.

18.15.13 Toughness of Welded Assemblies

The Contractor shall prove all welded steel structures are above the ductile-brittle transition temperature for the specified environmental exposure. Specifically, the weld Heat-Affected Zone (HAZ) and base metal shall resist service impact loads at the lowest specified operating temperature without brittle failure. If the Contractor's approved design does not require greater toughness, the minimum impact value for Charpy V-notch specimens shall be 15 ft-lbf of absorbed energy at the lowest specified operating temperature. The Customer shall have the right to require impact tests to verify the specified toughness.

18.15.14 Torch Brazing

All brazing, characterized by heating above 840°F, shall follow the recommendations contained in the AWS *Welding HandBook*, Volume 2. Procedures and personnel who do brazing work shall be qualified in accordance with AWS Standard B2.2, *Standard for Brazing Procedure and Performance Qualification*.

18.15.15 Torch Soldering

All structural (not electrical) soldering, characterized by heating below 840°F, shall follow the recommendations contained in the AWS *Welding HandBook*, Volume 2. Procedures and personnel who do torch soldering shall be qualified in accordance with AWS Standard B2.3/B2.3M, *Specification for Soldering Procedure and Performance Qualification*.

18.16 Exterior Marking Films and Graphics

Graphics shall be transportation grade materials, printed on opaque background with clear, vandal resistant overlayment. All graphics materials are to be approved by Customer. Application techniques shall be in accordance with manufacturer's recommendations.

18.16.1 Physical Properties

- Shall be able to withstand long-term exposure to all environmental and operating conditions specified in Amtrak Specification 963.
- Lettering film shall be sufficiently opaque so that, when applied, films shall completely hide any contrasting background and shall be readily legible.
- There shall be an initial 60-degree gloss value of 40 when tested in accordance with ASTM Standard D523-08.
- Films shall retain adhesive properties after one week of continuous exposure to a temperature of 66°C (150°F).
- Films shall be able to conform to moderate contours of the vehicle's interior and exterior surfaces at locations where decals are to be applied.
- Overall thickness of processed film shall be between 0.10 mm and 0.20 mm (0.004 and 0.008 in.).
- Films shall withstand immersion in either distilled water or SAE No. 20 motor oil for 24 hours at temperatures from 21°C to 32°C (70°F to 90°F) without any appreciable degradation in adhesion, color or general appearance.
- Marking films shall withstand effects of detergents and brushes used in washing procedures for removal of graffiti.
- Films shall use a removable grade adhesive that upon removal does not require use of solvents or secondary operations.
- Square or rectangular graphics shall have rounded corners of suitable radius.

18.17 Paints and Coatings

18.17.1 Materials and General Requirements

Painting of the car serves two primary purposes: 1) to protect the vehicle from corrosion and 2) to contribute to the overall aesthetic quality of the vehicle. Paint coatings should also assist in the overall maintenance of the vehicle by providing easy to clean surfaces. The vehicle must be fully and properly coated to achieve its service life with regular maintenance intervals

The surface preparation, primer, paint and graphics applications shall ensure that the car can operate at least eight years between major exterior finish repairs or replacement.

Preparation of the painted surface and application of painting materials for brushing or spraying shall be in accordance with the paint supplier's recommendations. Each coat shall be uniformly applied over all surfaces to be covered, and shall be free from runs, sags, or other application defects.

18.17.2 Paint Process Documentation

The Contractor shall prepare a paint coating and application document containing procedures for surface cleaning and preparation, priming, surfacing, and painting for the car body and all equipment that is painted or powder coated. A detailed paint schedule showing the equipment painted, paint type and manufacturers, recommended thickness, and other pertinent

information shall also be included. This document shall be included in the maintenance manuals. It shall meet Amtrak Specifications 353 and 354.

18.17.3 Painting Restrictions

Any equipment or parts of equipment which would be damaged or suffer impaired operation from painting shall not be painted and shall be corrosion resistant.

The following items shall not be painted:

- Copper tubing, piping, and fittings
- Wire and cable
- Heat transfer surfaces
- Elastomeric portions of air and refrigerant lines
- Grounding pads and straps
- Wheels
- Axles
- Brake rotors
- Brake shoes and pads
- Air hoses
- Pedestal liners
- Elastomeric parts
- Grease fittings
- Linkages
- Threaded parts used for adjustments
- Electrical equipment
- Couplers
- Wearing surfaces
- Corrosion Protection

Concealed surfaces capable of rusting or oxidation shall be properly cleaned, then primed with a rust inhibiting paint, and painted with an approved finish coat of paint.

All exposed surfaces shall be suitably finished to prevent corrosion during storage and operation, in accordance with the following requirements:

- Areas exposed to dirt shall be designed to minimize retention of dirt and moisture, and sections that may retain moisture or dirt shall be provided with adequate drainage and ventilation and shall be accessible for cleaning. Under-pans or covers, suitable sealed, may be used where applicable to protect underframe sections.
- Joints and crevices shall be sealed with a polysulphide, butyl rubber, or equivalent sealant which is resistant to the operating environment, shall not absorb moisture and shall remain resilient and maintain its sealing properties for the life of the vehicle.

- Metal surfaces shall be treated with surface preparation and primer materials specific for the metal with due consideration for the severity of exposure to which the surface is subjected.
- Any corrosion protection removed for welding shall be replaced after welding is completed.
- Where arc welding is performed on joints between stainless steel and other materials.

18.18 Insulation

18.18.1 Acoustical Insulation

To reduce movement, structurally-borne sound and noise generated by the vibration of the roof, floor and side sheets, panels, air conditioning ducts and other metal surfaces, in particular the doors, damping material shall be applied to the inner side of these surfaces (exterior of the HVAC ducts).

Korfund Vibrodamper Compound, Aquaplas DL-10-HV or Customer approved equal shall be applied to the interior of the complete structural car shell including the roof, sides, floor, ends, webs of all posts, carlines, floor beams and other structural elements.

Application of this damping compound and the surfaces to which it shall be applied shall be in accordance with recommendations of the manufacturer of the compound. The thickness of the damping material shall be such that it provides 10% of critical damping for the treated surface.

18.18.2 Thermal Insulation

The roof, sides, under floor, and ends of the vehicles, including the inside faces of posts and structural members shall be fully insulated.

The density, thickness and type insulation shall be determined by U value requirements established by the HVAC calculations and shall be in accordance with the requirements of these Technical Provisions.

18.18.2.1 General

Insulation materials shall be rigid, nonrigid or spray-on type. Materials shall be non-absorptive of fluids and gases, self-extinguishing, and vermin-proof, and shall have the required properties to meet the noise, vibration and heat loss limits as specified herein.

All materials shall be graded and labeled as standard with the recognized industry associations or societies. Labels shall be permanently affixed to, or imprinted on, the packages or containers of the materials.

18.18.2.2 Installation

All insulation materials shall be installed in accordance with the Manufacturer's recommendations. Rigid and non-rigid preformed insulation shall be secured with mechanical fasteners or fire-resistant adhesive, or both. Spray-on insulation shall be applied over surfaces free from dirt, grease and other contaminants that might affect the adherence of the material.

Parts subject to corrosion shall be given required protection prior to applying the insulation. The Contractor shall take care to avoid thermal shorts in the insulation as installed.

18.18.2.3 Materials

The following materials are acceptable for use on the vehicle:

- Rigid insulation
- Glass fiber preformed board
- Non-rigid Insulation
- Spun glass fiber in flexible rolls or mineral wool batts

18.18.2.4 Insulation Performance

Insulation materials shall be certified to conform to the following requirements:

Property	ASTM Test Method	Requirement
Flame Resistance		
Glass Fiber Board	E162 E662	Flame spread 25 max Ds(4.0) – 100 max
Non-rigid Insulation	E162 E662	Flame spread 25 max Ds(4.0) – 100 max.
Spray-on Insulation	E162 E662	Flame spread 25 max Ds(4.0) – 100 max.
Vapor Barrier		
Rating	C353 Water Method	2.5 perm at 90°F [32°C] and 50% relative humidity

Note: A vapor transmission rate of one grain of water vapor per square foot per hour at a pressure difference of one inch of mercury is defined as one perm.

The thermal conductivity of insulation materials shall be certified when tested in accordance with ASTM C177-04 at 75°F [24°C] mean temperature.

Insulation separated by a vapor barrier shall be used under the floor. The underfloor insulation shall be protected by stainless steel sheathing, which shall seal the underside of the vehicle against water, dust and debris.

Floor insulation material shall be compatible with the material used at locations in the vehicle structure and shall not mold, rot, or sustain vermin.

18.19 Flammability and Smoke Emissions

The vehicle and its components shall comply with the requirements of 49CFR Section 238.103, Appendix B and APTA Recommended Practice RP-PS-005-00. Compliance of the materials with these requirements shall be fully documented with test reports and certificates. For test reports submitted from previously performed tests, the Contractor shall demonstrate that materials included in the test report are identical to the actual materials used on the construction of the vehicles. For high risk materials, test data from these reports shall be dated no more than five years old from the Contract award data and shall be submitted to the

Customer for approval. For low risk materials, test data from these reports that are dated between five and 10 years old shall be accompanied by a letter from the manufacturer stating that the materials included in the test report are identical to the actual materials used in the construction of the vehicles. Materials deemed as low risk shall be approved by the Customer.

There are instances where the Specification calls for use of specific materials, such as Lexan, when it is known that they do not meet all requirements of this section. It is predetermined that use of materials defined by this Specification is acceptable.

A matrix showing the total weight of each combustible material, where used, supplier's name, flammability and smoke emission test identity, test facility, test requirements, test results, nature and quantity of the products of combustion, and heating value in Btu/lb and Btu/hr shall be submitted by the Contractor during detailed design review. **CDRL**

Maximum limits for smoke emission shall be determined using the smoke propagation mode which generates the most smoke.

Should the Contractor believe that the quantity of a particular material is such that it would not contribute significantly to a fire, the Contractor may request a waiver from testing for this material. The waiver shall be submitted in writing and shall include the total weight of the material to be used, the location and the distribution of the material in the vehicle, and any previous test reports available. Waivers shall be accompanied by proper justification and will be reviewed on a case-by-case basis. The Contractor shall be responsible for complete conformance with these standards for itself and its subcontractors and suppliers. The Customer may, at its discretion, require that the current batch of material being provided for this Contract be retested for conformance with these standards.

18.19.1 Electrical Fire Safety

Electrical equipment shall conform to NFPA Standard 130, Section 4-3, except where more restrictive requirements are imposed by this Specification.

18.19.2 Combustible Content

The design of the vehicle shall minimize the total combustible material content of the vehicle.

18.19.3 Toxicity

Those materials and products generally recognized to have highly toxic products of combustion shall not be used.

All materials used in the vehicle construction, except for materials used in small parts (such as knobs, rollers, fasteners, clips, grommets, and small electrical parts) that would not contribute significantly to fire propagation or to smoke or toxic gas generation, shall be tested for toxicity using Boeing Specification Support Standard BSS-7239. Materials shall meet the following maximum toxic gas release limits (ppm) as determined per BSS-7239.

Carbon Monoxide (CO)	3500 ppm
Hydrogen Fluoride (HF)	200 ppm
Nitrogen Dioxide (NO ₂)	100 ppm
Hydrogen Chloride (HCL)	500 ppm
Hydrogen Cyanide (HCN)	150 ppm
Sulfur Dioxide (SO ₂)	100 ppm

The tests shall be run in the flaming mode after 240 seconds using the NBS Smoke Density Chamber for sample combustion. The gas sampling may be conducted during the smoke density test. The test report shall indicate the maximum concentration (ppm) for each of the above gases at the specified sampling time.

18.20 Piping

All piping shall be deburred and blown out after cutting or forming. After installation, the piping runs shall be cleaned using an approved method and procedure.

Piping shall be installed free of low spots to provide complete drainage away from control devices and to prevent damage by freezing. All piping shall be adequately clamped (clamps not welded to pipe) to prevent vibration, using an approved elastomeric tape between the clamp and the pipe. Copper tubing shall be sheathed at clamps or sheathed clamps shall be used. Piping through bulkheads or structure shall be positioned to avoid chafing the use of clamping and/or grommets.

All piping shall be installed using a minimum number of fittings. Unions shall be used only where necessary to permit replacement of apparatus. Hoses shall be provided with swivel type fittings to allow replacement without disturbing surrounding piping or apparatus.

18.20.1 Air Brake Piping and Fittings

Air brake tubing and piping shall be of good commercial quality, free of burrs and scale.

Car body air lines ½ inch nominal and smaller, and in protected locations, shall be of seamless copper tubing, in accordance with Federal Specification WW-T-799F, Type "K", with wrought copper or cast brass sweat type fittings in accordance with ANSI Standards B16.22 and B16.18, or stainless steel with stainless steel flare fittings.

All air piping on trucks and car body air lines larger than 0.5 in. nominal or where subjected to flying debris shall be black pipe conforming to ASTM Standard A53/A53M (schedule 80) with black malleable iron welded fittings, all painted the same as the underframe. Stainless steel pipe and welded stainless steel fittings may also be used. Bends in piping shall utilize large bend radii whenever possible to prevent restriction to the free flow of air. Threaded fittings may be used only where approved on a case-by-case basis. Malleable iron street ells or close nipples shall not be used, except at brake valve exhaust ports.

Hoses shall be allowed only to allow for coupler motion, gladhand connections and connections to brake cylinders from truck body piping. Truck piping shall employ a minimum number of fittings and hoses.

Brake system piping shall be installed in accordance with the recommendations of AAR Standard S-400. Brake piping shall have no low spots (traps) or any 45° or 90° elbows that

form "doglegs" in piping runs. The highest point in the Brake Pipe shall be the branch pipe connection to the brake control unit.

Any piping or tubing which could be disconnected during servicing (event recorder air manifold, etc) shall be permanently labeled to enable the piping to be reconnected correctly when reassembled.

18.20.2 Air Conditioning and Refrigeration System Piping and Fittings

Air Conditioning and refrigeration refrigerant lines shall be fabricated using type K copper tubing and wrought copper sweat type fittings. This shall also apply to lines within supplier furnished apparatus except that finned tubing in evaporators and condensers need not be type K. Instead of elbows, tubing may be bent by means of a tubing bending tool. All tubing shall be deburred after cutting.

Piping shall be routed to keep the number of bends to a minimum. All inaccessible runs of tubing shall be without joints. All suction lines and those subject to sweating shall be insulated. If necessary to limit transmitted noise and vibration to the carbody or to protect the refrigerant compressor from external vibrations, vibration isolators shall be used in the piping connections to the refrigerant compressor.

After fabrication, the system shall be cleared of all dirt and foreign matter using an approved procedure. The completed refrigeration system shall be evacuated and charged with refrigerant using a Customer-approved procedure.

The discharge of condensate drains lines shall be directly to the roadbed avoiding car structure, electrical cables and other undercar equipment.

18.20.3 Soldering of Piping and Fittings

Copper air brake and refrigerant tubing shall be continuously purged with an inert gas during joining and shall be joined using silver solder conforming to Federal Specification QQ-B-654A, BCuP-5, or BAg-5. Condensate drain tubing and car body air brake tubing shall be joined using silver solder. Soldered joints shall be wiped and the flux cleaned from the tubing and fittings after soldering.

18.20.4 Water Piping and Fittings

Water piping shall be seamless copper tubing in accordance with ASTM Standard B75-02 and sized for the service intended. Piping shall be joined using silver solder. Piping shall be clamped with necessary sound insulation to prevent rattle and be sloped to allow drainage.

Fittings shall be sweat type wrought copper or cast brass in accordance with ANSI Standards B16.22 and B16.18 or "Swage-lok" compression type.

Piping shall be joined using silver solder conforming to AWS BAg-2 for cast brass fittings and to AWS BCuP-3 brazing filler metal for wrought copper fittings. The use of solder with lead content is strictly forbidden. The exterior of brazed joints shall be wiped clean after brazing. Flux shall be cleaned from the piping interior of brazed joints.

After installation, the complete water system shall be sanitized. The sanitizing procedure shall be approved by the Customer.

The piping shall be routed and sloped to allow for proper drainage. Low points in piping shall be equipped with Ogontz or equivalent automatic drain valves (specified in respective Sections), each equipped with a heater, which shall discharge all the water in the vehicle to the tracks whenever the air temperature at the valve falls below 38°F. This shall be demonstrated during the climate room testing described in Chapter 19. To insure complete drainage, venting valves shall be provided to operate in conjunction with the drain valves. At each automatic drain valve, a manual drain valve shall be piped in parallel. Sufficient manual drain valves shall be provided to allow complete draining of the car. Valves shall be labeled in accordance with Amtrak Specification 696.

Drains from the water system shall be routed to discharge directly onto the ground, avoiding car structure, electrical cables and all other undercar equipment.

Electrically powered freeze protection, such as heat trace tape secured with conductive aluminum tape, shall be provided for the water fill housings, underfloor and/or equipment area water piping, water system drain pipes, and water tanks. A blanket heater may be used to protect the water tank.

18.20.5 Sewage Piping and Fittings

18.20.5.1 Non-metallic Sewage Pipes and Fittings

A non-metallic 2 in. diameter waste line shall be provided, conforming to Amtrak Specification 759.

All connections shall be of a compression type such as Hydro-Flow fitting, or approved equivalent. All 90 and 45 degree turns shall be large radius sweeps using the flexible non-metallic pipe. The non-metallic piping shall run from each toilet tailpiece to the vacuum pump in the equipment room or underfloor, based upon the car series design. The piping system must be capable of holding a 15 in. vacuum at all times, since some cars are a constant vacuum type operation. All new non-metallic pipe shall be supported to prevent chaffing and vibration under normal train operations. When in use, the components shall not vibrate. Where possible, components requiring maintenance or replacement at overhaul shall be replaceable as individual units.

18.21 Fiberglass-Reinforced Plastic

Fiberglass-Reinforced Plastic (FRP) shall be a glass-fiber-reinforced, laminated material, composed of a gel coated surface, fiberglass reinforcement and a polyester or other approved thermoset resin. FRP shall withstand, without any physical deformation or structural damage, the environmental conditions in Amtrak Specification 963, be resistant to acids, alkalies and cleaning solutions used by the Customer.

FRP shall be manufactured by the matched die molding or open molding process. Production techniques shall ensure that the glass fiber reinforcement is distributed throughout the final product in such a manner as to avoid resin-rich or resin-starved sections. A structural analysis shall be provided to confirm that the construction method chosen is adequate for its intended purpose.

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FRP parts shall have a greater thickness at attachment points and edges. Exposed sharp edges will not be allowed on any parts.

18.21.1 Resin

The resin shall be of high-quality, commercial grade, thermosetting, polyester, phenolic or vinylester material selected to meet the requirements of the Contractor and manufacturer molding process requirements.

18.21.2 Reinforcement

The fiberglass reinforcement shall be mat, fabric woven roving, continuous roving, chopped spun roving, or swirl mat as required to meet the physical properties of this Specification and the molding process requirements. The glass content shall be a minimum of 20% by weight.

18.21.3 Gel Coat

The gel coat shall be a high gloss finish resistant to scuffing, fire, weather and cleaning agents. The gel coat shall have a minimum thickness of 0.015 in. If the surface of the FRP panel is to be painted, a primer gel coat shall be used and the part shall be painted in accordance with manufacturer's specifications. If the FRP panel does not receive paint, then the gel coat shall be pigmented to match the color selected by the Customer. The reinforced composite component shall be gel-coated on all exposed surfaces. The surfaces shall withstand, without any physical deformation or structural damage, the environmental conditions and resistance to acids, alkalis and cleaning solutions recommended by the Contractor.

18.21.4 Additives

Additives, fillers, monomers, catalysts, activators, pigments, fire retardants and smoke inhibitors shall be added to the resin mixes to obtain finished products with the required physical characteristics of this Specification.

Mineral filler shall not exceed 28% of finished weight for any preformed matched die molding process.

18.21.5 Strength Requirements

Independent laboratory test certificates shall be provided stating that the reinforced plastic material complies with the requirements of the following standards. Test specimens shall be conditioned in accordance with ASTM D618-08.

Mechanical Property	ASTM Test	Open Moldings	Matched Die Molding
Tensile Strength	D638-08	10,000 lbf/in. ²	12,000 lbf/in. ²
Compressive Strength	D 695	18,000 lbf/in. ²	22,000 lbf/in. ²
Flexural Strength	D790	15,000 lbf/in. ²	22,000 lbf/in. ²
Impact Strength	D 256	6 ft lb per in. of notch	8 ft lb per in. of notch
Hardness	--	45 Barcol	45 Barcol

18.22 Thermoplastic Sheet

Thermoplastic sheet used in the construction of the vehicle shall withstand, without any physical deformation or structural damage, the environmental conditions described in Amtrak Specification 429, and shall be resistant to the Customer cleaning solutions. Thermoplastic sheet shall be used as extruded or vacuum-formed.

Thermoplastic sheet shall be homogeneous and extruded from virgin stock which does not include any regrind of vacuum formed parts. Only UV stabilized pigments shall be used to create the specified color of the thermoplastic sheet. The color and surface finish of parts manufactured from this material shall be approved prior to the production run of any parts.

18.22.1 Quality

The finished parts shall be free of waves and quilting on both sides. Degraded polymer in the sheet shall not be allowed, and if present, shall be cause for rejection of the piece. Voids, lumps and contamination shall also be cause for rejection of parts if the defects are larger than 0.010 in., and the population of these defects is greater than one defect in four square feet.

18.22.2 Strength Requirements

Independent laboratory test certificates shall be provided stating that the thermoplastic sheet complies with the requirements of the following standards. Extruded sheet in the surface finish specified shall be used for testing.

Mechanical Properties	ASTM Method	Value
Specific Gravity	D 792	1.20 to 1.45
Tensile Strength	D638-08	5,500 lbf/in. ² minimum
Flexural Strength	D790	8,000 lbf/in. ² minimum
Flexural Modulus	D790	3.3 x 10 ⁵ lbf/in. ²
Hardness Rockwell	D 785	90 to 110 ("R" Scale)
Heat Deflection (annealed)	D 648 @ 264 lbf/in. ²	160°F minimum
Impact Strength (Fabricated Parts)	D 3029 Gardener Dart Drop 0.5" dia. ball at 73°F	160 in. lb minimum

18.23 Air Filters

18.23.1 HVAC and Equipment Ventilation Filters

HVAC system air filters shall conform to Amtrak Specification 685 and shall be selected in accordance with the manufacturer's recommendations for the specific equipment involved. All filters shall have an integral frame. Filters shall be the throw-away type available in standard commercial sizes except reusable filters that may be approved for specific applications where throw-away filters are not available. Filters shall be designed to meet the performance requirements of each installation and shall be approved. All filters shall be freely accessible for maintenance.

18.23.2 High Pressure Air Filters

An air filter assembly with a replaceable filter element shall be provided in the air line that connects each subsystem to the main reservoir air supply system. The main reservoir air filter filtering capability, flow rate capability and overall size shall be appropriate for the application so that the filter replacement interval is greater than one year. Quality of compressed air supplied by the locomotive shall conform to APTA Standard SS-M-011-99. It shall be possible to gain access to the filter element for replacement without requiring any pipe fittings to be disconnected or loosened. Glass fiber mat types of filter media shall not be used for high pressure or high volume applications. Filters shall be provided for each of the following systems and any others operated from the air supply system:

- Each air brake control assembly
- Waste system
- Door operators (if pneumatic)
- Horn
- Low pressure air filters

Replaceable media type filters shall use resin-bound, spun-glass fiber materials having an uncompressed thickness not less than 3.5 in. It shall be non-absorptive of fluids and gases, shall be processed in such a manner that material density increases progressively from air inlet to air exit side, and shall be coated with not less than 24 grams per square foot of a dust-retaining, viscous adhesive film. This film shall be stable at temperatures up to 150°F. The filter medium shall be cut not less than 0.5 in. oversize to ensure adequate sealing between the edge of pad and its integral frame.

18.24 Wire and Cable

All wire and cable used shall exhibit the physical and electrical properties for 110°C rated wire and cable specified in Amtrak Specification 323. High temperature wire, used for heater circuits, shall be as defined as Amtrak Specification 323.

A minimum number of wire types and sizes shall be used in the vehicle. Selection of wire size and insulation shall be based on the current carrying capacity, voltage drop, mechanical strength and temperature and flexibility requirements and in accordance with APTA Recommended Practice RP-E-009-98 and applicable AAR, ICEA, ASTM or MIL Specifications. The Contractor shall submit to the Customer for review and approval, a procedure for installation of wiring and cable, including the criteria and procedures for the repair of damaged wire or cable. This procedure shall be included in the heavy maintenance manual.

In no case shall wire smaller than the following sizes be used:

- Wire on electronic units, cards, and card racks - No. 22
- Wire on connector - No. 16
- All other wire - No. 12 unless approved by the Customer

18.24.1 Wiring - General

All vehicle wiring shall be in conformance with APTA Recommended Practice RP-E-002-98 and RP-E-009-98, Chapter 3 of the National Fire Protection Association's Publication NFPA No. 70, and the AAR Manual of Standards, Section F S-538, *Wiring Practice and Rolling Stock Standard*, except where otherwise specified, and except that all wire shall be as required in this Specification. Design wire ampere capacity shall comply with NEC Table 310-18, 110C Column. When more than three conductors are applied in a raceway or cable, the ampere capacity shall be derated, as described in Note 8 of Table 310-16. Circuit protection shall be in conformance with Chapter 2 of NFPA publication No. 70, Article 240.

18.24.2 Data Communications Wiring

All data communications (Ethernet) wiring shall be able to support EIA/TIA 568 Cat 5e communications for data on rolling stock. It shall be suitable for use in undercar and inter-car applications when installed in flexible (polyimide) or rigid conduit; it shall be suitable for the application and shall maintain long-term electrical integrity for all aspects of the EIA/TIA requirements including impedance, cross-talk, attenuation, and shielding effectiveness. The cable will also meet environmental and safety requirements associated with rolling-stock cables. The cable shall be designed with rolling-stock requirements in mind, and will support high-speed data transfer for no less than 20 years in the rail environment. All accelerated life tests performed in the qualification are specified with the intention of this service life. The cable shall be designed so that installation with normal care into new car shells or undercars will not damage its electrical integrity. The cable shall be designed so that installation in raceways with other cables is proper (cable will not be impacted by crushing or cable-to-cable abrasion). The cable shall be able to be terminated with vendor specified connectors that are suitable for use in industrial communication equipment (RJ45, M12 or similar.). The cable shall have the following characteristics:

18.24.2.1 Construction

- Conductors: Stranded silver-plated copper #22AWG (or .5mm²)
- Insulation: Radiation cross-linked data grade polyolefin 300V
- Component configuration: Wires are twisted or helically cabled to insure electrical performance to Cat 5e standards (see table) – 100Ω characteristic impedance on finished cable
- Shielding: Foil and TC braid designed to meet 200MΩ/m transfer impedance
- Binders/tapes: As required to enhance integrity
- Jacket: Radiation cross-linked polyolefin (low-smoke, halogen free) 0.8 mm minimum at thinnest point.

18.24.2.2 Electrical Requirements

- Impedance: 100Z+/-5Z
- Shielding effectiveness (30 Mhz- 100 Mhz): 40dB
- Voltage rating: 300V

Frequency (Mhz)	Attenuation (dB/ 100m)		Next (dB) Pr/Pr		Next (dB) Pr/Pr		Return loss (dB)		Attenuation Unbalance Near End (dB)
	Typical	Max	Typical	Min	Typical	Min	Typical >	Min	Min
1	2	3.2	80	65.3	79.5	-			40
4	4	6	76	56.3	70	-	35	23	34
10	6.5	9.5	67	50	65.5	43.8	35	25	30
31.5	10.5	17.1	60	42.9	58.5	33.9	35	23.6	25
62.5	14	24.8	56	38.4	59.5	27.9	33	21.5	22
100	18	32	53	35.3	67.5	23.8	33	20.1	20

18.24.2.3 Environmental Requirements

- Cable jacket will withstand the following tests per AAR RP 585
- Tensile and Elongation Section 5.1 and 5.2
- Oil Resistance 5.3 and 5.4
- Thermal Shock 5.8.4
- Penetration 5.9.4
- Abrasion 5.9.8.2
- Corrosion resistance ASTM D2671-00(2007)e1
- Temperature -40°C- 90°C

18.24.2.4 Mechanical Requirements

- Bending radius: 6x OD (fixed)
- Car-to-car cables should have a test modeling the installed condition, with periodic measurement of electrical characteristics - 3,000K cycles - with no application-altering failure in electrical performance.

18.24.2.5 Smoke and Flame

- NFPA 130 (UL1685) or equal i.e. UL 1581 (tray) or IEEE 383 1974
- Bombardier SMP 800-C (for combustion products)

18.24.3 Wire Handling

All wiring shall be performed by qualified, experienced wiring personnel using appropriate tools for stripping insulation, cutting, tinning, soldering, harness making, attaching terminals and

other wire fabrication tasks. All wiring tools and equipment shall be used as recommended by the tool and equipment manufacturer.

Wire shall be protected from damage during all phases of equipment manufacture. Wire shall not be walked on, dragged across sharp or abrasive objects, kinked or twisted, or otherwise mishandled. The ends of wire shall not be permitted to lay on wet floors or other damp areas where moisture may be absorbed into the conductors.

When removing insulation, wire strands shall not be nicked or broken in excess of the requirements of FAA Specification No. AC 43.13-1A, Section 449, *Stripping Insulation*. Additionally, the following criteria apply:

Wire Size	Maximum Number of Nicked Strands*
Wires smaller than No. 10	None
No. 10 through 1/0	7.4 percent
Above 1/0 through 1600/24	4.4 percent
Above 1600/24	graduated scale
*Definitions: A cutoff strand shall count as two nicked strands. A nick is defined as 25% or more of the strand area damaged, or cut more than 1/3 of its diameter.	

18.24.4 Wire Harness

The layout of wiring, for both vehicles and equipment, shall be designed in advance of its installation and in cooperation with the suppliers of the related equipment. Wiring shall be pre-fabricated into standard harnesses, wrapped and tied with nylon wire ties or a high strength, waxed lacing cord designed not to invade the wire insulation. Harnesses shall be installed with identical arrangement and location in each vehicle having similar equipment. Separate harnesses shall be provided for major circuit groups or types, or as required for specified circuit separation. All circuits and branches shall be separable by means of terminal boards to isolate portions from others for troubleshooting. All circuits subject to periodic high potential tests shall be so arranged that they can be conveniently isolated for the tests.

Alternative methods for fabricating and installing wiring, which are standard carbuilder practice, will be submitted for consideration at the appropriate design review.

Harnessed wires shall not be installed in conduit. Wires from different conduits or other openings shall not be harnessed together with wires running within the box or entering the box through another entrance point. Each harness or group of wires between equipment enclosures shall contain a minimum of 10% spares, but no fewer than two spares for each wire size.

18.24.5 Circuit Separation

Circuits shall be physically separated to reduce the possibility of unsafe conditions, electrical interference or equipment damage.

The following major circuit groups shall not be harnessed or bundled together, shall not run in the same conduit, and shall be physically separated and secured in enclosures, wire ducts, junction boxes, or other wire routing devices:

- 480Vac HEP trainline

- 27 point communications trainline
- 27 point MU trainline
- IITS/Cab Signal circuits
- AC power circuits
- DC control circuits
- Communication circuits
- Unprotected wiring (eg, battery or HEP trainline to circuit breaker)
- Data communications (Ethernet) wiring even though it might be in the same car to car 27 point communications trainline jumper

Conductors which shall operate at potentials differing by 50 volts or more shall not be cabled together and shall not be placed in the same conduit, raceway, duct, junction box, or enclosure, except that 120VAC and 480VAC may be run in same conduits providing all the wire insulation is rated at 600VAC minimum. Where it is impossible to avoid having wires at different voltages in the same equipment enclosure, the wires shall be physically separated, bundled, and secured separately such that contact between wiring is not possible. All wiring within an enclosure shall be insulated for the highest voltage in the enclosure, unless Customer approved otherwise.

Wiring connected to transient-generating apparatus shall not be run adjacent to wiring carrying signals to, from, or between semiconductor circuits, logic circuits, vital no-motion circuits, data transmission or communication circuits. In cases in which adequate physical separation is impossible, shielded wire shall be used for all conductors involved.

18.24.6 Wire and Cable Runs

Wire and cable runs shall be properly placed to be protected from the environment, debris and be arranged to allow for proper heat dissipation per manufacturer's requirements.

All wire and cable shall be free of kinks, insulation damage, insulation abrasions and nicked strands. Wire installation shall not be subject to accumulations of water, oil, or other foreign matter.

Cables shall be laid in place with sufficient slack at the bends so that cables will clear the inside bend surface of the strain relief device.

Conduit shall be attached to the carbody employing clamps; welding shall not be used under any circumstances.

Concealed wires, such as within conduits and wire ducts shall be such that wires may be replaced or added to without the removal of other than an access panel at each end of the wire. It shall not be necessary to disconnect or disassemble conduit to accomplish this task. Wires in conduits and wire ducts shall not utilize more than 40% of the interior cross-sectional area.

Wiring run in loom shall not be carried over a potential chafing hazard.

Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them. This applies to all current carrying wires, cables or buses on the vehicle.

18.24.7 Undercar

The 480Vac trainline conductors shall be cleated in place; No. 6 AWG and larger may be cleated in place or run in rigid conduit.

All undercar wiring smaller than No. 6 AWG shall be run in Rigid Galvanized Steel (RGS) conduits in an approved manner. Conduits shall be of waterproof construction. Permanently retained watertight strain relief bushings, with insulated throat liners of an approved design, shall be used at locations where wires, cords or harnesses enter or exit conduit, junction boxes and equipment enclosures. In addition, strain relief bushings on equipment enclosures shall include a permanently retained O-ring type seal.

Wires or cables shall not pass through or over the battery compartment and shall not pass over heat generating equipment, even if the wires or cables are in conduit.

Rigid galvanized steel conduit shall be run to all rigid-mounted enclosures. RGS conduit shall be run as near as possible to resiliently mounted equipment, with flexible conduit, not to exceed 18" in length, completing the run.

Flexible conduit shall not be used for any application on the exterior or underside of the car without Customer approval.

Open undercar wiring shall be protected over the trucks by running the wiring through RGS conduit, with suitable protective bushings applied at the ends.

Conduit routing and the connection to boxes shall minimize exposure to water entering the conduit: for example, conduit should not enter from the top of the enclosure if at all possible. Drip loops shall be employed as appropriate.

18.24.8 Exterior of Roof

All wiring to roof-mounted equipment shall be run in electrical metallic tubing steel or rigid galvanized steel conduits within the carshell.

Wires or cables exposed or in conduit shall not pass over or near heat generating equipment.

Conduit routing and the connection to boxes shall minimize exposure to water entering the conduit: for example, conduit should not enter from the top of the enclosure if at all possible. Drip loops shall be employed as appropriate. Boxes shall be raised above surfaces where water, snow/ ice could accumulate (including from plugged drains), to reduce the likelihood of water incursion.

18.24.9 Under Floor

Wiring run under the floor shall be either in conduit or wire duct. Care shall be taken to ensure water does not enter the conduit/ wire duct from above, such as from car cleaning.

18.24.10 Interior

Any wiring passing through the floor shall be run in rigid conduit. Wiring, even if enclosed in loom, must not be run through partitions without suitable bushings being provided at such points of passage. Conduit openings from below must extend at least 1 in. above the floor level to ensure water cannot enter the conduit from above, such as from a wet floor.

All 480V wiring above the car floor and within the sides, ends or roof of the car shall be carried in EMT or rigid steel conduits. Short runs, not to exceed 18 in., of flexible conduit may be employed to make final connections to equipment.

All wiring in the walls shall be in EMT or rigid conduit. Wiring in the roof shall be carried in thin-wall aluminum or steel conduit, in metal duct or "Panduit" material meeting the requirements of Amtrak Specification 352. All flexible non metal conduits shall be installed in protected areas only, unless specifically approved by the Customer. In wire ducts, wire shall be secured within and including each entrance and exit point, to prevent chafing movement.

18.24.11 Cable Cleating and Support

Open-run cable shall be supported by using split-block cleats of molded neoprene rubber, spaced no more than 4 feet apart. Slack shall be allowed in the cable to accommodate both thermal expansion and contraction of cable.

Each cleat shall have a channel-shaped stiffener of at least 10 gage material on the side away from the mounting bracket which shall act to spread the bolt clamping force over the entire length of the cleat. Bolts shall have lock nuts.

Cleats shall be designed to grip each cable individually and firmly, but without causing any damage to cable insulation, including cold flow of the insulation. Cleats shall include spacers in the mounting holes to prevent crushing the cleat by overtightening the mounting bolts. Each cable in the cleat shall have its own cutout sized to the correct wire diameter. The cleat material shall be fire retardant insulating material with a durometer of 50 to 60.

Cleated cables shall be routed and supported such that they cannot, under any combination of forces and car movement, touch each other or any other part of the car, except the cleat cushioning material.

18.24.12 Wire Securement and Termination

All wiring shall be secured and protected against movement, chafing, and any contact with conductive, sharp, or abrasive objects including the inside surfaces of wire runs.

No wiring shall be secured directly to the vehicle structure, equipment enclosures, or any metallic surface. Wiring securing devices shall be either completely non-metallic or metallic with a resilient, insulating member between the wiring and the metallic portion of the device.

All wiring shall be located and secured such that normal equipment motions, maintenance access, heat sources and the environment do not damage or reduce the life of the wiring.

Junction boxes, with terminal boards, shall be used, as required, for wire terminations. Harness connections to the boxes, as well as internal wiring to terminal boards, shall be as specified. Exterior junction boxes shall be watertight.

Wire and cable dress shall allow for sufficient slack at equipment terminals to provide for movements induced by shock and vibration, equipment shifting, alignment, cover removal and component replacement. Sufficient lengths shall be provided at points of termination for additional re-terminations without applying tension to the wire and without splicing the wire, as follows:

No. 10 AWG and smaller	Three re-terminations
No. 8 AWG and large	Two re-terminations

A drip loop shall be provided on all exposed wires and cables to prevent fluid runoff into connected equipment.

Wire tying devices shall be of such material and construction that they will adequately retain the wires for the life of the wiring and shall be resistant to ozone and ultraviolet light. Wire and cable ties shall be trimmed using the proper tool and located to eliminate any hazard to personnel from sharp edges. Wire tying devices shall be snug, but shall not be so tight as to cause indentation and cold flow damage to the insulation. Wire tying devices shall be mechanically fastened to a permanent structure. Adhesive-installed mounting bases shall not be used for ties or for cable support.

Wire tying devices shall not be used:

- For any external undercar application
- To support wire under its own weight
- To support/secure any type of conduit

All wire bundles and cables within an enclosure shall be supported by the use of tape rails, shall be spaced away from the equipment box structure, metal edges, bolt heads and other interference points and shall have electrical clearance from the covers, regardless of the insulation properties of covers. Wire bundles shall be located above or alongside the apparatus rather than at the bottom of the box wherever possible. In all cases, wire shall be a minimum of 1 inch above the bottom of the box. Wire entry into control or junction boxes shall not be permitted through the bottom of the box.

Truck wiring shall be designed to ensure sufficient slack, for pivoting, spring action and jacking and shall be provided with clamp supports and abrasion protection. T-splices will not be permitted.

All jumpers, jumper heads and jumper receptacles shall be sealed in an approved manner to prevent the entry of water at any operational speed.

Any wiring needed to calibrate and test vehicle functions shall be a part of the permanent vehicle wiring to enable the Customer to conveniently maintain the equipment. This wiring shall terminate in approved connectors in the respective control groups and cabinets.

The Customer requires wiring and cabling to be accessible for repairs; the Contractor shall submit a complete wiring plan for evaluation at the appropriate design reviews.

18.24.13 Marking

All terminals boards and terminal posts shall be plainly marked with non-conductive hot stamping type markings so that they shall be easily identified. Devices shall be labeled via silk-screening onto panels, mechanically-attached plastic labels (adhesives are not acceptable alternate), or other permanent means approved by the Customer in design review.

Wires shall be marked with sleeve-type labels with permanent typed-on lettering, such as Raychem TMS or approved equal, or with non-conductive hot stamping type markings. Both ends of each wire are to be identified. A wire 4 in. or less in length shall need only one label. For No. 16 and smaller wires, including multi-conductor cables, where individual wire marking would be impractical, color coding of each wire will be satisfactory.

18.24.14 Cable and Wire Identification

The Contractor shall provide a listing of all wire codes and device and connector identification used on its equipment as part of the integrated schematics manual.

The identification system shall be designed to utilize the minimum number of alphanumeric characters to identify devices and interconnecting wiring. Device, terminal and wire identification is intended to provide unique, consistent, clear, concise and recognizable identification of wiring and devices as an aid to maintenance of electrical systems. The wire-designation system shall be one which relates the designation in some way to indicate where it shall go and where it shall come from. Each individual piece of wire shall be given its own distinct identification so that it shall be positively identified at its opposite end without the necessity for "ringing through." As much as possible, naming shall be consistent among all the Customer equipment. This naming system will be employed on the following:

- Electrical Arrangement Drawings
- Electrical Schematics
- Wiring Diagrams
- Labels on hardware
- Car Electrical Panels, etc.
- Device names: circuit breakers, indicators lights, switches, relays, contactors, pressure switches, etc.
- Car Wiring
- The above categories on drawings provided by different vendors (for example, air brake schematic and electrical schematics)

By using the nomenclature and appropriate schematic, an electrician shall be able to easily identify any point in a circuit, such as an auxiliary contact, and locate that point on the hardware.

The identical name shall be used for a given component in all references - arrangement and schematic drawings, wiring diagrams, panel and switch plate legends, and maintenance manuals.

It shall be the Contractor's responsibility to ensure that:

- All equipment suppliers conform to this Specification;
- A consistent numbering system is used throughout the vehicles; and
- Component device and wire names are not duplicated.

At a minimum, the following major electrical system components shall be identified:

- Electrical panels
- Contactors and motor starters
- Relays and timers
- Switches and circuit breakers
- Electronic components
- Terminal blocks
- Connectors
- Each wire
- All labels shall be permanent and expected to be legible for the life of the vehicle.
- Labels shall be easy to read and observable without having to disturb wiring, especially for:
 - Relay names
 - Contactor/Motor starter names
 - Terminal block and terminal identity.
- In cases where two or more identical panels are used, the respective panel names "A" and "B" (as appropriate) shall be affixed to the car body or mounting plate, not the panel.
- Numbering system shall be consistent between Contractor and component supplier, such as floor heat wire names. It shall be possible for an electrician to connect all external car wiring to a panel without requiring a drawing.

18.24.15 Pulling Compound

Pulling compound shall be non-conductive, non-hygrosopic, non-odorous, and shall not attract vermin.

18.24.16 Solder

Solder shall be in accordance with ASTM Standard B32-08, Grade 60B. A flux of non-corrosive type shall be applied immediately before soldering and removed after soldering.

18.24.17 Tape

Electrical tape shall be polyvinyl chloride in accordance with UL 510, Standard *Insulating Tape*, CSA Standard C22.2, No. 197-M1983, *PVC Insulating Tape*, or equivalent approved railway

practice. Electrical tape shall meet or exceed the voltage rating of wire where the tape is applied.

18.25 Wire and Cable Connections

All wire and cable shall be free of kinks, insulation damage, insulation abrasions and nicked strands. Wire installation shall not be subject to accumulations of water, oil, or other foreign matter.

Cables shall be laid in place with sufficient slack at the bends so that cables will clear the inside bend surface of the strain relief device.

Conduit shall be attached to the carbody employing clamps; welding shall not be used under any circumstances.

Concealed wires, such as within conduits and wire ducts shall be such that wires may be replaced or added to without the removal of other than an access panel at each end of the wire. It shall not be necessary to disconnect or disassemble conduit to accomplish this task.

Wiring run in loom shall not be carried over a potential chafing hazard.

Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them. This applies to all current carrying wires, cables or buses on the vehicle.

All equipment enclosures and junction boxes shall be fitted with terminal boards or connectors. The Contractor shall submit the proposed design and product line for all connections for approval. Number 6 and smaller type terminal boards and quick-disconnect terminals, other than those stated herein, will only be permitted with approval.

18.25.1 Terminal Boards and Terminal Points

All electrical terminal points and terminal boards of wire size AWG 10 or larger shall have brass studs and connections, each of which shall be locked using a single brass nut with brass flat washer and a plated spring-type lock washer. Studs, nuts, and washers may also be made of corrosion-resistant plated steel, where approved. Each board or connector shall have the necessary number of terminations plus a minimum of 10% spares, but not fewer than one spare unless approved. Binding head screw type terminal boards will be permitted only where approved. All terminal boards shall be in accordance with Military Specification MIL-T-55164C.

All wires of size range AWG 12 to 14 shall use modular spring lock terminal blocks. The terminal block modules will be mounted on din rails. The supplier shall provide standard 35mm wide DIN-rail in 7.5mm, 15mm and 58mm heights. The DIN-rail shall meet RoHS (Restriction of Hazardous Substances Directive) standards and shall be available perforated or unperforated. Materials will include chromated-steel, copper, and aluminum. The modules shall be color coded for the ability to tell the signal type at a glance. The terminal blocks shall be available in the following colors/color combinations of gray, blue, red, yellow/green, black,

yellow, orange and brown. The metal body shall contain a high strength spring steel spring element that will provide a gas-tight connection with the conductor.

Spring connection shall be stainless steel. The terminal blocks shall come with car body ground modules that are connected directly to carbody ground. The terminal blocks shall come with insertable shorting plugs. The terminal blocks will have snap in positive lock labels. Terminal Blocks shall have a method of labeling for easy identification which is universal across all connection technologies. The modules will have a place to label the terminal number as well as the terminal block name. Each wire shall have a ferrule on its end and be able to be inserted by engaging the spring with a standard 3mm slot size screw driver.

Terminal Block accessories and bridging systems shall be compatible and interchangeable with all connection technologies (screw, spring and IDC technology) including flexible bridging system, modular testing, standardized labeling system and pluggability features.

Threaded studs shall have a minimum of 2-1/2 threads exposed beyond the final nuts. Adequate space shall be provided to permit connecting wire terminals with standard tools. All terminals shall be properly torqued to assure sound connections. Spacers shall not be used.

Jumpers between terminal board points shall be brass or plated steel. Wire jumpers between adjacent terminals of terminal boards will not be permitted.

Terminal blocks located outside the carbody or operating at 480V or above will employ closed bottom blocks.

An approved permanent marking strip on each terminal board shall be provided and attached adjacent to the wire junction point to identify the wires attached thereto. **CDRL**

A maximum of two terminals shall be connected to any one binding screw. A maximum of four terminals shall be connected to any one threaded stud, provided that there is no interference between terminal barrels. On terminal boards, the wiring shall be arranged so that no more than two terminals are connected to a stud, from each side of the terminal boards.

18.25.2 Wire Terminations

Terminals and connections used throughout the vehicle shall be the mechanical, solderless, crimp type made by AMP Incorporated or other approved manufacturer with a comprehensive line of terminals, connector pins and application tools available. The Contractor shall submit the proposed product line for approval. Terminals shall be tested to Military Specification MIL-T-16366F for temperature rise, voltage drop, vibration, current overload and corrosion.

All wire terminations shall be accessible to remove or replace. Wire terminations shall not be covered by other wires.

Terminals and connections shall be attached to the wiring with proper crimping tools and dies as recommended by the manufacturer. Application tooling shall incorporate die or piston stops to prevent over crimping. To prevent under crimping, all application tooling shall incorporate a "full cycle" feature that once started, requires the tool to be brought to the stops before the crimped connection can be removed. The Contractor and his suppliers shall employ a certification process to ensure that all tooling remains within calibration to properly crimp the lugs.

Spade and hook-type terminals shall not be used. Corrosive protection shall be provided for all base materials.

Conductors subject to motion relative to the terminal shall be protected by suitable means to prevent breakage of the conductor at or near the terminal. Sufficient slack shall be provided in all wires and cables to prevent breaking or pulling out of bushings and terminals. A maximum of one wire shall be crimped in any one terminal.

18.25.3 Power Cable Terminations

Power cables shall be terminated with an approved compression terminal. Sufficient cable slack shall be provided to preclude breaking or pull-out from bushings or terminals and to allow two terminal changes. Cable conductors shall be clean prior to installation of terminals. Compression terminals shall be applied using tools and procedures recommended by the terminal manufacturer for that purpose. Swaging tools shall be of a type that ensures complete swaging in every case.

18.25.4 Cable Connectors

All cable connectors shall conform to MIL-C-5015, or an equivalent standard as approved by the Customer. They shall employ removable crimp contacts of the correct size for the wire being terminated. Except as noted below, the connector contact area shall be plated with a minimum of 0.000030 in. of gold over a minimum of 0.000050 in. of low stress nickel. For high current applications, the connector contact area shall be plated with a minimum of 0.00010 in. of silver. Adjacent connectors shall either use different inserts or different insert orientations to prevent erroneous connections. One piece of all cable connectors shall be rigidly mounted.

Connectors shall be keyed so as to not be accidentally interchanged between adjacent connectors. Spare contact allocation shall be 10% to 15%, but no less than 4, per connector. Power and control wiring shall be separated in different connectors if they exceed 120VAC. Disconnected plugs will be supported so as to not drop to the ground, floor or other position in which they might be readily damaged. Connectors are to be mounted to provide convenient hand access so as to be easily mated and unmated.

All cable connectors used in exterior locations shall be of the environmental watertight variety and a molded type wherever possible (such as speed sensors). Cable connectors shall be equipped with sealing gaskets on the front mating surface and on the back where the cable enters. Bolts within the connector shall be long enough to ensure that there is sufficient room to terminate the cable wires within the connector body. The cable jacket shall be held by a clamp within the connector body. Unused connector pin positions shall be sealed with either connector contacts or plastic sealing plugs designed for that purpose.

Plastic bodied connectors shall not be used.

Except as provided above, all cable connectors in exterior locations, shall be 1/4-turn, bayonet-lock, quick disconnect type connectors, or approved equal. They shall conform to all provisions in MIL-C-5015, or an approved standard, except for the screw coupling requirement.

In waterproof interior locations, the use of non-weatherproof connectors will be allowed as approved. All other connector requirements specified in this section which do not directly apply to weatherproofing shall be met.

18.25.5 Quick-Disconnect Terminals

Only Customer-approved quick-disconnect terminals may be used. They shall be modular and they shall provide positive terminal engagement and be shock and vibration proof. All terminals shall be provided with insulation equal to that of the wire. No "push-to-fit" (FAST-ON) type terminals will be permitted unless specifically approved by the Customer for that unique application.

18.25.6 Grounding/ Bonding Connections

Grounding and bonding shall be done in accordance with APTA Standard SS-E-005-98. All grounding and bonding jumpers and straps shall be sized to handle fault current for which the voltage drop shall not exceed 25V. The bonding method employed shall not produce a dc resistance in excess of 0.0025 ohms, or more than 0.025 ohms at 150 kilohertz for any applied ac voltage. Grounding and bonding jumpers, and brazed shunt straps shall be flexible.

The car body shall be grounded to each truck frame by means of a separate cable which shall be sized to safely ground the car under normal conditions.

The 120VAC, 60 Hz, single-phase service shall be separately and firmly grounded to the car body structure and have a green indicating color band applied to the terminations.

All apparatus operating at 480VAC and not directly grounded to the car body through its mounting shall have grounding straps. This particularly applies to resiliently mounted equipment.

18.25.7 Wire Splicing

Splicing of conductors shall be avoided and shall be permitted only with approval on a case-by-case basis. Splicing of conductors in conduit will not be permitted. In the event a splice is approved, it shall be in a junction box and the spliced joint shall be mechanically as strong and have the same conductivity as any other part of the conductor. The splice shall be an insulated permanent crimp splice in accordance with Military Specification MIL-T-7928G, Type II, Class I, and shall be installed with the crimping tool and die of the splice manufacturer. All splices shall be insulated with a self-sealing, weathertight, seamless shrink tubing. The outside diameter of the spliced portion of the cable after the insulation is applied shall not exceed the outside diameter of the unspliced portion by more than 40%. Splices shall be identified in the integrated schematic.

18.26 Conduit

18.26.1 Types

Thin-wall EMT type conduit shall conform to Federal Specification WW-C-563A. Flexible metal conduit shall conform to Federal Specification WW-C-566C or MIL-T-81914.

18.26.2 Size and Fill

Conduit shall be sized such that the sum of the cross-sectional areas of the conductors and their insulation does not exceed 40% of the cross-sectional area of the conduit for three or more conductors. For two conductors, a limit of 31% shall be used, while for a single conductor, a limit of 53% will be permitted. Where conduit having a length not exceeding 24 in. without bends of more than 15° is used between enclosures, a maximum fill of 60% will be permitted.

18.26.3 Installation

A run of conduit between junction boxes and/or pulling outlets shall not contain more than the equivalent of four quarter bends, 360° total, including the outlet fittings. Bend radii at the inner surface of the bend shall be no less than eight times the nominal inside diameter of the conduit.

All conduit bends and offsets used shall be made by the use of special forms or tools and shall have the largest radius possible so that wires can be pulled without the use of tackle or power.

Conduit shall be securely clamped with all runs electrically grounded to make a continuous ground. Suitable approved insulation to prevent electrolysis shall be provided where steel and aluminum are in contact.

All conduit shall be arranged to prevent moisture traps and shall drain toward control boxes, except that all open-ended conduits shall be installed in such a manner as to ensure gravity drainage out the end. The conduit arrangement and installation shall be subject to approval. **CDRL**

18.26.4 Conduit Fittings and Junction Boxes

The conduit fittings and junction boxes for vehicle wiring shall be as manufactured by the Contractor or by a supplier of a comprehensive line of parts. The Contractor shall submit the proposed product line for approval. All conduit fittings and junction boxes shall be provided with gasketed covers. **CDRL**

18.26.4.1 Boxes

All exterior junction boxes shall be fabricated of steel with a minimum wall thickness of 14 gauge. All exterior junction boxes shall be weatherproof and shall be connected in such a way that drainage from equipment groups will not pass through conduit into the junction boxes. Interiors of all junction boxes shall be primed and then protected with a white, insulating epoxy powder coating. Equipment areas containing non-insulated electrical devices at more than 120 volts to ground shall be plainly marked with warning signs worded DANGER – XXX VOLTS. Covers for electrical junction boxes shall be accessible at all times without having to remove other equipment.

18.26.4.2 Conduit Interface

The open ends of conduit shall be provided with strain relief type fittings with extended rubber bushings, bell-mouth fittings, or insulated throat box connections as approved. All conduit entries into removable equipment boxes shall be secured by means of a bolt-on watertight access panel.

18.26.4.3 Covers

All junction box covers shall be retained by captive screws. All fasteners used in junction boxes shall be stainless steel. All covers shall be designed to accept or mate with a bulb-type clamp-on seal.

18.26.4.4 Wireways

Wireways will be permitted in approved ceiling locations only. They will not be permitted in the car body sidewall area. Only conduit will be permitted in the car body.

All wireways shall be "Panduit", meeting Amtrak Specification 352, or of rigid steel with a coating to minimize the risk of oxidation and rust formation. The trays shall be adequately supported throughout their entire length in an approved manner. There shall be absolutely no sharp edges. The trays shall be completely de-burred before installation on the vehicles. Grommet clamps shall be provided at all locations where cables or wires enter or leave the wireways. Under no circumstances shall leads be draped over the edge of the wireways, with or without wireway edge protection.

Wireways shall be located to provide access to the harnesses contained within for maintenance action.

Bends in wireways shall be avoided; however, if they are required, approved protection shall be provided to avoid insulation chafing at the bends.

Wireways shall not contain more than 30 current-carrying conductors at any cross-section. The sum of the cross-sectional areas of all conductors contained at any cross-section of a wireway shall not exceed 40% of the interior cross-sectional area of the wireway.

All wire and cable shall be securely fastened within wireways to eliminate movement and resultant chafing.

18.27 Electrical and Electronic Designs

18.27.1 Reliability Standards

All electrical and electronic control systems shall be designed and components shall be selected using the *Reliability Design HandBook* No. RDH376 as a guide. All devices shall be derated to operate within the "Acceptable" region for electrical stress versus temperature for "Airborne Applications". If there is a conflict between guidelines given elsewhere in this Specification and the *Reliability Design HandBook*, the more restrictive condition shall govern. Other service-proven devices may be submitted for approval.

18.27.2 Ability to Repair

All electrical devices including such items as PC boards, relays, contactors, and filters shall be capable of being repaired by the Customer in its electronics laboratory. It is recognized that some equipment, due to its complexity, cannot be economically repaired by the Customer. In preliminary design reviews, the Builder shall identify all situations where this could be the case, for ruling by the Customer, whose decision shall be final.

Units shall not be sealed, potted or constructed to prohibit repair by the Customer. Units that must be potted or sealed by design other than Lowest Level Replaceable Units (LLRUs) shall have a minimum 10-year warranty.

18.27.3 Hardware

All hardware associated with electronic and electrical systems, including the case, heat sinks, mounting brackets, etc., shall be protected against moisture, oxidation and common airborne contaminants.

18.27.4 Wiring

Wire selection, routing and securement shall be accomplished with the goal of having the wire and cable last the life of the car body. All movement and chafing of wire and cable shall be eliminated. The use of additional wear material(s) to extend life without elimination of the movement, wearing or chafing will not be permitted.

18.27.5 Optical Fibers

Any application of optical fibers shall be approved prior to implementation. This approval is not intended to discourage the use of optical fibers. Rather, it is to verify reliability and maintainability of the proposed application. In no case shall the on-car repair of an optical fiber require sophisticated or complex polishing and alignment. The connections between optical fibers and car-replaceable units shall be via approved "quick disconnects".

18.28 Electrical Devices and Hardware

All electrical devices shall be service-proven. Electrical connections shall use either captive screws or captive nuts, with crimp terminals.

18.28.1 Contactors and Relays

Contactors shall be defined as those devices, which control one kilowatt or more of electricity through their main contact tips. Unless specified, all contactors shall meet or exceed the requirements of Amtrak Specification 528, section 4.3- 4.5.

Relays shall be defined as those devices which switch less than one kilowatt of electricity through their contacts. Unless specified, all relays shall meet or exceed the requirements of Amtrak Specification 528, section 4.3- 4.5.

All contactor and relay coils shall be suppressed with a solid state device to prevent transients being generated onto the low-voltage network.

All devices shall be satisfactorily tested for proper functioning in orientations up to 30° from the mounting plane as fitted in the vehicle. They shall be installed to be fully accessible for inspection, servicing, repair and ease of replacement. There shall be no more than two wires connected to any one terminal. Installation shall be such that, when required, arc spray is directed, by a non-asbestos arc chute, away from ground and adjacent electrical devices.

All devices shall be constructed and utilized in a fail-safe manner; that is, all failures shall be in a direction such that neither: the passengers, the crew, nor the equipment is placed at risk.

All magnetic devices shall be a heavy-duty type suitable for railroad service. They shall be constructed such that the main tips or contacts "make" and "break" with a wiping or rolling motion that minimizes build-up of deposits and/or pitting. Contact and/or tip replacement shall not exceed 5% of the total number during any annual inspection period.

Device contacts or tips shall not be placed in parallel to increase the total current load in excess of the rating for an individual contact or tip.

All devices shall be readily identifiable by means of a permanent, durable marking strip giving the device circuit designation. No identifications shall be obscured, or partially obscured, by wire routing. The identification strip shall be mounted adjacent to the mounting of said device.

Bifurcated contacts shall be used in low voltage applications whenever necessary due to dry contacts or low current switching requirements.

All time delay relays shall be of the R-C delay or solid state type. No mechanical or pneumatic time delay devices will be permitted.

Where plug-in relays are approved, the relay shall be positively retained by means of a retaining clip or bar. This device shall be captive, of rugged construction and shall be easily positioned for relay installation and removal without the need for special tools. When the relay is removed, the retainer shall itself be retained so that it cannot come in contact with devices, which may have exposed energized electrical circuits, and it shall not interfere with the operation of any other device when in this position.

18.28.2 Switches

Switches are defined as those manually operated devices that control less than one kilowatt of electrical power through their contacts. Unless otherwise specified, switches shall meet the requirements of MIL-S-3950. Toggle and push button switches shall be per MIL-S-3950, MIL-S-8805, MIL-S-83731 or equal, as approved by the Customer. All switches provided shall be of high quality and shall be fully suitable for the rigors of the Customer's service environment, including cycle life. The design and selection of all switches shall be subject to review and approval.

Switches shall be provided with a "keying" feature such that after installation, the body of the switch will be constrained from mechanical rotation.

Under no circumstances shall poles of switches be placed in parallel in order to carry currents in excess of the contact pole rating given by the manufacturer.

There shall be a maximum of two wires connected to each terminal of the device.

Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

All control switches, which are subject to water splash, which is defined to mean any switches mounted near windows or doors, or mounted on the Operator's control console, shall be environmentally sealed.

18.28.3 Circuit Breakers

All circuit breakers provided shall be extremely rugged and fully suitable for the service intended. They shall meet the requirements of Amtrak Specification 498, section 4.4. Design and selection of all circuit breakers not available within the Customer's material control system shall be subject to review and approval.

The continuous current rating of thermal-magnetic trip circuit breakers shall be selected in accordance with ANSI C37.16 for the load and type of service specified. All thermal-magnetic trip circuit breakers shall conform to the requirements of ANSI C37.13 and ANSI C37.14.

All circuit breakers of the same rating shall be of the same manufacture and model throughout the vehicle. Circuit breaker current rating shall be clearly and permanently marked and shall be completely visible after installation.

The ON, OFF and TRIPPED positions of all circuit breakers shall be permanently marked on the handle or the case of the circuit breaker. The circuit breaker, when tripped, shall assume a distinct position between the ON and OFF positions to permit determination of the fact that it has been tripped by either its overcurrent or shunt trip elements.

Circuit breakers shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the breaker to be replaced.

Each and every input power circuit shall be protected by an individual circuit breaker. Separate circuit breakers shall be provided for major assemblies or functions. No circuit breaker shall protect more than one circuit, nor shall any one circuit be protected by more than one circuit breaker. Circuit breaker terminals shall not be used as junction points.

All circuit breakers shall be sized by current rating and tripping time to protect both the associated equipment and the minimum size wire used for power distribution within the protected circuit without causing nuisance tripping.

Each circuit breaker pole shall be equipped with adequate means of arc extinction to prevent flashover.

Circuit breakers shall not be intended for use as on/off switches. All circuits requiring on/off switches shall be so equipped.

18.28.4 Fuses

Circuit protection functions that can be performed by fuses shall normally be performed by appropriately rated circuit breakers. Fuses shall be used only where specifically called for in the Specification or where the use of circuit breakers is not technically feasible, and only with specific approval. Fuses may be considered in applications as follows:

- To protect solid-state equipment from catastrophic damage.
- Where current or voltage levels prohibit circuit breakers.

Fuses shall be permanently identified adjacent to the fuse, including functional name, fuse type and rating. The rating of each fuse shall be permanently and clearly marked directly on each fuse.

Fuses shall be readily accessible. All fuses mounted in exterior equipment boxes shall be accessible without going under the vehicle.

Fuse holders shall contain fuse retention devices at both ends.

Unless explicitly noted otherwise in this Specification, all fuse compartments shall have a spare fuse of identical size and rating for each "in-circuit" fuse, and shall be mounted next to the respective "in-circuit" fuse with the fuse holder clearly marked SPARE FUSE. The spare fuse holder shall not be enclosed and shall not consist of any loose parts.

The use of current limit-type fuses is prohibited.

18.28.5 Bus Bars

Bus bars are to be fabricated from OFE (Oxygen Free Electronic) or ETP (Electrolytic Tough Pitch) copper (CDA 101). The bus bar conductivity shall be 100% IACS. All bus bar joints shall be silver or tin plated.

Current densities, other than at joints, shall not exceed 1000 amperes per square inch, and in any case shall not exceed a value which would cause a bus bar temperature rise greater than 30°C. Current densities in joints shall not exceed 150 amperes per square inch.

Bus bars shall be properly brazed together at joints unless bolted connections are found to be absolutely necessary for maintenance purposes and are approved. The overlap at bus bar joints shall be no less than 10 times the thickness of the bus material. Bus bar connection bolts shall be torqued to obtain a uniform bus bar connection pressure of 200psi. Bolting hardware shall be plated steel with Belleville washers to maintain connection pressure.

Except for connection areas, bus bars shall be safety insulated, using a high-dielectric, powder coating or other approved means. Tape will not be acceptable. Bus bars that are behind insulating panels will be exempt from this requirement.

18.28.6 Capacitors and Resistors

Dry tantalum capacitors, shall be used in place of aluminum electrolytics, except for high values which are not commercially practical or available, in which case long life grade aluminum electrolytics shall be used. Dry tantalum capacitors shall be in hermetically sealed

metal cases, except for surface mounted types when hermetically sealed metal cases are not available.

Commutating capacitors shall be a paper or plastic film type, shall incorporate a non-toxic impregnant, and shall be chosen to give a service life of at least 20 years. Filter capacitors shall have high ripple current rating for long life.

Capacitors shall be derated 20% for voltage based on the nominal supply voltage and maximum case temperature. If filter capacitors are exposed to low ripple voltages, lesser values of derating may be accepted if it can be shown that reduced operating temperatures can be achieved due to lower dissipation; however, the sum of the dc and ac ripple voltages shall always be less than the capacitor's voltage rating at a maximum case temperature of 85°C.

All resistors shall be operated at less than 50% of their rated maximum power dissipation. Other power resistor applications may be submitted for approval of lower derating, on a case-by-case basis.

Use of trim potentiometers or adjustable resistors shall not be permitted without Customer approval. Generally, the need for adjustments shall be avoided by use of the appropriate circuitry, and stable precision components.

18.28.7 Transformers and Inductors

Transformers and inductors shall be rated at 20% over the maximum specified current level.

18.28.8 Switch, Circuit Breaker and Fuse Panels

All switch, circuit breaker and fuse panels shall conform to Amtrak Specification 498, with dead front, mounted in the specified equipment enclosures and switch/ electric lockers.

Each switch and circuit breaker panel shall carry the necessary apparatus, arranged to be easily accessible to connections and designed to prevent operating or maintenance personnel from coming in contact with live parts when operating the switches or circuit breakers. All live portions of the protected circuitry shall be completely concealed so that no danger of electrocution or shock exists from the touching of the panel or any appurtenances or devices mounted thereto.

All switches, breakers, fuses, and indicating lights shall be provided with a nameplate of raised or recessed lettering on the dead front, clearly identifying the circuit which each controls and its circuit designation. The dead front panel shall conform to NFPA No. 70, Article 384. A wiring gutter shall be provided along the top, sides and bottom, for the routing of high voltage leads to their designated circuit breakers.

The panel shall be secured by approved, captive fasteners and shall be configured for easy removal so that maintenance and repair action is not impeded.

Power distribution to circuit breakers and switches shall be from a bus bar or bus circuit. Distributing power by successive or "daisy-chained" connections between device terminals will not be permitted.

18.28.9 Battery Backup Circuits

Any device provided that requires a backup battery must be designed with a five year battery life unless specifically approved by the Customer.

18.29 Semiconductor Standards

Semiconductors shall be selected to withstand all continuous and transient voltage and power demands present in the circuit application without damage or reduction in life. All circuit designs shall provide for the presence of high current switching equipment on the vehicle and the resultant induced voltages and currents in electrical equipment.

All transistors and diodes shall be silicon devices that meet or exceed the specifications of all of the original equipment devices; and shall secure proper operation over the full dynamic range for which each circuit shall be designed. Alternatively semiconductor numbers traceable to the manufacturer and component characteristics shall be included in the maintenance and spare parts manuals.

18.29.1 Rating

Discrete semi-conductors shall have the following minimum voltage breakdown rating, dependent on the use:

- Transistors and thyristors operated from the nominal battery supply, or those connected to trainlines, shall have minimum breakdown ratings of four times the maximum circuit rating. Suppression devices shall be provided as necessary to protect the devices and limit the circuit voltage.
- Diodes operated from the nominal battery supply, used as suppression devices, or those connected to trainlines shall have a minimum Peak Inverse-Voltage rating (PIV) of 1000V.
- All discrete semiconductors operated in inverters or other isolating devices shall have minimum breakdown ratings of two times the maximum circuit voltage (except where specifically detailed otherwise). Suppression shall be provided, as necessary, to protect the devices and maintain the circuit voltage and current operating conditions within all limits specified by the semiconductor manufacturer.
- All diodes, transistors and thyristors shall have a PIV rating of at least twice the maximum normal operating voltage but in no case less than 800V. This requirement shall not apply to circuits operating from an isolated power supply and whose wires and circuits shall be kept physically separate from battery-supplied wires and circuits by at least one-half inch.

Semiconductors shall be placed in a clean and ventilated environment which shall favor easy replacement.

All semiconductor junction temperatures shall be limited to 150°C (or to the maximum rated temperature for the device, whichever is less) or less at maximum ambient temperature and at maximum rated output power.

All semiconductors shall be operated at less than 50% of the maximum continuous current rating or maximum continuous power rating, whichever is more restrictive.

Integrated circuits operated from the battery supply through inverters or other isolating devices shall be operated within the voltage and current ratings specified by the manufacturer, derated to less than 50% of the maximum stress level at the maximum operating temperature of the device as specified by the manufacturer.

Where the supplies to integrated circuits are regulated and surge protected, the voltage rating shall be 15% below the manufacturer's recommended maximum. In addition, the maximum power shall be limited to 50% of the manufacturer's specified maximum at the maximum operating temperature.

Integrated circuits shall be soldered into the printed circuit board; plug-in connectors are not permitted.

All gallium arsenide and similar optical semi-conductors shall be rated for operation over the temperature range of -40°C to +85°C.

All semiconductors shall be rated "industrial or automotive grade" for reliable operation over the temperature range of -40°C to +85°C, except for discrete power semiconductors (≥ 1 Watt) which shall be rated for temperature range of -55°C to +125°C. Exceptions shall not be taken without proper identification and written authorization from the Customer prior to first article tests.

All suppliers of semiconductors shall be selected according to a recognized standard such as ISO-9002 Section 4.6 or better. Exceptions shall not be taken to the above provisions without proper identification and written authorization from the Customer prior to the first article inspection.

18.29.2 Availability and JEDEC Registration

All thyristors, transistors and diodes shall be JEDEC registered and numbered, and must be available from at least two different manufacturers. Non-JEDEC registered devices carrying more than 10 amps may be used provided that the Contractor obtains prior approval based on submission of each item's completed procurement specifications and evidence of availability from two or more manufacturers based on those specifications.

All semiconductors shall be available from at least two manufacturers and available from U.S. distributors. Single source devices, such as high voltage power devices, microprocessors, ASICs and related support chips may be used only if approved. Such devices shall be essential to the proposed equipment, shall meet the service-proven requirements and shall be supplied by veteran manufacturers likely to support the device.

18.29.3 Burn-in

Either all integrated circuits shall be burned-in and screened for defects to MIL-STD-883G, Method 5004, Reliability Class B or all units shall be 24 hours burned in according to an approved process and re-inspected for defects. The records must be maintained for review by the Customer inspectors.

18.30 Printed Circuit Board Standards

Printed circuit boards shall be designed, constructed and inspected to MIL-STD-275, unless more stringent requirements are noted here. Traces shall be made as wide as practical, with the minimum width being based on a 10°C temperature rise. Run spacing shall conform to MIL-STD-275.

Circuit board material shall be per MIL-P-13949, with a minimum thickness of 0.0625 in. using type GB or GH base material. Type GE material may be used for boards which have no components whose power dissipation is greater than two watts and when said board is not mounted adjacent to components dissipating greater than two watts. The copper laminate shall be firmly attached to the board and shall be resistant to blistering and peeling when heated with a soldering iron.

Components with pins shall be mounted only on one side. Connections shall be made to the other side or internal layers via plated through holes. Surface mounted components may be mounted on both sides if part of an approved existing design.

All circuit boards shall be inherently stiff or shall be reinforced to prevent damage due to vibration or handling. Unless otherwise approved circuit boards larger than 100 in.² shall be centrally stiffened.

All equipment shall be designed using stable, high tolerance components to eliminate the need for adjustments. Compensation for manufacturing tolerances may be made through parallel precision resistors. All replacement printed circuit boards shall be directly interchangeable without any additional adjustments.

All printed circuit boards shall be of the "plug-in" type, with positive support against vibration, except where approved otherwise.

Not more than one PC board shall be stacked on each PC card.

Printed circuit board connectors shall be heavy duty, high reliability, and proven in prior successful rail service. All printed circuit boards shall plug into keyed sockets. Contact fingers and edge connectors shall have 0.000050 in. thick gold plating.

18.30.1 Marking

All circuit boards shall be labeled with a part number, serial number and descriptive nomenclature.

All components shall be labeled on the board with component drawing references and such other information as may be required to repair and troubleshoot the board. The component and wiring sides of the board shall each be marked to indicate capacitor and diode polarity, and at least two leads or one lead and a graphic symbol indicating orientation of all transistors and thyristors.

Integrated circuits and other multi-terminal devices shall have an index mark on the component side of the board, visible with the component inserted, to indicate proper keying and insertion; the first pin on all integrated circuits packages shall be identified on the wiring side of the board.

For boards whose component density is greater than 2.25 components per square inch, the Contractor may submit an alternate marking plan for possible approval. Such a plan should include board marking, augmented by layout drawings.

18.30.2 Component Mounting

Components shall be fastened to the board in such a manner as to withstand repeated exposure to shock and vibration. Large components shall be supported in addition to the solder connections. Power resistors shall be mounted on standoffs so that the resistor bodies do not contact the board, spaced far enough away from the board so that resistor-produced heat will not discolor or damage the board or adjacent wires or components.

18.30.3 IC and Device Sockets

IC and device sockets shall comply with MIL-S-83502 and MIL-S-83734, as is applicable for the device.

18.30.4 Conformal Coating

Both sides of the assembled printed circuit boards shall be coated with a clear insulating and protective coating material conforming to MIL-I-46058C, or approved equal.

The coating shall be easily removed with a brush-applied solvent or penetrated by a hot soldering iron when a component must be unsoldered. The coating solvent shall not adversely affect board-mounted components.

All IC sockets, connectors and test points shall be masked when the coating is applied.

18.30.5 Keying

All printed-circuit boards shall be "keyed" to prevent insertion into the wrong socket. Further, circuit boards in safety related control systems, such as friction brakes, cab signal, and systems which can cause damage or unsafe train operation if the vehicle is operated with a card removed, shall be connected through a safety circuit or checked through an auto test to disable the vehicle if a circuit board is removed.

18.30.6 Circuit Board Connectors

Printed circuit board connectors shall be heavy duty, high reliability, two-part type with a history of successful service in rail applications and shall be approved by the Customer prior to commencing design.

Connectors which comply with MIL-C-55302, and which have plated contacts as described below, are considered to comply with the requirements of this section.

The connector contact area shall be plated with a minimum of 0.000050 in. of gold over a minimum of 0.000050 in. of low stress nickel.

Card edge connectors are prohibited.

All connectors within one panel assembly shall be keyed to prevent damage or malfunction due to incorrect insertion.

18.30.7 Testing

Sufficient clearance shall be provided between components to allow testing, removal and replacement without difficulty due to lack of space.

Test points shall be provided in appropriate locations on modules and printed circuit boards. A negative return test point shall also be provided. The test points shall either accept and hold a standard 0.080 in. diameter tip plug or shall be a turret lug similar to Cambion No. 160-1026-01-05, or approved equal, with sufficient clearance to permit it to accept a standard oscilloscope probe clip, and shall be identified by appropriate markings.

When test points are not suitable, as for complex circuits or micro-processor based control system, self-diagnostic routines and/or special test equipment may be used to identify the failed Lowest Replaceable Unit.

18.30.8 Plated-Through Holes

In addition to the general guidelines of the Institute of Printed Circuits (IPC), the following requirements shall be met:

- Plating Holes - Copper plate shall be a minimum of 0.001 in. minimum average thickness, and 0.003 in. maximum average thickness. Solder plates shall be 0.0003 in. minimum average thickness and 0.0015 in. maximum average thickness.
- Plated Hole Defects - No more than three voids per hole will be acceptable. Total area of the voids shall not exceed 10% of the total wall area. The largest void dimension shall not exceed 25% of the core diameter or the board thickness, whichever is smaller. There shall be no pits, voids or cracks at the junction of the whole wall and terminal area to a depth of 1-1/2 times the total copper thickness on the surface.
- Enclosures

All circuit boards that are rack mounted shall plug into racks containing the mating half of the circuit board connector. The circuit board rack shall mount in an enclosure conforming to requirements in this document. The rack, circuit board and circuit board hardware shall be designed as an integrated system.

The rack and enclosure shall provide environmental and EMI shielding necessary to meet the requirements of this Specification.

Printed circuit boards shall be positively retained by means of keeper bars or other approved method. The enclosure or rack cover shall not be used to retain the circuit boards.

Each circuit board shall be fitted with an ejector or hand grip to assist in board removal. The rack and the edge of each board, or the card ejector, shall be labeled with corresponding numbers to identify board location within the enclosure.

18.30.9 Extenders

Printed circuit board extenders (six sets of each type) shall be provided by the Contractor for test purposes. At least two extenders of each type shall be available for use and evaluation throughout the design conformance and acceptance test programs.

18.31 Microprocessor-Based Systems

The microprocessor-based control systems shall be based on an established family of microprocessors in wide use in the control system industry. They shall be supported by a full range of software development languages and diagnostic programs.

Should the Contractor elect to use multiprocessor bus architecture, the architecture shall be based on the Intel Multibus, Motorola VME or similar bus used widely in industrial process control equipment. Alternative bus structures may be submitted for the Customer approval.

Program code and fixed data shall be stored in Programmable Read-Only Memory (PROM) or Erasable Programmable Read Only Memory (EPROM). Either static or dynamic Random Access Memory (RAM) or EPROM may be used for temporary data storage. All EPROM windows shall be covered with labels that are opaque at the Ultraviolet (UV) erasing wavelengths.

Battery-backed RAM may be used only to store fault information. Batteries shall be sized to retain data for at least six months without charging and shall be located such that leakage cannot damage any control system components. Battery life shall be no less than five years, regardless of type.

At least 30% additional memory space shall be installed and available for future modifications to program code, fixed data space and temporary data space.

18.31.1 Software

Software may be written in a high or low level language. The language, and its implementation for the selected microprocessor system, shall be commercially available in English.

All software, whether interrupt based or polled, shall always assign the highest priority to safety-related tasks.

Software shall perform the following basic functions:

- Implement the desired control scheme such that the specified performance is achieved;
- Monitor all inputs for unsafe, erroneous, or unknown conditions or combinations of conditions;
- Sample all input conditions at rates sufficient to detect and remedy all unsafe or damaging conditions in the shortest possible time. Sampling rates and program execution times shall be such that the control system is not the limiting factor in response to unsafe or damaging conditions;
- Limit all output commands to safe levels regardless of any combination of input conditions;

- Perform self-diagnostic routines and respond promptly, safely, and predictably to detected faults;
- Respond safely and predictably when powering up or recovering from power interruptions. All power interruptions likely to have corrupted temporary storage shall be detected and cause the system to re-initialize all affected routines and temporary data. Detection of power interruptions may be by hardware.
- Permit thorough interrogation of all input, output and internal conditions by external diagnostic equipment.

18.31.2 Isolation and Interfacing

Any microprocessor-based control system shall be powered by dedicated isolated power supplies driven from the vehicle battery circuit.

All control system input and output signals shall be through isolation buffers unless specifically approved by the Customer. High voltage inputs and outputs shall be isolated external to the microcomputer card rack unless specifically approved by the Customer. Low voltage (battery and logic voltage level) inputs and outputs shall be isolated via buffer cards in or external to the microcomputer card rack.

The isolation buffers shall:

- Protect and isolate the control system from damage due to overvoltage, undervoltage, transients, shorts and open circuits.
- Perform necessary voltage transformations.
- Remove noise and undesired signals.
- Limit, pre-process, discriminate and format those signals that would otherwise require excessive processor time.
- Consist of optical isolators, transformer isolators, and other circuits appropriate to the application.

18.31.3 Software Documentation

The Contractor shall submit, for approval, a software quality assurance plan in accordance with ANSI/IEEE Standard 730-2002. For reference, this Standard has the following minimum software documentation requirements:

- Software requirements specification
- Software design description
- Software verification and validation plan
- Software verification and validation report
- User documentation

The Software Design Description (SDD) shall be in accordance with ANSI/IEEE Standard 1016-1998. The final Software Design Description shall include details are summarized below only for information:

Level 1	Computer description and operation
Level 2	Software architecture, basic program and functions
Level 3	Detailed flow information
Level 4	Annotated compiler/assembly listing
Level 5	Detailed memory map and listing
Level 6	Input/output port map

At its option, the Customer will participate in both the Software Requirements and the Preliminary Design Review, as defined by ANSI/IEEE Standard 730-2002. Following these reviews, the Contractor shall submit, for approval, the Software Requirements Specification and the Software Design Description. All subsequent changes to these documents shall also be submitted and approved prior to implementation.

The Contractor shall provide at the final design review a hardware and software safety plan in accordance with 49CFR Section 238.105.

18.32 Auxiliary AC Motors

Motors shall limit starting current to within industry recommended practices and be equipped with NEMA C-frame type sealed bearings that shall not require re-lubrication for the life of the bearing. Bearings shall be sized to provide a minimum life of 6 years. Any motor mounted with the shaft vertical shall have bearings suitable for this type of application. Any motor which is exposed to weather shall be a type specifically designed for the environment. Any motor with a vertical shaft and subject to the weather shall include a moisture seal on the shaft to prevent water from entering the bearings.

18.33 Recyclable Materials

Expendable items that are recyclable shall be identified with the appropriate symbols, as defined by the Society of the Plastics Industry, permanently imbedded in the material.

* End of Chapter 18 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee
Bi-Level Passenger Rail Cars

Chapter 19

Test Requirements

Table of Contents

19.0	Test Requirements.....	19-3
19.1	Overview	19-3
19.2	General Requirements.....	19-4
19.3	Test Plans and Reports	19-4
19.3.1	Master Test Plan.....	19-4
19.3.2	Test Procedures.....	19-5
19.3.3	Testing Notification.....	19-7
19.3.4	Test Documentation	19-7
19.3.5	Car Acceptance Testing Facilities.....	19-8
19.4	Material Certification Tests	19-8
19.5	Proof-of-Design Tests	19-9
19.5.1	Carbody Structural Tests	19-9
19.5.2	Trucks.....	19-25
19.5.3	Couplers.....	19-28
19.5.4	Brakes.....	19-28
19.5.5	Door System.....	19-29
19.5.6	Interior.....	19-31
19.5.7	HVAC	19-32
19.5.8	Lighting.....	19-40
19.5.9	Communication/OTIS	19-41
19.5.10	Electrical	19-43
19.5.11	Food Service	19-43
19.5.12	Water and Waste	19-45
19.5.13	Cab and Controls	19-45
19.5.14	Pilot Car and Pilot Train Testing	19-47
19.6	Production Tests	19-52
19.6.1	Carbody	19-53
19.6.2	Truck Tests	19-54
19.6.3	Couplers.....	19-55
19.6.4	Brakes.....	19-55
19.6.5	Door System Tests.....	19-56
19.6.6	Interior.....	19-56
19.6.7	HVAC	19-57
19.6.8	Lighting.....	19-58
19.6.9	Communication/OTIS	19-58
19.6.10	Electrical	19-59
19.6.11	Food Service	19-61
19.6.12	Water and Waste	19-62
19.6.13	Cab and Controls	19-63

Table of Contents	19-2
19.6.14 Completed Car	19-65
19.7 Acceptance Tests.....	19-66
19.7.1 Car Acceptance Tests	19-66
19.7.2 Functional Tests.....	19-66
19.8 Post-delivery Testing of Pilot Train with Other Equipment	19-66
19.9 Reliability and Post-Delivery Tests.....	19-67

19.0 Test Requirements

19.1 Overview

As part of the production of the cars under this Contract, the Contractor shall be responsible for a comprehensive series of tests to be performed to verify both the suitability of design and workmanship of each car. The Contractor is also responsible to fulfill all requirements called for by the Federal Railroad Administration (FRA) for testing passenger equipment per the applicable requirements of 49CFR Section 238.111(b) for Tier I equipment, for submission by the Customer to the FRA. The tests and any required adjustments to be performed are grouped into four classifications: Material Certification, Proof of Design, Production and Acceptance. Whenever test requirements overlap, the more comprehensive shall govern. The Contractor shall perform all tests under Customer observation, and the FRA may also observe such tests. All contractual tests shall be conducted in accordance with Customer approved test procedures. Testing activity scheduled and/or conducted before test procedure approval will be at the Contractor's risk.

Material Certification Tests consist of all tests required to certify that the materials used in the manufacture of the rail cars meet the performance and behavior requirements of the manufacturer's specifications, all applicable industry standards, and Federal requirements. A full listing of the material certification tests shall be included in the Master Test Plan, and the certifications and test results shall be submitted to the Customer for review and approval. All material samples used for certification testing shall be scrapped upon the conclusion of testing and shall not be used in the manufacture of the cars.

Proof of Design Tests are those tests conducted on the systems and components to validate the design of the cars, to confirm that the systems and components function as intended and in accordance with specifications, and to ensure that no unintended or undesirable consequences are encountered during production or operation of the cars. Proof-of-design tests shall be conducted on all major systems and components prior to release of the first cars of each type, and as necessary during production in the event of a design change or component substitution.

Production Tests consists of all component, system and car tests to be performed on each production car to ensure that each car meets all functional, operational and workmanship requirements and standards, and that any production errors or nonconforming materials or components are revealed and corrected prior to the vehicle being released from the Contractor's facility. These tests comprise component-level testing at the supplier's facility, and system-level testing at the Contractor's facility during and at the completion of production to demonstrate conformance with Technical Specification and baseline configuration requirements prior to delivery.

Acceptance Tests consist of production car tests to be performed on each car by the Contractor after delivery of each car to the Contractor's field site or Customer's facilities to demonstrate conformance with the Technical Specifications, to ensure that no system functionality was lost during shipment and transit of the vehicle, and as a condition for Acceptance.

19.2 General Requirements

The Contractor is required to perform all tests as specified herein. The Contractor and its subcontractors may, at their option, perform additional testing as they deem necessary as part of the quality assurance program. Unless indicated otherwise, all costs associated with any of the tests performed are to be borne by the Contractor. In the event of a failure to meet the Technical Specification requirements in any test, necessary corrections shall be made by the Contractor at its expense, and the failed test shall be rerun in its entirety at the Contractor's expense. If further corrections or modifications affecting the item under test are instituted, the Contractor shall perform a complete retest at its expense to demonstrate compliance with the Technical Specification requirements. The Contractor shall give at least ten days notice to the Customer prior to the start of any test referred to herein. In the case of pre-revenue service tests per 49CFR Section 238.111 (b) (2), 45 calendar days notice shall be given to the Customer in order to assure timely notification of the FRA.

Except as provided herein, the Customer, at its own discretion, may allow the Contractor to furnish test reports which indicate that equipment furnished under this Contract is identical to equipment which has been previously tested for the same application and accept this as showing conformance with the requirements of this Technical Specification.

19.3 Test Plans and Reports

The Contractor shall prepare and provide to the Customer as specified the following test documentation. See Chapter 22 for additional details regarding submittal of documents to the Customer.

19.3.1 Master Test Plan

The Contractor shall submit to the Customer for approval a master test plan covering all tests listed in or otherwise required by this Technical Specification. The master test plan shall be submitted to the Customer for review and approval no later than 180 calendar days after Notice to Proceed (NTP). This document shall be updated monthly and presented as an attachment to the program meeting minutes. **CDRL**

The master test plan shall include, but is not limited to, all tests as required to be performed by the Contractor and suppliers:

- Material certification tests;
- Proof-of-design tests, including all required carshell, truck and suspension and ride quality tests;
- Production tests; and
- Acceptance tests.

It shall include a detailed schedule showing the sequence in which the test will be performed, and the time and place of each test to be performed. The plan shall be updated periodically, showing the status of each test procedure, test and associated report summarized in a spreadsheet format.

19.3.2 Test Procedures

The Contractor shall prepare a detailed test procedure for all tests required by this Specification and for all other tests to be conducted by the Contractor or its suppliers in connection with its own quality assurance program.

Tests procedures shall be submitted for approval in advance of the anticipated test dates as follows:

Supplier Qualification, Proof of Design and Production	No less than 60 days prior to start of testing
Contractor Qualification, Proof of Design Tests	No less than 60 days prior to start of testing
Contractor Production Tests	No less than 45 days prior to start of testing

All required testing shall be conducted in accordance with the Customer-approved master test plan and approved test procedures.

The test procedures shall include the following information:

Title/Approval Page: Includes the name of the test, test number, revision level, date, author, signature of engineer responsible for system, signature of personnel who reviewed and approved the test, etc.

Revision History: Provides the history of changes made to the document, including description, not merely date.

Table of Contents:

1.0	Purpose	Identifies what the test is to accomplish.
2.0	Application	Identifies which car types/equipment is tested with this procedure.
3.0	References	Identifies any documents used as guidance for the test, such as APTA, FRA, ASTM, etc.
4.0	Definitions	Provides definitions of terms used in the test.
5.0	Prerequisites	Provides requirements of car condition before the test can be conducted, such as which tests must be successfully conducted before this test.
6.0	Equipment	Identifies test equipment and any other special requirements; lists instrument model numbers, calibration dates and serial numbers.
7.0	Initial Conditions	Identifies positions and/or state of all devices, controls and equipment.

- | | | |
|------|-------------|--|
| 8.0 | Procedure | <p>This is the actual test sequence. The test procedure shall identify pass/fail (or in some cases, intentional overload) criteria for each step in the procedure. Test data may be recorded within this section, or in a separate data section.</p> <p>The test procedure shall identify the conditions required for the performance of the test, including a sheet where test conditions can be recorded, such as voltage, current, resistance, time, etc.</p> <p>Each test performed shall be signed and dated by the technician performing the test.</p> |
| 9.0 | Conclusion | <p>Provides summary of the test findings, including vehicle number, date, test conducted, overall pass/fail, test technician signature, Customer witness, etc.</p> |
| 10.0 | Data Sheets | <p>This is a form in which data is recorded, if it is not recorded within the body of the test. If data is recorded by instruments, such as strip chart format, etc, those results shall be attached here.</p> |

Each car and system shall be tested in exact accordance with the Customer-approved revision of the test procedure. All test and inspection instruments shall be properly calibrated.

Should a system or component fail a test, the component or system shall be repaired or replaced and the test repeated from the beginning. The test shall not be restarted at the point at which the failure occurred. The Customer may, at its sole discretion, determine that portions of the failed test need not be repeated.

Each test shall be a separately controlled document and identified by its own number, title and revision. All revisions shall be submitted to the Customer for approval. A history of test revisions and changes shall be maintained and recorded within the test document. All tests must be written in an instructional form describing the full activity of each test step, and written in duplex-numerical form (similar numbering system as seen in this specification). All special tools and/or equipment to be used must be specified within the test document. A data collection form shall be used with each procedure and shall be fully identified.

Each individual test shall be accompanied by a separate sheet where the test results are documented. Each step of the test requiring a specified result or measurement shall be included and identified by the duplex-numeric step number referenced in the test document. Areas shall be provided for recording actual values produced during the test where needed. In addition, acceptance criteria and associated tolerances shall also be shown in parenthesis near the space available for recording the actual value. The test number, revision and page number shall be shown on the header of each page or all test procedures. Areas shall also be allocated for the date, car number, component serial numbers (as applicable), test equipment serial numbers, verification of test equipment calibration, test status (accepted/rejected) and signature areas for the test technician, Contractor Quality Assurance (QA) representative and Customer representative.

19.3.3 Testing Notification

In the case of pre-revenue service tests per 49CFR Section 238.111 (b) (2), the Contractor shall provide no less than 45 calendar days notice to the Customer in order to assure timely notification of the FRA. For other tests, each detailed test procedure shall be submitted to the Customer for review far enough in advance of the planned test date to allow the Customer at least 15 working days to initially review and comment on, or approve the procedure, and still have sufficient time to allow the Contractor to modify a rejected procedure and resubmit to the Customer, to have approval a minimum of three working days prior to any testing covered by the procedure. The Customer shall witness all tests. Under no circumstances will the Customer accept the results of a test performed without approved procedures.

19.3.4 Test Documentation

The Contractor shall be responsible to provide the Customer with written test reports for all tests performed on the cars and their components, including supplier test reports.

Upon the completion of each test, the Contractor shall submit a written report of each test, including copies of all test data, to the Customer for approval. In every case, the report shall include a description of the test, all raw data collected in the test, and a summary of the results in a form that can be directly compared to the Technical Specification without further calculations. A test shall not be considered as completed until the Customer (and the FRA, as required) has approved its final written test report.

Should the test procedure or reports be inadequate and not meet the requirements of the Technical Specification of the FRA, the Customer reserves the right to require additional plans, procedures, details, and schedules to satisfy itself that the test program or report is adequate and does meet FRA and Specification requirements. The approval of the Customer does not in any way relieve the Contractor of responsibility for the adequacy of the test program within the scope of this Technical Specification.

Upon the completion of all required engineering tests associated with the pilot program, all copies of all test procedures, reports and approvals shall be copied and presented to the Customer in a single volume.

All material certification and proof-of-design test procedures and reports shall be supplied by the Contractor in a separate binder and submitted to the Customer for review and approval prior to acceptance of the first car of each type. The master test plan shall be included in this binder. Reports on all certification and proof of design tests plus the acceptance tests for the first car of each type shall be submitted and approved by the Customer prior to acceptance of the first car of each type.

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For production tests, which are performed on all cars or all components, a separate volume shall be submitted to the Customer containing all approved tests applicable to individual cars. In the event a test is revised, the Contractor shall supply a copy of the test reflecting approved changes and the upgraded revision status to replace the existing test within this volume. The test reports required by this specification that are performed on all cars or all components shall be included in the vehicle history books. At the front of the test diction of the vehicle history book there shall be a test log. This test log shall be maintained by the Contractor during the equipment assembly. The test log shall have a place for a technician signature and date and will be signed when each test procedure has been completed. The test log shall be submitted to the Customer for review before each car shall be released for shipment to the delivery site.

All Contractor and Customer in process inspection sheets and test data records for that car shall be contained in this test log.

19.3.5 Car Acceptance Testing Facilities

The Contractor shall establish a site where completed cars may be shipped for acceptance testing and inspection. This site shall be within five miles of the Customer's designated maintenance facility, or at another location as approved by the Customer. The Contractor shall use this site to prepare cars for acceptance testing, and to perform modification or rework required on cars under its control prior to acceptance, as well as warranty work.

19.4 Material Certification Tests

All materials used in the production of the vehicles shall be tested to verify conformance with all applicable standards, regulations and specifications, and to ensure that the material performs as specified. At a minimum, the following materials shall undergo material certification testing:

- All exterior glazing shall be certified to conform to 49CFR Part 223 requirements.
- All interior materials shall be certified to meet smoke, flame and toxicity requirements.
- All subfloor panels shall be certified to meet strength and impact resistance requirements.
- All stainless steel and carbon steel used in production of the carshell shall be certified to meet material strength, composition and performance characteristics.
- All components used in the manufacture of truck, suspension and coupler assemblies shall be certified to meet all applicable strength, composition and performance requirements.
- All insulation materials shall be certified to meet applicable insulation performance standards.
- All materials used in food preparation areas of the café-lounge car, potable water systems and trash storage shall be certified to meet all applicable Public Health Service sanitation requirements.
- All interior and exterior emergency signage materials shall be certified to meet FRA emergency exit signage requirements.
- All emergency power sources shall be certified to meet FRA emergency exit pathway.
- All emergency equipment shall be certified to conform to all applicable FRA regulations and other requirements as necessary.
- All exterior graphics components, including paint, decals and hardware, shall be certified to meet all applicable performance requirements including environmental and air quality requirements, durability in accordance with environmental and climatic conditions, and application in a railroad environment.

19.5 Proof-of-Design Tests

The Contractor shall develop a series of tests to evaluate the design of the carshell and each car system, subsystem and major component to verify that the performance requirements of the carshell structure, systems and components have been met, that the system and all component parts function as intended and within all specified parameters, and that no unintended or unanticipated functions, problems or non-conformances are discovered during production or operation of the cars. These tests shall validate the design of all systems and components as supplied by the Contractor and subcontractors, and prove that these designs are fully compliant with all applicable specifications, regulations and performance requirements. Proof-of-design tests shall be conducted on systems and components at the facilities of the Contractor or suppliers, or at other facilities as designated by the Contractor. The carshell and its primary structure shall undergo extensive proof-of-design testing to validate the structural strength, dimensional accuracy and performance of the carshell. Proof-of-design tests shall also be conducted on completed cars at the Contractor's facility, to ensure that the individual systems and components have been integrated to function as intended within the completed car or train, without unanticipated or undesirable effect or degradation of performance of other systems or components.

19.5.1 Carbody Structural Tests

19.5.1.1 General

Unless otherwise indicated, all references to APTA, FRA and other standards indicate applicability of the current versions of the standards, as of the date of the NTP.

One of the first four cab car bodies shall be tested by the Contractor to confirm that the FEA is sufficiently accurate to ensure that the carbody structure complies with this Specification. If there are no major structural differences between the car shell types and the test results are comparable with the FEA, one cab car shell shall be tested. The tests shall be performed at an Engineer-approved facility. To be acceptable, the test facility must have documentation showing calibration of all instrumentation, have qualified personnel with experience in conducting similar tests, and have the necessary equipment, instrumentation and control equipment to conduct the test. The tests shall not begin until the carbody stress and energy absorption analyses have been submitted and approved by the Engineer.

The test carshell shall be completely inspected and any non-conformances corrected. All inspection, test, rework, repair and corrective action reports shall be available for review. Particular attention shall be given to recording flatness and straightness.

The test carshell shall be structurally complete, including all structural parts and fiberglass ends (if part of the design), but excluding such items as exterior and interior trim, windows, doors, seats, lights, interior lining, or other parts that would obscure any structural member from view, or that would interfere with the performance of the test. The test shell shall have no paint, primer, sound damping coating, or insulation. The weight of under floor and above floor compartment-mounted equipment and heavy roof-mounted equipment shall be simulated by equivalent weights at their respective locations. All structural tests shall be conducted on the same carshell.

The carshell shall be weighed and the weight recorded prior to installation of any test equipment. For the tests, the car shall be supported on the trucks or equivalent supports to allow longitudinal movement.

All gauges and instruments shall be in current calibration and remain so for the duration of the test. The methods of calibration and time periods for recalibration shall be in accordance with the test laboratory's national standard or ISO standards. The laboratory shall have on file a current certification of calibration traceable to the laboratory's national standard or ISO Standards.

The Contractor may conduct preliminary tests, but all critical dimensions and flatness shall be verified after the Contractor tests and before the official test begins. The test of record is to be witnessed by the Engineer. A copy of all recorded data shall be given to the Engineer at the conclusion of each test.

Where practical, all gauges shall have an electric output suitable for recording on electronic (magnetic) media. A data acquisition system shall be provided to permanently record all gauge outputs at each load step. At the end of each load step, a printout of all strain gauge readings in proper engineering units (micro-strains) and a plot of load vs. gauge reading for critical gauge locations shall be given to the Engineer or his representative for review. The Contractor shall obtain approval of the Engineer or his representative after every load step before proceeding with the next step. The Contractor shall not break down the test fixtures until the Engineer or his representative has reviewed and accepted all data.

The Contractor shall prepare a color photographic record of the test. This record shall include photographs of the car in the several test fixtures, installation of critical strain gauges, repairs or modifications, deviations from the drawings, and any areas found to be non-compliant. The entire procedure shall be video recorded by the Contractor with a sound-equipped VHS color video camera or other suitable digital video equipment. The camera shall rove to view and record key areas. All videotapes taken during this test shall become the property of the Authority.

The Engineer reserves the right to test a second car of each type during the construction period. Should such a test be ordered, it shall be at the expense of the Authority unless such tests prove the design is non-compliant in any structural area, in which case, the Contractor shall be responsible for the test expense and for all of the Authorities' costs, and the cost of modifications necessary for the car and all other cars to be made compliant with the Specification. The Contractor (at its expense) shall also perform a complete set of structural tests to qualify the modified car.

19.5.1.2 Test procedures

A procedure shall be prepared for each test. The procedure shall include a description of the test, its purpose, how and with what equipment the specimen is to be loaded and the load increments, the type and location of strain gauges, the location of deflection gauges, a complete description of all fixtures, instruments and gauges and a detailed description of the data acquisition system. Annotated copies of catalogue cuts may be used to provide parts of the description. An explanation of the accuracy of the instrumentation shall be provided. Drawings and sketches shall be included to clarify the text. The test procedure shall provide a step by step instruction describing how the load is to be applied, the load at each step, when data is to be recorded, a space for the signature of the test supervisor and a space for recording the authorization to proceed obtained from the Engineer or his representative. Test procedures

shall be submitted not less than 60 days in advance of the proposed test date; approvals of the test procedure and stress analysis are prerequisites for the start of testing.

The test procedure shall include a copy of the current calibration certification for each instrument and gauge to be used for the test. Typical logging sheets, print-outs, plotting forms and examples of any other data sheets for the test or in the final report shall also be submitted as part of the test procedure.

Tables shall be included to give the maximum allowable reading for each gauge and loading condition. Other tables shall be included to provide the requirements for all other test criteria. Each test procedure shall contain a table of predicted strain (or stress) and deflection at selected gauge locations. This table shall list the strain or deflection gauge number, the location of the gauge, the predicted strain (or stress) or deflection from the stress analysis, spaces to enter the actual gauge readings, and a space to enter the calculated percent difference, defined as:

$$\% \text{ difference} = \frac{\text{Actual} - \text{Predicted}}{\text{Actual}} \times 100$$

19.5.1.3 Strain gauges

A minimum of 240 strain gauges shall be applied to the car structure for each of the compression, vertical load and diagonal jacking tests. Some gauges may be used for more than one test if their location on the structure is appropriate for other tests, but readings from at least 240 strain gauges in locations shall be obtained for each test. The location of the strain gauges shall be based on the Contractor's experience, the stress analysis and the Engineer's recommendations.

In order to appraise the stress distribution in the carbody at these cross sections, there shall be no less than three locations where there are a sufficient number of gauges to encircle the carbody. One location shall be outboard of the bolster, one shall be between the bolster and the transition to the upper and lower levels and one shall be at the center of the car. Gauges shall be placed, for example, on all four sides of the side sill and body sills, on the side framing, along the cant rail, on the cross members, and at the center line of the car.

For each post load test, there shall be a minimum of 100 strain gauges applied to the post and car structure in the vicinity of the post. Some of the gauges may be for more than one test if their location on the structure is appropriate for other tests, but readings from at least 100 strain gauges in locations where the stress may be critical shall be obtained for each test.

Drawings and sketches showing the location of each strain gauge shall be prepared by the Contractor and submitted for approval as part of the test procedure. These drawings shall dimension the location of each gauge, showing their distances from edges, connections and bends. Their locations on the upper or lower, inner or outer surface shall be noted on these drawings.

The strain gauges shall be bonded resistance (SR-4) type or other approved gauges suitable for the application. The gauges shall be calibrated in accordance with the manufacturer's instructions for the material being measured. The gauges shall be compensated for temperature.

19.5.1.4 Deflection gauges

Vertical deflection of the carbody shall be measured along both side sills at each load step during all tests. At least 11 gauges per side shall be used. Gauges shall be located at the end sills, at the bolsters, and at the mid-point between the bolsters. The remaining gauges shall be evenly spaced between the five locations. Measurements shall be taken to the nearest 0.01 in., and the deflections shall be considered as the average of the readings recorded on both sides of the car.

To measure the longitudinal deflection of the car during compression testing, additional deflection gauges shall be applied at the end sill, near the ram, and at the opposite end sill, near the reaction.

For the diagonal jacking test, an additional deflection gauge shall be applied at the jack that is lowered or raised to measure the vertical movement at jack location.

During the vertical load test, the change in carbody width due to bending shall be measured and recorded at the belt rail in the center of the car. Two additional deflection gauges shall be applied in one of the side door openings closest to the center of the car to measure the change in the diagonal dimensions of the opening during the tests.

To measure the bending of the collision and corner posts during the post tests, deflection gauges shall be applied at a minimum of seven locations on each post being tested: top, bottom, middle, load application point, between the load application point and the bottom, between the load application point and the center, and between the center and the top. These gauges shall be mounted to measure the deflection of the post in the direction of the applied force.

Deflection gauges shall be mounted on rigid stands separate from the carbody and its fixtures. The contact surface on the car shall have a smooth, polished, low-friction surface plate mounted perpendicular to the axis of the deflection gauge. If, during a test, the deflection gauge moves off of this surface plate or contacts the test carshell or the fixtures, the test shall be terminated. The gauges shall be readjusted and the test repeated from the beginning.

The deflection gauges shall have electrical outputs compatible with the data logging apparatus used with the strain gauges. All deflections shall be recorded simultaneously with the strain gauge recordings.

In addition to the above electronic recordings, dial indicators (mechanical) of sufficient stroke shall be employed. Two shall measure the vertical deflection at the center of both side sills during all tests. During the compression tests, dial indicators shall be employed to measure the longitudinal deflection at the end sill next to the ram and next to the reaction at the opposite end of the car. An indicator shall be located next to the lowering jack during the diagonal jacking test. A dial indicator shall be mounted at the center of the post during each post tested. These dial indicators shall be read and manually recorded at each load step.

All deflection gauges shall have sufficient stroke capacity to measure the maximum deflection expected in the test without the need for resetting any gauge during the test.

19.5.1.5 Load cells

In order to verify the accuracy of the applied loads and reactions, load cells shall be provided at the appropriate locations for each test. Each load cell shall be calibrated to 1.0% accuracy and certified within one year before commencement of the tests over the full range of 1.5 times the maximum load to which the load cell will be subjected during these tests. The Contractor shall provide records of calibration results prior to commencing these tests. The load cells shall have electrical outputs compatible with the data logging apparatus used with the strain gauges. All loads shall be recorded simultaneously with the strain gauge recordings.

Load cells shall be placed at the end of the ram and at the reaction point for the compression test. A load cell shall be placed at each secondary spring location for the vertical test and at each ram if the load is applied hydraulically. A load cell shall be placed at each jack location for the diagonal jacking test. A load cell shall be placed at the end of the ram for each post test. Load cell readings shall be taken and recorded at each step of load application and removal process.

19.5.1.6 Vertical load test

19.5.1.6.1 Test description

The carbody supported on trucks or simulation thereof, shall be subjected to a vertical load test. The instrumented carshell shall be loaded to simulate ready-to-run weight. A test load, equal to 170 lbs for each seated passenger in seats and an additional 15 lbs "luggage" for each seated passenger in overhead racks, uniformly distributed, shall be applied to the car in 4 equal steps, resulting in a total of five vertical load increments. The test load may be applied by means of weights or jacks, but shall be distributed in proportion to the distribution of weight in the furnished car. The specimen shall be unloaded in the increments in which it was loaded. Strain gauge, deflection and load cell readings shall be taken at each load increment.

At each step of the load, the all car doors shall be exercised to verify they continue to operate normally, with normal cycle times.

19.5.1.6.2 Test criteria

The car shall be considered compliant with this Specification if all of the following conditions are met:

- Stresses are in accordance with the requirements of APTA Standard SS-C&S-034-99.
- Vertical deflection readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at that point which represents the measured deflection for maximum vertical load.
- Strain readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.
- Maximum stresses calculated from stain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.

- Recorded residual vertical deflection between bolsters following removal of the maximum vertical test loading does not exceed 0.01 in.
- Recorded residual car transverse width and/or opening diagonal dimensions following removal of the maximum vertical test load do not exceed 0.01 in.
- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum vertical loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- Carbody deflection, as measured during the vertical load tests under a load equal to the passenger load of AW3, is not more than the design camber in the side sill at any point between the carbody bolsters.
- Door operation is normal, including normally expected cycle times.
- There are no permanent deformations, fractures, cracks, or separations in the car structure. Broken welds resulting from the test are to be inspected jointly by the Contractor and Customer to determine if the failure is the result of weld quality or stress.

19.5.1.7 End sill compression load test

19.5.1.7.1 Test description

A compression test load as defined in APTA Standard SS-C&S-034-99 is to be applied to the end sill assembly in the underframe of the test specimen by means of a ram. This load shall be applied horizontally at the horizontal centerline of the carbody.

During the compression test, the carshell shall be supported on trucks or simulations thereof to allow free longitudinal movement. The carshell shall be loaded with sufficient dead weight to bring the total body weight of the test specimen to that of an AW0 loaded car. This loading shall be distributed in proportion to the distribution of weight in the finished car.

The compression test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of those producing the force. The force shall be measured at the ram and at the reaction at the opposite end of the car. The ram shall be supported at the car end, but shall remain free to move longitudinally with respect to the car end.

19.5.1.7.2 Test criteria

The car shall be compliant with this Specification if all of the following conditions are met:

- Stresses are in accordance with the requirements of APTA Standard SS-C&S-034-99.
- The vertical deflection of each side of the test structure is within +/-10% of the value determined by the analysis.
- The force measured at the reaction load cell is within 1.0% of the force applied at the ram.
- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.

- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum vertical loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There are no permanent deformations, fractures, cracks or separations in the car structure. Broken welds are to be jointly inspected by the Contractor and Customer to determine if the failure is the result of weld quality or stress.

19.5.1.8 Compression load test at the draft stop

19.5.1.8.1 Test description

A compression test load of 800,000 lbs shall be applied to the rear draft stop in the draft gear housing. This load shall be applied at the car transverse centerline and vertically at centerline of shaft. No allowance shall be made for the camber of the carbody.

A fixture, which simulates the regular draft gear and carrier, shall be installed. During the compression test, the carshell shall be supported on trucks, or a simulation thereof to allow free longitudinal movement. The carshell shall be loaded with sufficient dead weight to bring the total body weight of the test specimen to that of an AWO loaded car. This loading shall be distributed in proportion to the distribution of weight in the finished car.

The compression test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of those producing the force. The force shall be measured at the ram and at the reaction at the opposite end of the car. The load shall be applied in increments of 25%, 50%, 75%, 87.5% and 100% of full load. After each load increment is applied, the load shall be reduced to not more than 2% of full load. Strain gauge, deflection and load readings shall be taken at each load increment and at each relaxation of load. The ram may be supported at the car end, but shall remain free to rotate at its contact with the car end.

19.5.1.8.2 Test criteria

The car shall be compliant with this Specification if all of the following conditions are met:

- Stresses are in accordance with the requirements of APTA Standard SS-C&S-034-99.
- The vertical deflection of each side of the test structure is within +/- 10% of the value determined by the analysis.
- The force measured at the reaction load cell is within 1.0% of the force applied at the ram.
- Vertical deflection readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.
- Strain readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point, which represents the measured deflection, at maximum load.
- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.
- Recorded residual vertical deflection between bolsters following removal of the maximum vertical test load does not exceed 0.01 in.

- The residual horizontal deflection between ends following removal of the maximum load does not exceed 0.04 in.
- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum vertical loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There are no permanent deformations, fractures, cracks, or separations in the car structure. Broken welds are to be jointly inspected by the Contractor and Customer to determine if the failure is the result of weld quality or stress.

19.5.1.9 Diagonal jacking test

19.5.1.9.1 Test description

The carshell shall be loaded to its AWO weight, with trucks, or equivalent weight, hanging from the body bolsters. The carshell shall be supported symmetrically at the jack pads at the four corners of the car. One of the jacks shall be lowered in five equal increments until it is free of the jacking pad. The selection of the jack to be lowered should be based on its relation to the center of gravity of the carshell so that the diagonally opposite jack remains in contact with the jacking pad and carries some car weight. All gauges shall be recorded at each increment of jack position. The procedure shall be reversed until the load on the jack is returned to its original level.

The amount of torsional deflection or twist shall be measured.

19.5.1.9.2 Test criteria

The car shall be compliant with this Specification if all of the following conditions are met:

- Passing criteria for the test shall have a factor of 1.25, when compared to yield stress values.
- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to the start of the test program as part of the stress analysis.
- Strain readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point that represents the measured deflection at maximum load.
- Indicated residual strains at strain gauges following return to original level do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There are no permanent deformations, fractures, cracks or separations in the car structure.
- Broken welds are to be jointly inspected by the Contractor and Customer to determine if the failure is the result of weld quality or stress.

19.5.1.10 Collision post elastic test

19.5.1.10.1 Test description

The ability of the carbody structure to resist the collision post longitudinal loads specified in APTA Standard SS-C&S-034-99 shall be tested.

During the collision post test, the carshell shall be supported on trucks or simulations thereof to allow free longitudinal movement. The post-applied load shall be reacted at the coupler. The carshell shall be loaded with sufficient dead weight to bring the total carbody weight of the test specimen to that of an AWO loaded carbody. This loading shall be distributed in proportion to the distribution of weight in the finished car.

The specimen shall be instrumented as required for the car and collision post per the corresponding test plan. Strain gauges and deflection gauges shall be installed at the same places at some locations so that the structural equivalence of the model to the carbody can be determined.

A longitudinal test load as specified in APTA Standard SS-C&S-034-99 shall be applied to, and centered on, the collision post at an elevation 18 in. above the top of the underframe. This load shall be distributed over an area not to exceed the width of the collision post by 6 in. in height.

The test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of that producing the force. A fixture and means of cushioning, such as lead sheets, shall be provided to assure uniform bearing and to prevent crippling around the area of force application. This fixture and cushion shall not be attached to the post. The test load shall be applied horizontally parallel to the car longitudinal centerline. The load shall be applied in increments of 25%, 50%, 75%, 87.5% and 100% of full load. The load shall be reduced to not more than 2 percent of full load after each step. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load. The ram shall be supported at the car end, but shall remain free to move longitudinally with respect to the car end.

19.5.1.10.2 Test criteria

The car shall be compliant with this Specification if all of the following conditions are met:

- Deflection readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point that represents the measured deflection at maximum load.
- Strain readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.
- Maximum stresses calculated from strain readings in any structural element ~ exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.
- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There is no permanent deformation, fractures, cracks or separations in the car structure.
- Broken welds are to be jointly inspected by the Contractor and Customer to determine if the failure is the result of weld quality or stress.

19.5.1.11 Corner post longitudinal load test

19.5.1.11.1 Test description

The ability of the carbody structure to resist the primary side corner post longitudinal compressive loads specified in APTA Standard SS-C&S-034-99 cab cars and coach cars shall be tested.

During the corner post longitudinal test, the carshell shall be supported on trucks or simulations thereof to allow free longitudinal movement. The post applied load shall be reacted at the coupler. The carshell shall be loaded with sufficient dead weight to bring the total carbody weight of the test specimen to that of an AWO loaded carbody. This loading shall be distributed in proportion to the distribution of weight in the finished car.

The specimen shall be instrumented as required for the car and corner post in the corresponding test plan. The strain gauges and deflection gauges shall be installed at the same places at some locations so that the structural equivalence of the model to the carbody can be determined.

Longitudinal test loads shall be applied to, and centered on, the corner post at an elevation of 18 in. and 30 in. above the top of the underframe as specified in APTA Standard SS-C&S-034-99. The magnitudes of the loads shall be limited to values that approach the yield strength of the post as predicted by the approved FEA. These loads shall be distributed over an area not to exceed the width of the collision post and not to exceed 6 in. in height.

The test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of that producing the force. A fixture and means of cushioning, such as lead sheets, shall be provided to assure uniform bearing and prevent crippling around the area of force application. This fixture and cushion shall not be attached to the post. The test load shall be applied horizontally parallel to the car longitudinal centerline. The load shall be applied in increments of 25%, 50%, 75%, 87.5% and 100% of full load. The load shall be reduced to not more than 2% of full load after each step. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load. The ram shall be supported at the car end but shall remain free to move longitudinally with respect to the car end.

19.5.1.11.2 Test criteria

The car shall be compliant with this Specification if all of the following conditions are met:

- Deflection readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.
- Strain readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.
- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.

- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There is no permanent deformation, fractures, cracks or separations in the car structure. Broken welds shall be jointly inspected by the Contractor and the Customer to determine if the failure is the result of weld quality or stress.

19.5.1.12 Corner post transverse load test

19.5.1.12.1 Test description

The ability of the carbody structure to resist the corner post transverse load specified in APTA Standard SS-C&S-034-99 shall be tested.

During the corner post test, the carshell shall be supported on trucks or simulations thereof. Transverse restraint shall be at the lateral stops between the carbody bolsters and truck frame. The carshell shall be loaded with sufficient dead weight to bring the total body weight of the test specimen to that of an AWO loaded carbody. This loading shall be distributed in proportion to the distribution of weight in the finished car.

The specimen shall be instrumented as required for the car and corner post in the corresponding test plan. The strain gauges and deflection gauges shall be installed at the same places at some locations so that the structural equivalence of the model to the carbody can be determined.

Longitudinal test loads as specified in APTA Standard SS-C&S-034-99 shall be applied to and centered on the corner post at an elevation of 18 in. above the top of the underframe. This load shall be distributed over an area not to exceed the width of the corner post and not to exceed 6 in. in height.

The test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of that producing the force. A fixture and means of cushioning, such as lead sheets, shall be provided to assure uniform bearing and prevent crippling around the area of force application. This fixture and cushion shall not be attached to the post. The test load shall be applied horizontally perpendicular to the car longitudinal centerline. The load shall be applied in increments of 25%, 50%, 75%, 87.5% and 100% of full load. The load shall be reduced to not more than 2% of full load after each step. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load. The ram shall be supported at the car end but shall remain free to move transversely with respect to the car end.

19.5.1.12.2 Test criteria

The car shall be compliant with this Specification if all of the following conditions are met:

- Deflection readings plotted against load do not vary by more than +/- 5% percent from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.
- Strain readings plotted against load do not vary by more than +/- 5% from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other at the point which represents the measured deflection at maximum load.

- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.
- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There are no locations of permanent deformation, fractures, cracks or separations in the car structure. Broken welds are to be jointly inspected by the Contractor and Customer to determine if the failure is the result of weld quality or stress.

19.5.1.13 Collision post elastic-plastic test

19.5.1.13.1 Test description

The ability of the connections between the collision posts and the carbody structure to withstand a longitudinal load equal to the ultimate load carrying capacity of the post as specified in APTA Standard SS-C&S-034-99 shall be tested.

This test shall also verify the structural energy absorption requirement outlined in APTA Standard SS-C&S-034-99, Rev 2.

The test specimen shall be a full-scale structural model of the cab end of a car. The structural model shall include all structural elements required to support the collision posts including the end underframe and roof between the forward end of the end frame and the bolster. All connections shall be identical to those of production cars. The bolster end of the model shall be attached to a rigid fixture so that the stresses in the post and its supporting structure shall be the same as those in a car subjected to the same load.

The specimen shall be instrumented in the same manner in which it was instrumented in the collision post elastic test, except that instruments of greater capacity may be needed for this test. The strain gauges and deflection gauges shall be installed in the same locations so that the structural equivalence of the specimen to the carbody can be determined. Longitudinal test loads shall be applied to and centered on the collision post at an elevation of 30 in. above the top of the underframe. This load shall be distributed over an area not to exceed the width of the collision post and not to exceed by 6 in. in height.

The compression test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of that producing the force. A fixture and means of cushioning, such as lead sheets, shall be provided to assure uniform bearing and prevent crippling around the area of force application. This fixture and cushion shall not be attached to the post. The test load shall be applied horizontally parallel to the car longitudinal centerline.

The initial load shall be applied in increments of the same magnitude as those used during the collision post elastic load test. The load shall be reduced to not more than 2% of full load after each step. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load.

The strain gauge readings and deflections measured during this test shall be within 5% of the gauge readings for the same load and location measured during the collision post elastic test. If difference between the two test results, the fixture and/or the model shall be corrected until agreement within 5% between the two tests is obtained.

After agreement between the two tests is demonstrated, the collision post shall continue to be loaded in stroke increments of 20% of the full depth of the collision post until the load carrying capacity of the collision post is obtained. At each 20% load increment, all load cell(s), strain gauges and deflection gauges shall be recorded. The load need not be relaxed after each step.

The ultimate load carrying capacity of the post shall be defined as the condition where the post cannot support an increased load or the center of the post has deflected more than its full depth. This deflection shall be measured at the middle of the post from a string connected between the top and bottom of the post.

19.5.1.13.2 Test criteria

The collision post shall be compliant with this Specification if all of the following conditions are met:

- All strain gauges and deflection gauges have the same readings within +/- 5% for the same loads at the same locations as the collision post elastic load test for 0% to 100% as tested in the elastic test.
- The connections between the collision post and all other structural members are not completely broken.
- The collision post and supporting structure have absorbed energy as per APTA Standard SS-C&S-034-99, Rev 2.

19.5.1.14 Corner post elastic-plastic test

19.5.1.14.1 Test description

The ability of the connections between the corner posts and the carbody structure to withstand a longitudinal load equal to the ultimate load carrying capacity of the post as specified in APTA Standard SS-C&S-034-99 shall be tested.

This test shall also verify the structural energy absorption requirement outlined in APTA Standard SS-C&S-034-99, Rev 2.

The test specimen shall be a full-scale structural model of the cab end of a car. The structural model shall include all structural elements required to support the corner posts including the end underframe and roof between the forward end of the end frame and the bolster. All connections shall be identical to those of production cars. The bolster end of the model shall be attached to a rigid fixture so that the stresses in the post and its supporting structure shall be the same as those in a car subjected to the same load.

The specimen shall be instrumented in the same manner in which it was instrumented in the corner post elastic test (longitudinal), except that instruments of greater capacity may be needed for this test. The strain gauges and deflection gauges shall be installed in the same locations so that the structural equivalence of the specimen to the carbody can be determined. Longitudinal test loads shall be applied to and centered on the corner post at an elevation of 30 in. above the top of the underframe. This load shall be distributed over an area not to exceed the width of the corner post and not to exceed by 6 in. in height.

The compression test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of that producing the force. A fixture and means of cushioning, such as lead sheets, shall be provided to assure uniform bearing and prevent

crippling around the area of force application. This fixture and cushion shall not be attached to the post. The test load shall be applied horizontally parallel to the car longitudinal centerline.

The initial load shall be applied in increments of the same magnitude as those used during the corner post elastic load test. The load shall be reduced to not more than 2% of full load after each step. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load.

The strain gauge readings and deflections measured during this test shall be within 5% of the gauge readings for the same load and location measured during the corner post elastic test. If difference between the two test results, the fixture and/or the model shall be corrected until agreement within 5% between the two tests is obtained.

After agreement between the two tests is demonstrated, the corner post shall continue to be loaded in stroke increments of 20% of the full depth of the corner post until the load carrying capacity of the corner post is obtained. At each 20% load increment, all load cell(s), strain gauges, and deflection gauges shall be recorded. The load need not be relaxed after each step.

The ultimate load carrying capacity of the post shall be defined as the condition where the post cannot support an increased load or the center of the post has deflected more than its full depth or 10 in., whichever is greater. This deflection shall be measured at the middle of the post from a string connected between the top and bottom of the post.

19.5.1.14.2 Test criteria

The corner post shall be compliant with this Specification if all of the following conditions are met:

- All strain gauges and deflection gauges have the same readings within +/- 5% for the same loads at the same locations as the corner post elastic load test for 0% to 100% as tested in the elastic test.
- The connections between the corner post and all other structural members are not completely broken.
- The corner post and supporting structure have absorbed energy as per APTA Standard SS-C&S-034-99, Rev 2.

19.5.1.15 Crash energy management

A series of tests shall be conducted to validate the Crash Energy Management (CEM) design. This shall include dynamic or quasi-static testing as appropriate of each type of coupler and structural absorber to validate the design of each of the absorbers. The principal objective of these tests shall be to measure the force/crush characteristics of the coupler and structural energy absorbing elements. Full-sized elements shall be tested.

Validation of the analysis models shall be by testing of crush elements and fuse elements. The validated models of these elements or their crush performance characteristics shall be assembled into a model of the crush zone on the end of the car. The assembled model shall be used to perform a full 3D explicit analysis of the car (flat wall for coaches, into a locomotive for cabs) to prove compliance with this specification.

The Contractor shall submit a CEM Analysis as per Sections 6.0 and 7.4 of APTA Standard SS-C&S-034-99, for review and approval by the Engineer. The following shall be analyzed:

- Individual energy absorbing structural elements,
- Individual frangible structural elements (“fuses”),
- Each crush zone, consisting of the validated energy absorbing and frangible elements,
- The remainder of the carbody structure occupied by passengers and crew.

19.5.1.15.1 CEM test plan

CEM system design validation shall be provided according to separate CEM System Test Plan that shall be integrated into the Carbody and Truck Stress Analyses and Tests Plan of this Chapter. The Contractor shall provide a CEM System Tests Plan for review and approval by the Engineer. The CEM System Tests Plan shall include, as a minimum, the tests included the CEM System Test Matrix.

Table 19-1: CEM System Test Matrix

Test	Spec	Type	Car End	Level	Input Parameter	Criterion
Structural Absorber Energy Absorption	4.21.4 & 4.21.5	Dynamic	All	Component	Energy Absorption	Exceeds Minimum Required Value
Coupler Energy Absorbed	6.9	Dynamic	All	Component	Energy Absorption	Exceeds Minimum Required Value
Coupler Initiation Load*	6.9	Dynamic or Quasi-Static	All	Component	Initiation Load	Exceeds Minimum Required Value
Trigger, Frangible Element, Fuse*	4.21.4 & 4.21.5	Dynamic or Quasi-Static	All	Component	Load and Failure Mode	Within Design Range
* May be combined with the related absorber test into one dynamic test if appropriate for the design of the absorber. Include all necessary details in the Plan.						

For each element to be tested, the related part of the Plan shall include description of the element to be tested, description of required test fixtures, the conditions under which the test will be conducted, and the data to be measured.

19.5.1.15.2 CEM test procedure

Prepare a Test Procedure for each element to be tested. The Procedure shall describe the test in step-by-step detail, and shall include details of the test fixtures, instrumentation, data acquisition system and pass-fail criteria. For each test, approval of the Plan and the specific Procedure is required prior to starting the test.

19.5.1.15.3 CEM tests

Perform each test in accordance with its approved Procedure. The primary results shall be force and displacement histories. Sufficient data shall be gathered to determine peak and average force. Photograph each test article before and after testing, and at any intermediate steps. Sufficient additional data and measurements shall be taken to evaluate modes of crush. Each dynamic test shall be documented with high-speed cameras. The record of the test shall be provided on storage media as agreed.

19.5.1.15.4 CEM tests, evaluation of results

Compare force/crush characteristic from test with analytical predictions. Average force, peak force and force and displacement histories shall be compared. Modes of crush shall also be compared.

19.5.1.15.5 Test correlation criteria

Upon completion of test, the contractor shall validate his analytical predictions against the test results. If needed, appropriate parameters in the analytical model may be modified such that the model better reflects actual behavior.

The values specified in the following are the difference between test and validated analytical result with the former as the base:

- Peak force, $\pm P\%$,
- Average force, $\pm A\%$,
- Force and displacement vs. time, $\pm T\%$ at any particular time, and
- Modes of crush as predicted by analysis.

The Contractor shall provide meaningful and realistic correlation criteria for $P\%$, $A\%$, and $T\%$ for review and acceptance by the Engineer. The criteria must be based on state-of-the-art analysis and testing techniques. The basis of the criteria must be defined by the Contractor and supported by established correlation criteria of other CEM designs that have been analyzed and tested.

Upon satisfactory validation of the CEM element analytical models, the overall 3D model of the car structure shall be updated to reflect the test results and compliance with the CEM section of this Specification shall be verified.

If the above process indicates a need for CEM element or structure re-design, the performance of the redesigned elements shall be verified by test, the CEM element model validated and compliance of the overall vehicle performance re-verified against the CEM specification.

19.5.1.16 Wheelchair lift

The powered wheelchair lift shall undergo proof-of-design testing to evaluate and verify that the lift meets all specification requirements for:

- Compliance with all applicable ADA requirements;
- Functional and operational performance under all design loads, track conditions as specified, and safety factors without deformation or deflection;
- Rate of travel upward and downward for the lift platform under loaded and unloaded conditions;
- Full range of vertical movement for the lift to adequately reach the range of station platforms as specified;
- Proper operation of all safety provisions and functional interlocks and isolation devices within the unit and with the door system, brakes and indicators;
- Function of lift after loss of power while in mid-travel, then with restoration of power;
- Proper and secure storage of the lift within the car;

- Maintainability and reliability requirements; and
- Manual operation of lift at rated load.

These tests shall include an endurance test in which the lift shall be subjected to no less than 2,500 repeated cycles of deployment and storage.

19.5.2 Trucks

19.5.2.1 Allowable stresses

For the purposes of truck frame and component load and fatigue testing, the Contractor and/or the truck designer shall determine the maximum allowable stresses that the truck shall be designed to accommodate in order to perform without degradation over the 40-year useful life of the major components of the truck, under AW3 load conditions, all specified track conditions, and the truck's service life cycle as defined in this specification. The allowable stresses shall be determined using industry standard practice, and shall be submitted to the Customer for approval prior to the start of any truck frame load or fatigue testing.

19.5.2.2 Equalization

The truck shall be tested in accordance with APTA Standard SS-M-014-06, for car type "G".

To verify the equalization provided by the truck design, one truck on the first car at AW0 load shall have one wheel jacked up 2.5 in. and then increasing to 3 in. and suitable instrumentation provided to measure the load carried on the other wheels. The load changes shall be in accordance with the requirements of APTA Standard SS-M-014-06. In the event that suitable equalization is not attained as indicated by the tests, the truck design shall be corrected, the truck retested at the expense of the Contractor, and all trucks installed under the cars shall be modified to be in accordance with the corrected design.

19.5.2.3 Truck frame load tests

The truck frame and bolster shall be tested to verify that the maximum allowable stresses established by the Contractor and approved by the Customer under an AW3 load are not exceeded. This is a static load test, repeated twice with a complete release between applications and shall be performed with the suspension elements replaced by solid blocking (with resilient pads if necessary). The truck shall be tested either as individual load bearing components or as an assembly, as the Contractor elects. If the load bearing components of the truck rather than the complete assembly are tested, provision must be made to apply all input loads described herein and for the member under test to react to these input loads in a manner which is identical to the reactions that would occur when included as part of the assembly. Forces shall enter the parts or truck at the normal application points, and shall be so combined in each case as to produce the maximum unit stresses at the critical points for which the stress estimates were furnished. The tests shall be witnessed by the Customer.

No less than 75 strain gauges shall be applied to the truck near the locations of maximum stress points as agreed to by the Contractor and the Customer, the Customer having the power of decision in disagreement. The location of maximum stress points are to be determined by analysis. The loads specified are minimum values. The Contractor shall be responsible for selecting loads that will develop a high level of confidence in the adequacy of the truck design for the intended purpose and application. The critical stress readings of the two applications

shall be averaged for comparison with the estimated stresses. The highest vertical load of all car types, as seen at the truck, shall be used for the loadings. The vertical load component shall be 110% of the AW3 loaded carbody weight normally carried by the truck. The lateral component shall be 25% of the vertical component. The longitudinal component shall be 15% of the vertical component.

All loads shall be applied simultaneously. At no point shall the average stress exceed the allowable stress as established herein this section. If it does, the Customer shall have the right to require that the design be corrected to bring the test stresses with the allowable stresses; the truck shall be retested at the expense of the Contractor, and all trucks installed in the cars shall be modified to be in accordance with the corrected design. Testing will not be required on service qualified components which can be shown to have had satisfactory service experience of comparable severity and duration, as determined by the Customer.

19.5.2.4 Truck frame overload tests

To demonstrate that the truck design has adequate strength to sustain a maximum load in the presence of a combination of minor manufacturing defects, a truck frame and bolster shall be overloaded statically. The suspension elements shall be replaced by solid blocking (with resilient pads if required). The loads shall be as follows:

- Vertical load = $1.5 \times \text{AW3 car weight per truck}$.
- Lateral load = $0.3g \times \text{AW3 car weight per truck}$ applied at the carbody center of gravity (note: this produces additional vertical loads on the truck).
- Longitudinal load = $1g \times \text{truck weight}$.
- Brake loads consistent with maximum specified deceleration, split between tread and disc mounting locations according to Chapter 7.

All loads shall be applied simultaneously.

No less than 75 strain gauges shall be applied to the truck near the locations of maximum stress points as agreed to by the Contractor and the Customer, the Customer having the power of decision in case of disagreement. The location of maximum stress is to be determined by analysis. The loads specified are minimum values. The Contractor shall be responsible for selecting loads that will develop a high level of confidence in the adequacy of the truck design for the intended purpose.

Unit stresses at critical locations shall be measured before and after the test at representative points on the truck as agreed to between the Contractor and the Customer, the Customer having the power of decision in the event of disagreement. Certain before-test and after-test critical characteristic dimensional checks may be agreed upon to supplement strain gauge readings. The Customer shall be present for the tests. There shall be no permanent deformation as determined from strain gauge readings. If such deformation appears, the design shall be corrected to bring the stress under the test condition within the elastic limit of the material involved, the truck shall be retested at the expense of the Contractor, and all trucks installed in the cars shall be modified to be in accordance with the corrected design. Testing will not be required on service qualified components which can be shown to have had satisfactory service experience of comparable severity and duration, as determined by the Customer.

19.5.2.5 Truck frame fatigue tests

To demonstrate that the truck has adequate fatigue strength under dynamic loading, the truck frame and bolster shall be tested according to the provisions of APTA Recommended Practice RP-M-009-98. The loads specified below are minimum values. The Contractor shall be responsible for selecting loads that will develop a high level of confidence in the adequacy of the truck design for the intended purpose.

The truck frame and bolster shall be tested as a unit, with the suspension elements replaced by solid blocking (with resilient pads if necessary). The vertical component shall be plus and minus 0.2g times the AW1 loaded carbody weight normally carried by the truck with the highest loading. The lateral component shall be plus and minus 0.15g times the above AW1 load and shall vary with it. The longitudinal component shall be plus and minus 0.15g times the above AW1 load and shall vary with it. Accessory loads, as determined by the Customer, shall vary between plus and minus 100% of their maximum steady state or harmonic dynamic conditions. Loads applied to the truck bolster shall include those resulting from the transfer vertically of the applied lateral force from the height of loaded carbody center of gravity to the lateral bumper height. The phasing of loads shall result in maximum combined stresses at the critical locations. The test shall demonstrate that the maximum combined stresses at the critical locations do not exceed those required. Critical locations shall be agreed upon by the Contractor and the Customer, the Customer having the power of decision in the event of disagreement.

The frequency of the load cycling shall be as proposed by the Contractor for approval by the Customer. Prior to the test, the Contractor shall provide documentation and/or drawings for all defects that existed in the truck elements as produced, and the repairs made to the parts containing these defects.

During the fatigue tests, the truck shall be inspected regularly to detect possible crack initiation and progression. If evidence of progressive cracking or failure is found, the cause shall be assessed by the Customer and the Contractor after which an appropriate correction shall be established and the test repeated.

At the conclusion of the fatigue test, a magnetic particle or dye penetrate inspection shall be made for cracks in the presence of the Customer. If any crack is found, or pre-existing cracks have propagated, the design shall be corrected, the truck retested at the expense of the Contractor and all trucks installed under the cars shall be modified to be in accordance with the corrected design. Testing will not be required on service qualified components which can be shown to have had satisfactory service experience of comparable severity and duration, as determined by the Customer.

19.5.2.6 Truck primary suspension tests

A load deflection test, including a creep test for rubber or similar components if necessary, shall be performed to demonstrate that the spring rates of the primary suspension system in all axes are within the design limits. This test shall demonstrate that the primary suspension system behaves as predicted and will not result in excessive deflection or a decrease in truck clearance above top of rail to less than the minimums prescribed. If defects are found, the design shall be corrected. The truck, or the primary suspension simulating its installation in the truck, shall be retested at the expense of the Contractor, and all trucks modified to be in accordance with the corrected design.

19.5.3 Couplers

The complete coupler assembly; including draft gear, radial connector, yoke, coupler carrier and uncoupling mechanism, shall be tested to validate conformance to the requirements, including all FRA regulations and applicable APTA standards and recommended practices, including CEM performance requirements, range of motion, vertical loading, draft and buff loads and operations.

19.5.4 Brakes

The design and specifications of the friction brake system shall be verified through a series of tests that simulate the environment in which the brake system will function. These tests shall analyze the brake system's performance, reliability and safety under the extreme conditions found in revenue service, including full-service and emergency brake rate measurements, analysis of component fatigue, heat creation and dissipation calculations, handbrake performance, and materials analysis. These tests shall include computer simulations and dynamic testing of brake system components as performed by the brake system supplier, as well as track tests performed by the Contractor using completed cars.

19.5.4.1 Brake pad/shoe force tests

Tests shall be conducted on the first car to verify the actual force produced at the brake pad by the disc brake assembly, and at the brake shoe by the tread brake unit at both a handbrake and a non-handbrake location agree with calculated values. Tests shall be conducted with brake cylinder pneumatic pressures in 5 pounds/square inch increments, from 0 pounds per square inch to the maximum used, and from application of the handbrake.

19.5.4.2 Brake component fatigue tests

A test set-up shall be arranged such that a disc brake assembly, tread brake unit and brake pad and shoe are exposed as nearly as possible to the same conditions as they will encounter in service. The brake pad and shoe shall be loaded by applying air pressure equivalent to a maximum service brake (friction only) application to the disc brake assembly and the tread brake unit, and the forces developed by brake reaction torque shall be applied through the mounting arrangement. The entire brake assembly shall be subjected to 1,000,000 cycles of applications and releases at the working loads predicted for an AW2 loaded car. The direction of the reaction torque shall be reversed every ten brake applications. This test will not be required for hardware that has had satisfactory service experience of comparable severity and duration, as determined by the Customer.

19.5.4.3 Friction brake system endurance tests

The first complete car set of the friction brake pneumatic control system produced, before mounting on a car, shall be subjected to an endurance test of 1,000,000 cycles of normal applications and releases to demonstrate that the control apparatus has the endurance required for rail service. The system will not be considered acceptable until the test has been performed without a component failure of any kind during 1,000,000 consecutive operating cycles. Testing will not be required on service qualified components which can be shown to have had satisfactory service experience of comparable severity and duration, as determined by the Customer.

19.5.4.4 Brake capacity tests

The first production disc brake assembly, tread brake unit and brake pad and shoe for the car shall be tested using a full scale dynamometer to verify that the friction brake system design can perform the specified friction brake-only operation. A dynamometer test shall be performed to simulate the proposed revenue speed profile, driven by Customer defined train schedule service for speeds up to 125 mph. Any elevation grades exceeding 0.2% shall also be taken into account. The complete dynamometer procedure, dynamometer facility and test protocol shall be provided by the Contractor and approved by the Customer. This procedure is an amendment to the qualification of brake shoe and disc brake materials as specified in Amtrak Specification 80-276. All other attributes of friction brake material performance shall be in accordance with Amtrak Specification 80-276. The production brake pads and materials shall be used, and temperature limits specified by the brake and wheel supplier shall not be exceeded. The test shall be coordinated according to the planned operating pattern.

19.5.4.5 Handbrake tests

Handbrake performance shall be verified for compliance to the specification as well as APTA Standard SS-M-006-98 using new and fully worn brake shoes/pads.

On the first car a test of the adequacy of the design of the handbrake shall be made (using first new and then fully worn brake shoes) by measuring with a scale the force needed to move the car with the handbrake applied on level tangent track.

The “handbrake-applied” indicator light shall also be tested.

19.5.5 Door System

The side and end door systems shall be subjected to extensive testing to confirm that the systems and components meet all requirements for:

- System integrity
- Safety
- Functionality and operation
- Opening and closing times and speeds
- Trainline controls, indicators and interlocks
- Compliance with regulations, recommendations and standards
- Reliability
- Maintainability
- Sustained and compliant performance under all specified operational and environmental conditions

All door system components shall be tested through rigorous multiple-cycle operation that simulates the actual installation, hardware and climatic conditions as specified.

19.5.5.1 Side door system reliability test

A set of side door panels and operators, fully equipped with all required equipment as designed, shall be installed in a test fixture at the facilities of the door system supplier, and subjected to a repeated open and close cycle test of no less than 500,000 full cycles, so demonstrate the durability of the operators, hangers, switches, motors and all other components of the door system. The test fixture shall simulate the actual door opening, threshold and pocket in which the doors will be mounted. Power and control to the doors shall be via the actual wire leads that will connect the door operator to the carbody wiring in a production installation. The door operators shall be monitored for proper function and continued operation. Any failure of the door operators to function or perform according to the specifications, test procedure or performance criteria shall be considered a failure. All failures shall be investigated and analyzed as to cause, and the Contractor or door system supplier shall propose corrective action. Once approved by the Customer, the door operators shall be modified to conform to the corrective action, and the test shall be started over again. The door system test shall be conducted until both operators function continuously without failure for 500,000 cycles.

Once the first car has been completely assembled, and the entire side door system has been installed and the functionality has been verified, the side doors shall be operated for 14,400 continuous trouble-free cycles each. The system shall be monitored to confirm that each door operates through a complete cycle of fully opening and fully closing and latching for all 14,400 cycles. No adjustments or maintenance will be allowed during the test. Any door or door control failure occurring prior to completion of the test will require that the test be stopped, corrective action be taken to document and resolve the failure, and start the test at the beginning for all car doors.

19.5.5.2 Side door safety test

Once installed in a completed car, the side door system, including all side doors, shall be functionally tested to verify that the door system design conforms to all applicable safety requirements, including:

- Trainline and local control, door summary circuit and zero-speed operation
- Obstruction detection and recycle operation
- Interlocks, isolation and manual locking
- Interior, exterior and trainline door status indicators
- Manual release (interior and exterior), including the force to activate the manual release, the force to open a door that has been released and the process for resetting the doors to normal operation
- Structural integrity of the door panel and glazing
- Signage and emergency operation

Under no circumstances shall a door be allowed to create an unsafe condition.

19.5.5.3 End door reliability test

An end door panel and operator, fully equipped with all required equipment as designed, shall be installed in a test fixture at the facilities of the door system supplier, and subjected to a repeated open and close cycle test of no less than 100,000 full cycles, so demonstrate the durability of the operator, hanger, switches, motor and all other components of the door system. The test fixture shall simulate the actual door opening, threshold and pocket that the door will be mounted in. Power and control to the door shall be via the actual wire leads that will connect the door operator to the carbody wiring in a production installation. The door operator shall be monitored for proper function and continued operation. Any failure of the door operator to function or perform according to the specifications, test procedure or performance criteria shall be considered a failure. All failures shall be investigated and analyzed as to cause, and the Contractor or door system supplier shall propose corrective action. Once approved by the Customer, the door operator shall be modified to conform to the corrective action, and the test shall be started over again. The end door test shall be conducted until the operator functions continuously without failure for 100,000 cycles.

The end door shall also be tested for proper opening, closing and hold-open times, the force required to manually open the door in manual mode, and for proper operation of the obstruction detection system, the normal/manual/open selector switch, the mortise lock and the press plates.

A set of end door press plates shall be subjected to a 100,000-cycle test that simulates the use of the press plates to command an end door to open. The press plates shall perform as intended through the 100,000-cycle test without showing signs of wear, abrasion or degradation of the switch, wiring, connectors or seals.

19.5.6 Interior

19.5.6.1 Overhead luggage bins

A complete overhead luggage bin, mounted on simulated carbody structure, shall be tested to verify it meets the 250 lb load requirement. A complete overhead luggage bin, fully loaded with actual weighted luggage and mounted on simulated carbody structure, shall be tested to verify it meets the 8/4/4g crashworthiness requirements. A complete overhead luggage bin, mounted on simulated carbody structure, shall be tested to verify the door and associated hardware meet the 50,000 cycle endurance requirement. The door shall be cycled to simulate opening and closing by passengers, with force and speed representative of actual passenger use applied to the latch and moving the door open and closed. Failure of a component, component coming off (such as hinge, damper or self-opening device), failure of latch to engage, hold door closed or release each constitutes failure.

19.5.6.2 Seats

One sample seat of each seat type identical to a production version shall be tested by the manufacturer for all criteria specified in APTA Standard SS-C&S-016-99 and submitted to the Customer with a detailed test report. This test result must be approved by the Customer before additional seats can be ordered and assembled into the pilot cars for pre-delivery testing.

19.5.6.3 Seat tests

Seat cushions selected twice at random by the Customer during cushion production shall be tested to verify compliance with section requirements.

Seat cushions (both foam and upholstery) shall be tested to verify compliance with requirements.

19.5.7 HVAC

19.5.7.1 Heating and air-conditioning unit tests

One complete Heating, Ventilation and Air Conditioning (HVAC) unit and its complete controls shall be given a qualification and capacity test by the air conditioning manufacturer to verify the performance of the unit. This test shall be successfully completed before commencement of the vehicle climate room test. The test shall be conducted in accordance with ANSI/ASHRAE Standard 37. The testing laboratory shall be approved by the Customer.

The actual HVAC control system, with actual temperature sensors, shall control all system operations during the test, unless indicated otherwise for specific tests.

Tests shall be conducted at nominal voltage and frequency, except where otherwise specified. Appropriate test log sheets and calculation forms shall be generated and included with the test procedure for approval. They shall become a part of the test report.

The accuracy and tolerances of all instrumentation and tests shall comply with the requirements of the ASHRAE Standard 37 Table 4 and all of the required data shall be continuously recorded. Temperature measurements and measurement techniques shall comply with ASHRAE Standard 41.1. An event recorder shall be provided to monitor operation of relays and contactors.

19.5.7.2 System pre-test requirements

Prior to any cooling and heating system test, an air balance test, control scan test and a vehicle heat transfer test shall be conducted. The purpose of these tests is to demonstrate conformance with interior ventilation, air flow and pressurization requirements, to demonstrate that the HVAC control, and thermostats perform as specified, and to demonstrate that the overall car body heat transmission does not exceed the specified limits.

The pre-tests shall be satisfactorily completed before continuing to further climate room testing.

19.5.7.3 Air balance test

Prior to any cooling and heating tests, an air balance test and a vehicle pressurization test shall be conducted. Any adjustments to air baffle plates, grilles and diffusers shall be documented during this test.

Each car to be tested shall be measured and the results recorded to verify specification requirements are met for air distribution and balance, including:

- Fresh air flow rate
- Return air flow rate
- Exhaust air flow rate
- Air flow rates into cab
- Car pressurization: cab, car interior, restrooms, baggage room
- Pressure differential of restrooms relative to adjacent car interior
- Uniformity of supply air flow
- Interior car noise levels after balancing with blowers on

Correct air distribution shall be verified with the fresh air and diversion dampers in each of the nominal positions (e.g. For fresh air dampers, closed, partial, full open positions, etc.). Once the required values are established, the system adjustments and settings shall be recorded to be used as base settings for the remaining cars of that type.

19.5.7.4 Temperature control tests

The temperature control components shall be exposed to the specified thermal environments. All points of the approved temperature control schedule referenced in Chapter 10 shall be verified for both the temperature rising and the temperature falling cycles. The temperatures shall be varied as slowly as practical to reflect natural temperature lags as experienced in the actual installation. Demonstration of the pump-down operation, when appropriate, shall be included.

Under steady state operation at design conditions, the control voltage shall be varied between the limits allowed by Amtrak Specification 963. The system shall operate steadily without malfunction.

19.5.7.5 Refrigerant charge test

The refrigerant charge, by weight, shall be confirmed at the system design conditions. The Contractor shall include the testing criteria in the test procedure which shall be approved by the Customer. The criteria shall include the following, at a minimum:

- Level of superheat at the evaporator outlet;
- Level of superheat at the compressor suction valve;
- Compressor suction and discharge pressures;
- Level of liquid refrigerant sub-cooling at condenser outlet;
- No air bubbles in liquid line sight glass;
- Compressor(s) working at full load/capacity.

19.5.7.6 Heating and air-conditioning system tests

The first of each type of car shall be tested in an approved climate room test facility capable of maintaining any test temperatures from –30°F to 130°F and any relative humidity throughout that range between 25% and 95%. Temperature in the facility shall be uniform throughout. There shall be no more than 5°F variation from 24 in. above top of rail to 24 in. above the vehicle roof and from end to end of the vehicle. Fans may be used to circulate air. Passenger load shall be simulated by means of evenly distributed heaters and humidifiers inside the vehicle; solar loads shall be simulated by means of evenly distributed heaters inside or outside the vehicles. Humidity introduced into the vehicle shall be calculated and measured to accurately simulate the passengers' latent heat load. The climate room shall have the equipment available to locally raise the condenser temperature to demonstrate the air conditioning system's pressure modulation capability.

After all testing is completed; the Contractor shall remove a sample of the refrigerant from each system for analysis by an independent laboratory. Contaminants level shall not exceed the allowable requirements of ARI Standard 700.

19.5.7.6.1 Data requirements

The Contractor shall record sufficient data at intervals of no more than 5 minutes for each air conditioning and heating test to show that the equipment operates satisfactorily and meets design requirements. The recorded data shall include the following:

Temperatures - °FDB:

- Return air at both HVAC units;
- Mixed air at both HVAC units;
- Fresh air at all air intakes (for both HVAC units);
- Distributed air throughout the car;
- Condenser air inlet at both units;
- Liquid at the filter-drier outlet on both units;
- Suction at evaporator on both units;
- Suction at compressor(s) on both units;
- All temperature sensors and thermostats;
- Exterior temperature at 24 in. above the rail at both ends of the car;
- Exterior temperature at 24 in. above the roof at both ends of the vehicle;
- Interior temperature at 14 seat positions on the upper level and 10 seat positions on the lower level at 6 in. and 48 in. above the floor;
- Interior temperature at 4 aisle positions on the upper level and 3 aisle positions on the lower level at 6 in. above the floor and 12 in. below the ceiling;
- Cab compartment on both sides of the car at 6 inches and 48 in. above the floor and 12 in. below the ceiling;
- Toilet room 6 in. and 48 in. above the floor and 12 in. below the ceiling;
- Heater guard temperature at all heater locations;

- Overheat heater compartment at all overheat protection devices;
- Wet bulb temperatures at a minimum of two ambient locations next to the fresh air intakes.

Pressures:

- Compressor(s) discharge on both units;
- Compressor(s) suction on both units;
- Liquid leaving condenser/sub-cooler outlet on both units;
- Suction at evaporator at each evaporator circuit on both units;
- Evaporator air pressure drop on both units;
- Condenser air pressure drop on both units;
- Vehicle pressurization (inches of water gauge).

Electrical Data:

- Input Voltage;
- Blower motor current, power, and speed on both units;
- Compressor(s) motor current, and power on both units;
- Condenser fan motor current, power, speed on both units.
- Fresh air damper motor current, power, and position on both units,
- Supply air Diversion damper motor current, power, and position an all dampers.

Relative Humidity Data:

- Relative Humidity (RH) sensors at 3 aisle positions on the upper level and 2 aisle positions on the lower level at 12 in. below the ceiling.

For the heating tests all heater circuits and devices shall be continuously monitored to determine all device input voltages, currents and power draw. For all tests, the status of all temperature control modes shall be “event recorded” in parallel with the temperature, pressure and electrical data in a manner which will allow total system functional status to be followed throughout the testing. Coordinating time marks shall be used on all data recording devices.

The data acquisition system shall have the capability to add channels, if required.

19.5.7.7 Control scan test

All control switching points for rising and falling temperatures shall be tested, by varying and adjusting the ambient conditions in the climate chamber and the interior loads in the car. All temperatures that affect the control system shall be tested individually. While stabilized within each control mode the interior comfort requirements of Chapter 10, shall be met. Stabilization shall be when the temperature swing at each of the interior car thermocouples, including all spaces such as cab, and toilet room, stay within $\pm 3^{\circ}\text{F}$ per hour. In the event of any control failure, appropriate adjustments shall be made and the entire scan test shall be repeated until all system controls performs as intended. If any air flow adjustments are made during the scan test, the airflow balance test shall be repeated. Cooling pump-down cycle and cooling lockout shall also be demonstrated during this test.

19.5.7.8 Vehicle heat transfer test

The overall carbody heat transmission, value shall be determined during this test. The fresh air intakes and exhaust openings shall be sealed, the vehicle doors shall remain closed and the car ventilation system shall be shut down during this test. The climate room ambient temperature shall be maintained at a constant ambient temperature below 20°F during this test. Portable heaters and fans shall be evenly distributed throughout the car, and shall be used to heat the car until the car interior temperature stabilizes. Once the car interior temperature is stabilized, the overall carbody heat transmission, value can be calculated by dividing the total heat applied in the car by the floor heaters (in BTU per hour) by the stabilized temperature difference between the ambient and interior temperature (in °F). The calculated value must be less than or equal to 1200 BTU/hr/°F.

In the event the Heat Transfer test is failed, appropriate changes to the car body insulation system shall be made, and the test shall be repeated.

19.5.7.9 Cooling system tests

The air-conditioning tests shall demonstrate the performance of the air-conditioning system in cooling the car and maintaining specified car interior temperatures at various designated ambient conditions. Unless otherwise stated, the applied ambient temperatures shall remain constant, within $\pm 3^\circ\text{F}$, during all tests.

19.5.7.9.1 Pull down and steady state operation at design conditions test

Prior to this test, the car shall be "soaked" at 110°F Dry Bulb/76°F Wet Bulb in the climate chamber for at least 6 hours with all doors closed and maximum solar load applied until the interior temperature has stabilized as described above.

After the completing the "soak" period, all electrical circuits, including car lights, shall be energized and the air conditioning system shall be turned ON with all car doors and windows closed. Fresh air dampers shall operate per control logic.

The time required for the system to reduce the interior air temperature to $74^\circ\text{F} \pm 2^\circ\text{F}$ shall be recorded, as well as the time for stabilization. Stabilization shall be when the temperature swing at each of the interior car thermocouples, including all spaces such as cab, and toilet room, stay within $\pm 3^\circ\text{F}$ per hour. Once stabilized conditions have been reached the test operation shall be continued for 30 minutes with temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior comfort requirements of Chapter 10 shall be met.

The maximum design passenger load shall be introduced into the car, and the temperature of the ambient air entering the condenser units shall be raised locally to 130°F Dry Bulb, while maintaining 110°F Dry Bulb/76°F Wet Bulb in the climate chamber. Again, once stabilized conditions have been reached inside the car, the test operation shall be continued for 30 minutes with temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior comfort requirements of Chapter 10 shall be met.

19.5.7.9.2 Door cycling test (cooling)

At the same conditions following the pull down and steady state operation at design conditions test, the doors shall be cycled on one side of the car at a rate of 2 minutes open and 15 minutes closed for two hours. The average car temperature, including the upper and lower levels, shall recover within 2°F of the required interior car temperature within 3 minutes maximum after each door closing.

19.5.7.9.3 High ambient test

At the same conditions following the pull down and steady state operation at design conditions Test or upon completion of the door cycling test, the climate chamber's ambient temperature shall slowly be raised to 130°F Dry Bulb. After 130°F is reached, the system shall operate continuously for one hour. During the entire test, the system shall not shut down from high pressure, circuit breaker trip, compressor motor overload or failure of any device. Cooling shall be provided at a reduced capacity as described in chapter 10 during this test. Temperatures, pressures, electrical and humidity data shall recorded at one minute intervals during the entire test.

After the one hour operation, the 480VAC power to the car shall be removed for 2 seconds, and then reapplied. The system shall recover from the power interruption and restart with no system or component malfunction.

19.5.7.9.4 High pressure cut-out test

Upon completion of the high ambient test, the climate room temperature (or condenser air inlet temperature) shall be further increased until the high pressure devices on both units are actuated, whereby shutting down the cooling. After actuation, both units must restart as directed by the control system. Temperatures, pressures, electrical and humidity data shall recorded at one minute intervals during the entire test.

19.5.7.9.5 Condensate carry over test

With the Climate Chamber temperature at 80°F Dry Bulb/75°F Wet Bulb, operate the air-conditioning system continuously for a period of 4 hours in the cooling mode. The interior passenger load and solar load must be adjusted during this test to maintain system operation in cooling mode. Any adjustments to internal loads must hold the interior sensible heat ratio constant at 50%.

At the end of the test, the heater coil, evaporator blower's compartment, supply-air discharge plenum, air ducts and diffusers shall be examined for the presence of water.

The test shall be considered successful if, during the test, no condensed water drops, runs, or is blown from the evaporator unit casing and/or its drain pan, and carried in the air stream to the heater coil, evaporator blowers, supply-air discharge plenum, air ducts or diffusers. Overhead heater elements must remain dry.

19.5.7.9.6 Low ambient temperature test

Upon completion of the condensate carry over test, the climate chamber shall be adjusted to the lowest ambient air temperature at 40% relative humidity that provides the minimum cooling mode with no reheat according to the Contractor's control schedule. The interior passenger load and solar load must be adjusted during this test to maintain system operation

in this cooling mode. Any adjustments to internal loads must hold the interior sensible heat ratio constant at 50%. This HVAC system shall operate for 4 hours under these conditions without damage to the equipment, and the evaporator air flow shall not drop more than 15% from the manufacturer's design point. Temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior must conform to the comfort requirements of Chapter 10. While the unit is still running, examine the evaporator coils for evidence of icing, and verify the oil level at each compressor sight glass.

19.5.7.9.7 Low ambient temperature test with high internal load

Upon completion of the low ambient temperature test, the interior loads shall be increased to the maximum design passenger load and full solar load. Operate the system continuously for a period of 4 hours. During the entire test, the system shall operate without damage to the equipment, Temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior must conform to the comfort requirements of Chapter 10.

19.5.7.10 Heating system tests

The heating tests shall demonstrate the heating system's ability to heat the car interior and maintain specified interior car temperatures at various designated ambient conditions. Unless otherwise stated, the applied ambient temperatures shall remain constant, within $\pm 3^{\circ}\text{F}$, during all tests.

19.5.7.10.1 Layover verification test

This test begins with the car in a stabilized automatic heating condition with an ambient temperature of 60°F . The car is then placed in its layover mode and the ambient temperature reduced to -30°F at a rate of change not to exceed $20^{\circ}\text{F}/\text{hour}$. This ambient temperature is maintained for a maximum of eight hours. The average interior temperature must remain within the allowed layover temperature range during the eight hour period.

The layover state is continued an additional four hours with reduced applied voltage to its lowest allowable value. Again, the average interior temperature must remain within the allowed layover temperature range during the entire four hour period.

19.5.7.10.2 Steady state heating at design conditions test

Following the layover verification test, the nominal voltage supply is reapply and the car is placed in its normal mode, with all car doors and windows closed. Fresh air dampers shall operate per control logic.

The time required for the system to raise the interior air temperature to $70^{\circ}\text{F} \pm 2^{\circ}\text{F}$ shall be recorded, as well as the time for stabilization. Stabilization shall be when the temperature swing at each of the interior car thermocouples, including all spaces such as cab, and toilet room, stay within $\pm 3^{\circ}\text{F}$ per hour. Once stabilized conditions have been reached, the test operation shall be continued for 30 minutes with temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior comfort requirements of Chapter 10 shall be met and no heater guard temperature shall exceed the specified maximum, 125°F during the entire test.

19.5.7.10.3 Steady state heating (minimum voltage)

Upon completion of the steady state heating at design conditions test, the applied voltage shall be reduced to its lowest allowable value. Again, the system shall stabilize the interior air temperature to $70^{\circ}\text{F} \pm 2^{\circ}\text{F}$. Once stabilized conditions have been reached, the test operation shall be continued for 30 minutes with temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior comfort requirements of Chapter 10 shall be met and no heater guard temperature shall exceed the specified maximum, 125°F , during the entire test.

19.5.7.10.4 Door cycling test (heating)

At the same conditions following the steady state heating (minimum voltage) test, the doors shall be cycled on one side of the car at a rate of 2 minutes open and 15 minutes closed for two hours. The average car temperature, including the upper and lower levels, shall recover within 2°F of the required interior car temperature within three minutes maximum after each door closing.

19.5.7.10.5 Steady state heating tests

Upon completion of the door cycling test, the doors shall be closed, the nominal voltage shall be re-applied and the maximum design passenger load passengers shall be introduced into the car. Again, once stabilized conditions have been reached, the test operation shall be continued for 30 minutes with temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior comfort requirements of Chapter 10 shall be met and no heater guard temperature shall exceed the specified maximum, 125°F , during the entire test.

This test shall be repeated at the applied voltage reduced to its lowest allowable value and at the applied voltage increased to its highest allowable value.

Upon completion of the steady state heating test (with design passenger load), the nominal voltage shall be re-applied, and the design solar load shall be introduced into the car. The climate chamber ambient temperature shall be raised and maintained at 42°F . Allow the system to stabilize the interior air temperature to $70^{\circ}\text{F} \pm 2^{\circ}\text{F}$. Once stabilized conditions have been reached, the test operation shall be continued for 30 minutes with temperatures, pressures, electrical and humidity data recorded at one minute intervals in order to evaluate temperature variations and interior humidity requirement as the controls and equipment cycle. The interior comfort requirements of Chapter 10 shall be met and no heater guard temperature shall exceed the specified maximum, 125°F , during the entire test.

19.5.7.10.6 Overhead heater safety tests

The overhead heater protection devices shall be tested with restricted and with no airflow. All protection devices and backup protection devices protecting the heaters and housing from overheating shall be tested individually. The tests shall be conducted at nominal voltage supply with an ambient temperature maintained at 40°F , and then repeated at the applied voltage reduced to its lowest allowable value and at the applied voltage increased to its highest allowable value. The overhead heater shall be activated independently of the normal regulating controls. Temperature measurements at the devices and heater power measurements shall be

taken throughout each test. After the functioning of the device, temperature measurement records shall be continued until steady temperature fall is observed.

Each test shall be considered satisfactorily completed if the protection device under test has functioned as intended, backup overheat protection devices do not actuate, there is no damage to any equipment or component, and there is no smoke or significant odors detected. When the last level of backup protection device is tested, the test shall be considered satisfactorily completed if the protection device under test functioned as intended, there is no damage to any equipment or component, and there is no smoke or significant odors detected.

19.5.7.10.7 Freeze protection tests

The operation of the door threshold, door pocket, water tank and water drain valve heaters shall be demonstrated in the climate chamber. This test begins with the car in a stabilized automatic heating condition with an ambient temperature of 60°F. The car is then placed in its layover mode and the ambient temperature reduced to -30°F at a rate of change not to exceed 20°F/hour, no internal loads and the antifreeze protection circuit energized.

With the HVAC system operating in automatic mode, cycle the doors on one side of the car open and closed at the same rate as for the door cycling tests. When the doors are closed, spray water at 33°F onto the lower half of at least one pair of doors and the door threshold.

Continue this operation for one hour. The door thresholds must remain free of ice, door pocket drains must drain freely and doors must open and close smoothly for the entire test period.

Repeat the test using an application of simulated snow. Snow may be made prior to test and applied by hand to the threshold when doors are open, closed or both. The snow may be hard packed to simulate tracking in on footwear, or may be spread out to simulate natural snowfall.

Verify that the freeze protection for the water tanks and water drain valves is working correctly and record the temperature that the systems turned on. Following the Freeze Protection Test, the nominal voltage supply is reapplied and the car is placed in its normal mode. Verify that the freeze protection systems for the water tanks and water drain valves continue to function as specified.

19.5.7.10.8 Cab heating tests

The operation of the cab heater and cab windshield defroster/defogger system shall be demonstrated in the climate chamber. Cab heater tests shall include overheat protection safety tests.

19.5.7.10.9 Equipment room heater test

The operation of the equipment room heater system shall be demonstrated in the climate chamber.

19.5.8 Lighting

The function and intensity of all lighting systems shall be tested in the first car to verify compliance with the requirements.

19.5.8.1 Lighting fixture performance

- Light level of each fixture shall be measured and compared to the design requirements.
- Temperature of surfaces exposed to passengers/crew shall be measured to verify compliance with specification.

19.5.8.2 Ballast qualification

Performance of all electronic ballasts shall be verified.

19.5.8.3 Independent power sources (for emergency lights)

Performance shall be verified in all modes of operation. Charge and discharge time shall be measured.

19.5.8.4 Marker light certification

The marker lights and fixture shall be tested to verify compliance with FRA 49CFR Part 221.

19.5.8.5 Lighting intensity-interior

Test shall verify light levels are in accordance with APTA Recommended Practice RP-E-012-99 and this specification under all lighting modes as specified.

19.5.8.6 Lighting intensity-exterior

Test shall verify headlight and auxiliary light levels comply with 49CFR Section 229.125 and 229.133 respectively.

19.5.8.7 Emergency lighting intensity and duration

The test shall verify light levels and duration of each car type are in accordance with APTA Standard SS-E-013-99, 49CFR Section 238.115 and any additional requirements of the specification. Tests shall be conducted in both Normal and Emergency modes and compete operation of independent power sources, including recharge times.

19.5.9 Communication/OTIS

The communication system shall be tested on the first car of each type to verify that it functions in accordance with the requirements. The diagnostic function of each individual system shall be tested as a separate test or in combination with other functional testing. The PTU shall be used to successfully access all available car subsystems. The capability to modify all password-protected software parameters shall be verified. The interface and functionality of the Central Diagnostics Terminal (CDT) and the wireless Local Area Network shall be tested. Testing shall be conducted to ensure that car faults can be downloaded over the network and that the AVL system database can be updated, the CDT and wireless LAN systems shall be fully functionally tested.

19.5.9.1 PA/IC system performance

The performance of the public address and passenger intercom system shall be tested to verify that all aspects of the system perform as intended:

- System selector switch function and indication
- PA announcements to the car interior only
- PA announcements to the car interior and to other cars in the train
- PA announcements received from other cars in the train
- PA interface with the CCU and the passenger information system
- Intercom function between IC stations within the car and between the car and other cars in the train
- Speaker volume, including interior and exterior speakers

19.5.9.2 Destination sign system performance

The performance of the sign system shall be verified for specification compliance on each car type. All modes of trainline operation shall be demonstrated, as well as interaction with the PA/IC system. The function used to advance the sign reading to the next message shall be demonstrated, using the actual input message to the system.

19.5.9.3 EMI/EMC

The test plan shall meet the requirements of APTA Standard SS-E-010-98, plus any additional requirements of the specification. All modes of operation shall be tested.

19.5.9.4 Wayside equipment tests

Each wayside and Control Center component of the communications system installed under this Contract, including the radio system, GPS, automatic vehicle location system, the wireless local area network system, and all other communications and interface with the wayside shall be tested to verify that they function in accordance with the requirements. The ability to modify software data files and change parameters for the wayside communications system equipment shall be successfully demonstrated. The interface and functionality of the car CDT and the wireless local area network shall be fully tested. Testing shall be conducted to insure that car faults can be downloaded over the LAN and that the AVL system database can be updated.

Each component of the communications system, including the GPS, automatic vehicle location system and wireless local area network, shall be tested to verify that they function in accordance with the requirements. Wayside simulations shall be performed as approved by the Customer to fully verify all functions. All equipment which is installed under the Contract on the Customer wayside or the Customer Control Center shall also be tested to verify compliance. The ability to modify software data files and change parameters for the communications system equipment shall be successfully demonstrated.

19.5.10 Electrical**19.5.10.1 Electrical load/phase balance/power factor**

One completed car of each type shall be tested to determine the actual electrical loads, their phase balance and power factor. This shall be done under at least three different conditions: maximum heating load, maximum cooling electrical load and ventilation. These values shall be used to verify specification compliance.

19.5.10.2 Trainline tests

Trainline tests shall be conducted at both ends of the first cars of each type. All receptacles for the HEP, MU and COMM trainline circuits shall be tested for proper functionality using a trainline test unit.

The first two cars shall be coupled together on the Contractor's test track, and all trainline functions, including coupling and uncoupling and diagnostic messages, shall be tested to verify correct operation.

19.5.10.3 Battery and battery charger tests

Tests of battery capacity and the battery charger shall be made to show compliance with their requirements. The ability to charge the batteries and support other low voltage loads shall be verified. The capacity of the battery to support essential loads for the required time upon loss of HEP output shall also be verified. The ability to check the battery fluid levels and refilling shall be demonstrated.

19.5.10.3.1 Battery capacity

Battery on each car type shall be tested to demonstrate specification compliance.

19.5.10.3.2 Battery/battery charger performance

The battery and battery charger shall be tested to measure charge/discharge characteristics of the overall system. This shall include: 24 hour charge with DC loads active; discharge to load shed; recharge for 24 hours. Strip chart-type instrumentation shall monitor battery voltage and load and battery current over the entire interval. The system shall be tested to verify fault coordination between battery charger, battery and main DC circuit breakers and the ability to support large step loads on car, such as door operators cycling.

19.5.10.3.3 Battery tilt and shock

Verify each battery type complies with the 45 degree tilt and 8/4/4g acceleration requirements of 49CFR Section 238.115.

19.5.11 Food Service

The following food service equipment shall be tested:

19.5.11.1 Structural performance

Verify crashworthiness structural requirements for retaining carts, chillers and appliances are met.

19.5.11.2 Elevator performance

The following shall be verified:

- All crew controls (including “negative” tests, in which you verify something does not happen)
- Limit/proximity switches
- Door latches and interlocks
- Result of electric power outage mid travel
- Operation at low & high line voltage
- All safety features/interlocks/lockouts
- Lift capacity rating is met
- Operation under adverse track conditions – maximum grade and superelevation as specified.
- Operation while train is in motion.

19.5.11.3 Refrigeration system performance

A complete car set of equipment, including carts and chillers, shall be assembled and connected to operate. The following shall be verified:

- Pull down capacity at rated conditions with nominal condenser inlet air temperature of 70°F and 110°F
- Hot-soak pull down: boxes soaked > 95°F rated high ambient
- Operation at light load
- Operation of condenser environmental controls
- Ability to maintain carts/boxes to required values, including minimal temperature gradient within cart/box
- Ability of thermometer on units to accurately track air temperature
- Operation of protective devices, such as pressure switches.

Instrumentation shall include inlet and outlet temperature of each galley cart

All chillers shall be instrumented to measure:

- Evaporator temperature top and bottom of coil
- Expansion valve bulb temperature
- Chiller inlet and outlet temperature
- Chiller condenser inlet and outlet temperature
- Chiller suction and discharge pressures

- Activation of chiller thermostat
- Activation of chiller defrost cycle

All food service galley equipment shall be installed and shall be operated in a test simulating revenue service to verify the proper operation of the appliances, power distribution system (including proper operation of the battery and inverter for backup power for chillers and freezers), chillers and HVAC, lighting, and the water and waste systems.

19.5.12 Water and Waste

19.5.12.1 Water and waste system performance

A set of equipment that simulates the fresh water distribution and waste retention systems on a car shall be assembled and connected to operate. The system shall be piped to simulate actual car piping.

The proper operation of the following shall be verified:

- Performance of all system components and controls in normal and standby mode
- System pressures, temperatures and flow rates
- Safety controls
- Backflow prevention devices
- Tank level indications
- Vacuum levels attained and maintained
- Flush valve life cycle

19.5.13 Cab and Controls

19.5.13.1 Train control, event recorder, train data system and video camera

The train control system, event recorder, forward-facing camera, train data system and associated components shall be subjected to qualification tests to verify that they comply with the requirements. As a minimum, these tests shall include complete functional tests before and after the equipment is subjected to the simulated environmental conditions such as appropriate extremes of temperature, vibration and shock. Tests shall also confirm resistance to interference limits as specified. Equipment so tested shall conform to the manufacturing drawings.

19.5.13.2 Operation of positive train control

The Contractor shall develop proof-of-design test procedures that validate all systemic, operational and programming designs, functions and requirements for the Positive Train Control (PTC) system, including component performance, integrity of system architecture, data collection and retention functions, and train status evaluation. These procedures shall be developed in accordance with system requirements as established by the system manufacturer,

the FRA and railroads, and shall include evaluation and verification of compliance with requirements for:

- Accurate determination of train location, speed, direction of travel and status of all operating systems;
- Communication to wayside signal systems and railroad data centers;
- System monitoring of train performance;
- Display of graphic data as received from the railroad;
- Initiation of service or penalty brake applications and locomotive PKO functions;
- Interface between the PTC system and on-board systems, including event recorders, train monitoring systems and others;
- Data recording, security and download requirements; and
- Compliance with all applicable regulations, standards and system requirements.

Additional railroad-specific data transfer and uploading to the system may occur after the cars have been delivered to the Customer if necessary. The PTC system as designed and installed shall be subject to review and approval by the Customer, the FRA, Amtrak and representatives of the host railroads over which the cars will operate

19.5.13.3 Cab audio alarm levels performance

The audio level of all cab alarms: loco failure, wheelslip/brake warning, alerter, overspeed, PTC and conductor signal shall be tested to verify suitable loudness.

19.5.13.4 Event recorder (FRA) performance

Tests shall verify proper operation of the entire integrated system hardware and software. They shall show correct interpretation of each input, including combinations (such as throttle) through the use of the verifier function on a laptop. Resolution, set point and calibration of all analogue inputs shall be shown at zero, midscale and maximum values, which will include applying pneumatic pressure to those inputs by manipulating the brake system. All modes of downloading shall be demonstrated. After downloading, graphic and tabular readings shall be compared in detail to verify all channels show activity consistent with the test code and that graphic and tabular values of analogue functions match: speed, brake pipe, brake cylinder pressures at zero, full scale and mid scale values. Operation of self-test and health monitoring functions shall be demonstrated. A disk of the down load, labeled for car number and date, shall be provided for each car.

19.5.13.5 Event recorder-video performance

Tests shall verify operation of the entire integrated system hardware and software. They shall show correct interpretation of each input. Video focus and resolution, and other inputs shall be demonstrated. All modes of downloading shall be demonstrated. Software demonstration shall include validation of inputs and their calibration as a "real time" display as well as data analysis software playback. Operation of self-test and health monitoring functions shall be demonstrated.

19.5.13.6 Horn and bell performance

The horn shall be tested to verify compliance with FRA 49CFR Part 229 loudness requirement. The bell shall be tested to measure loudness and proper continued operation.

19.5.14 Pilot Car and Pilot Train Testing

19.5.14.1 Roll angle tests

The first pilot car, simulated to be at AW3 load, shall be placed upon a superelevated track to determine compliance with the clearance requirements by verifying the Contractor's clearance diagram despite any body roll and lateral shifting of the car body. The test shall be made at superelevation of 7 in. The static lean allowance shall also be tested at both AW0 and AW1 load to verify compliance under all specified suspension conditions. In addition, tests shall be performed at AW0 load on a superelevation of both 5 in. and 6 in. to measure body roll and wheel unloading to verify compliance with 49CFR Section 213.57(d). The Contractor shall provide a test report providing all data required by 49CFR Section 213.57, and shall fully support Customer's submission to the FRA with additional information as requested by the FRA.

19.5.14.2 Pilot cars

Pilot car testing refers to the test of the first three cars (one of each type) at the Contractor's final assembly facility prior to shipment. To implement pre-delivery testing of the pilot cars, the Contractor shall provide at its assembly facility a test site on which the specified tests can be conducted. In addition, this site shall be equipped with locomotive HEP power simulation with which it shall be possible to test performance.

19.5.14.2.1 Pilot train testing

After the pilot cars have undergone and passed all applicable proof-of-design and production testing requirements, the three cars shall be combined to form the pilot train for car-to-car operational, compatibility and coupler tests.

All trainline functions shall be tested and verified, including:

- Door control, door system status and traction inhibit
- End of train identification
- Locomotive control
- PA, IC and PIS communications and data transfer
- HEP and power distribution
- Air brake application and release

The pilot train shall be tested to confirm compliance with track geometry requirements, including curve and crossover negotiation. All car-to-car connections shall be verified as performing in compliance with the track geometry requirements, including:

- Carbody clearance
- Truck swing
- Coupler swing
- MU, COMM and HEP cables
- Brake pipe and main reservoir air hoses
- Diaphragms, buffer plates and diaphragm curtains

The clearances between the carbody and the trucks, between the carbody and the couplers, and between cars shall be checked on all pilot cars by methods which place the relevant components in the correct angular relationship corresponding to the worst case conditions to be incurred by operation in the static car envelope. In addition to demonstrating adequate mechanical clearance of the major elements involved, this test shall demonstrate that no interferences or potentially damaging contacts or stress conditions occur between or to any parts of the car, including stops, wires, cables, or enclosures. Trainline cables shall not droop when under slack conditions such that they can potentially contact the ground, the top of rail, or other obstructions below the car's operating envelope.

The cars, with springs loaded statically to AW0 and AW3 conditions, shall be demonstrated by either testing (measured against a template, plumb line or other approved method) or analysis to confirm that the car conforms to the Contractor's designs and that all the specified clearances and static car envelope requirements have been met, both to wayside and rail. This test shall be performed successfully with each end of each car coupled to another car. Test results must verify compliance with the Contractor's clearance calculations and diagrams for a train of cars under all operating conditions.

19.5.14.2.2 Pilot train compatibility testing

After the three pilot cars have undergone and passed the above, an existing bi-level car will be coupled between two of the three pilot cars. The bi-level car can be a *California Car*, *Superliner*, *Surfliner* or a previously built car to this Specification.

All trainline functions shall be tested and verified, including:

- Door control, door system status and traction inhibit
- End of train identification
- Locomotive control
- PA, IC and PIS communications and data transfer
- HEP and power distribution
- Air brake application and release

The compatibility test train shall be tested to confirm compliance with track geometry requirements, including curve and crossover negotiation. All car-to-car connections shall be verified as performing in compliance with the track geometry requirements, including:

- Carbody clearance

- Truck swing
- Coupler swing
- MU, COMM and HEP cables
- Brake pipe and main reservoir air hoses
- Diaphragms, buffer plates and diaphragm curtains

The clearances between the carbody and the trucks, between the carbody and the couplers, and between cars shall be checked on the pilot cars and existing bi-level by methods which place the relevant components in the correct angular relationship corresponding to the worst case conditions to be incurred by operation in the static car envelope. In addition to demonstrating adequate mechanical clearance of the major elements involved, this test shall demonstrate that no interferences or potentially damaging contacts or stress conditions occur between or to any parts of the car, including stops, wires, cables or enclosures. Trainline cables shall not droop when under slack conditions such that they can potentially contact the ground, the top of rail or other obstructions below the car's operating envelope. After completion of these tests, the existing bi-level car can be removed from the test train.

19.5.14.2.3 High-speed testing

The Pilot Train shall be tested in accordance with the applicable requirements of 49CFR 213.345 for vehicle testing at speeds up to 125 mph on the track of a qualified test facility to be selected by the Contractor. Testing shall begin at a speed of up to 50 mph and test speeds will be incrementally increased as described below. Test results shall be made available on the pilot train immediately after the completion of each test trip, and will be reviewed by the Customer before the decision is made to proceed to the next higher speed increment. The maximum test speed shall be 130 mph using the Pilot Train with a minimum of one instrumented car of each car type to be tested. Vehicles with minor variations in their physical properties that do not result in significant changes to their dynamic characteristics are considered to be of the same type for testing purposes.

As track class, signal, propulsion and other required infrastructure becomes available on the route intended for service to support speeds of 125 mph, the equipment shall be tested in accordance with 49CFR Section 213.345. Should the infrastructure to achieve 125 mph (test speed of 130 mph) become available at the time of delivery of the vehicle order, the Contractor will be responsible for the conduct of these tests.

19.5.14.2.4 Test instrumentation

Test instrumentation shall be provided by the Contractor to record all data necessary to demonstrate compliance with the acceleration limits identified in 49CFR Section 213.345. Each of the instrumented cars on the Pilot Train shall be provided with one truck equipped with two Instrumented Wheelset (IWS) axles. The IWS-equipped truck shall be located at the cab end of the car and shall be located in the test train such that it is either the leading truck or trailing truck of the train, depending on the direction of movement. Friction brakes on the IWS-equipped truck shall be cutout for the duration of testing.

Each truck on each instrumented car shall be equipped with two lateral accelerometers, mounted on the truck frame at diagonally opposite locations along the vertical line passing through the center of the journal bearing. Both instrumented cars shall also be equipped with three carbody lateral and vertical accelerometers. They shall be located on the interior floor, on the car longitudinal centerline, above each carbody bolster and at the middle of the car.

A GPS location system shall be used during testing to accurately report the location of the IWS trucks. This may be done by use of the existing destination sign system GPS, or by a separate GPS system for testing, in which case the GPS antenna shall be located on the roof of the IWS-equipped car. An accurate speed signal shall be provided in the data. This signal may be provided by the locomotive or cab car speed measurement system or by separate test instrumentation. The speed signal data and the cab speedometer display shall agree to within 1 percent across the entire speed range.

19.5.14.2.5 Data collection and reporting

The Contractor shall provide carborne test equipment capable of recording all data required, analyzing these data for compliance with FRA criteria and reporting results to test train personnel in graphical form. Results will be reviewed on the test train for acceptability by the Customer before the decision is made to move to the next higher test speed. Reports for a given test trip may be generated as a series of data packages, each covering a distance of approximately 2 to 5 miles.

The reporting software shall be capable of generating the following for each data package:

- A time and date stamp.
- A graphical depiction of train location and speed by railroad milepost.
- A graphical depiction of the various wheel/rail force signals and the truck acceleration and carbody acceleration signals. It shall be possible to directly correlate these signals with the location, speed and time/date data. The location of the worst case data in each data set shall be indicated.
- A summary report of the worst case values recorded for the IWS wheel/rail force criteria, and the truck acceleration and carbody acceleration data. Any values which are in excess of those allowed by FRA shall be flagged as exceptions.

Exception reports shall be provided for all events flagged as exceptions. These reports shall include the values recorded plus a close-up view of the data signal associated with each exception.

Data packages shall be available within 10 minutes after collection of test data. Simultaneous data collection and report generation shall be required. All necessary calibration data, sign conventions, sampling rates, headers, etc. required to process the data shall be included in the report. Data shall be provided to the Customer in both paper and electronic media which shall include all software required to format, process and graphically view the test data.

19.5.14.2.6 Test reports

The Contractor shall prepare the required final test reports for submission to the FRA by Customer. This shall include the track geometry data for the test zones, which accurately reflects the state of the track condition at the time of test. The Customer reserves the right to require additional vehicle modeling, instrumentation and/or testing if test results show failure to comply with the FRA requirements for operation at any speed below 125 mph, or if additional dynamic behavior which may present a safety issue is observed.

19.5.14.2.7 Noise and vibration tests

The interior and exterior noise levels and vibration levels of the pilot cars shall be measured to prove compliance with all specification requirements. Interior noise measurements shall be made with all car systems operational while operating on level tangent track in an open area, from standstill to 70 miles/hour and back to zero speed using full service braking. The sound level meter shall conform, as a minimum, to the requirements of ANSI Standard S1.4, Type 2, and set to an A-weighted slow response or with an audio dosimeter of equivalent accuracy and precision.

In conducting interior sound level measurements with a sound level meter, the microphone shall be oriented vertically and positioned to simulate the location of a seated passenger or Engineer's ear. Measurements with an audio dosimeter shall be conducted in accordance with manufacturer's procedures as to microphone placement and orientation.

Measurement of the sound level of the horn shall be made using a sound level meter conforming, at a minimum, to the requirements of ANSI Standard S1.4, Type 2, and set to an A-weighted slow response. While the car is on level tangent track, the microphone shall be positioned 4 feet above the ground at the center line of the track, and shall be oriented with respect to the sound source in accordance with the manufacturer's recommendations. A 4 dB(A) measurement tolerance is allowable for a given measurement.

Vibration tests shall be made with all car subsystems operating, with the car stationary.

19.5.14.2.8 Friction brake performance tests

The friction brake system on one of the pilot cars shall be tested to demonstrate that it meets the requirements. The brake disc, brake pad, brake shoe and wheel temperature shall not exceed the supplier's working range, defined as that within which the material is capable of meeting the specified performance and tolerances. Successful completion of all of the preceding tests and acceptance of the test results by the Customer will be required for final approval of the friction brake system.

19.5.14.2.9 Ride quality tests

To verify conformance to the ride quality requirements, one of the first pilot cars shall be subjected to ride quality road tests. At a minimum, the ride quality tests shall consist of testing of one or more cars on minimally compliant track that conforms with all FRA track standards for the classes of track over which the cars are designed to operate. The car or cars shall also be tested on a major segment of track over which the cars are intended to operate in revenue service, making all local stops while operating at normal scheduled speed, under AW0 and AW1 load conditions. The Contractor shall prepare a ride quality testing plan for submittal to the Customer for review and approval, specifying the start and end points, speeds, test methodology, measurement parameters and criteria, and method of instrumentation for the ride quality tests. Results from previous ride quality tests that closely simulate the Customer's revenue service environment may, at the sole discretion of the Customer, be accepted in lieu of additional ride quality testing.

The results of these tests shall be compared to the results from the modeling performed as specified in chapter 5.

Instrumentation capable of measuring and charting (for permanent record) the magnitude and frequency of the vertical and lateral shocks expected, up to 1.0g and 0.5 to 50 Hertz, shall be

provided and operated by the Contractor, who shall reduce the raw data for presentation to the Customer. Sensing units shall be located on the car floor above the intersection of the car longitudinal center line and each truck transverse center line. Weights used in simulating the AW1 load, as well as their loading and unloading, shall be provided by the Contractor.

In the event that the dynamic behavior of the cars is non compliant in any respect with the requirements, the Contractor shall submit to the Customer, within 60 calendar days, a program containing mathematical analysis of the problem and a course of action for its correction. If the Customer approves the analysis and corrective measures, those corrective measures shall be made effective on the pilot cars within 90 calendar days at the expense of the Contractor, the car shall be retested, and if the measures are successful, they shall be applied to all the cars. If not, the analysis and correction steps shall be repeated, resubmitted and retested until success is attained.

19.6 Production Tests

As a minimum, the tests listed in this section shall be performed on each car (including all pilot cars) prior to the issuance of a release for shipment document by the Customer. The Contractor's production conformance test shall include all tests and adjustments which can be made prior to delivery in order to keep car acceptance testing and adjustments at Customer to a minimum.

After completion of each car, the Contractor shall demonstrate that each car subsystem is operational and that each car and cab can properly control a train. The Contractor shall also demonstrate that all cab controls and cut-outs and bypass switches function correctly. The following static tests where power is required on the car shall be conducted by applying a supply voltage to the trainline cables to the car and functionally testing all car systems.

The test procedure shall include and use a check-off list that shall become a record that all systems have been actuated and have functioned as required. This is particularly required for all protective and safety related devices. All equipment final adjustments shall be made prior to car shipment. After completion of each car, the Contractor shall demonstrate that all discrepancies logged against the car during its construction and test period, by either the Contractor's own inspection forces or Customer inspectors, have been suitably resolved to the Customer's satisfaction.

After the installation, connection and cleaning of all piping as specified, the piping shall be pressure tested in accordance with the latest edition of the Code for Pressure Piping, ANSI B31.1. All leaks which appear during pressure testing shall be repaired, after which the system shall be retested until leak-free.

All air, water, waste system and HVAC pipework, hoses and fittings shall be properly cleaned, purged checked for leaks with all systems in operation and any faults rectified.

All equipment on each car (including all pilot cars) shall be given tests for proper operation and conformance, at the manufacturer's facility prior to shipment to the Contractor. All equipment shall also be given a functional test (pre-delivery) on the completed car to test for proper operation, by the Contractor prior to issuance of a release for shipment document by the Customer. The test to be performed by each manufacturer and the Contractor on each car component or subsystem shall be in accordance with the applicable industry standards listed in this Technical Specification and the approved test plan. The following tests in this Section list some but not all of these tests to be performed; all Technical Specification requirements

must be achieved in any case. The test reports of all tests shall become the property of Customer and be included in each vehicle history book as specified. This is in addition to, and is not to replace, the Contractor's and suppliers' QA plans.

19.6.1 Carbody

19.6.1.1 Watertightness tests

Each car shall be tested for watertightness in both the completed shell and assembled car stages prior to pre-shipment.

Water shall be sprayed from nozzles which are spaced no more than 3 ft from, and aimed directly at, the roof and sides of the car, with the side wall nozzles continuing in a vertical plane to 1 ft above top of rail. Not less than 0.625 gpm shall be delivered to each square foot of surface being tested, and the nozzle velocity of the water shall not be less than 150 feet per second. All spray applications shall run for 10 minutes before the inspection for leaks, and shall run continuously during the inspection.

During the shell watertightness test, all areas of the sides, ends and roof of each car shall be given a complete test for watertightness. The tests shall be made before installation of sound deadening material, thermal insulation and interior finish.

19.6.1.1.1 Water spray - bare car shell (watertightness test)

Each car shell shall be sprayed with water, simulating the conditions at the rated speed of the car, to verify there are no leaks in the joints. All surfaces shall be sprayed. This shall be done before the application of any sound deadening material or thermal insulation. Openings, such as doors, windows, etc, shall be closed off by suitable means, such as blanking plates, during testing. All spray applications shall run ten minutes before and continuously during the inspection. Test arrangement is subject to Customer approval.

19.6.1.1.2 Water spray - completed car

Each completed car shall be sprayed with water, simulating the conditions at the rated speed of the car, to verify there are no leaks. Of special interest are the door and window openings and any roof penetrations, such as those for antennae. Water shall be directed at the F-end to verify there are no leaks there, especially at the end door. All spray applications shall run ten minutes before and continuously during the inspection.

19.6.1.2 Wheelchair lift

- Verify all functions, interlocks, safety features and timing
- Demonstrate lifting range
- Demonstrate manual operation of lift

19.6.1.3 AEI tag

A tag reader shall be used to verify that each AEI tag on each car operates correctly and contains the correct data.

19.6.2 Truck Tests

19.6.2.1 All trucks

All trucks (including the frame, bolster, and any primary structural members) shall have its fabrication technique qualified by means of a complete inspection of every weld and casting critical area, preferably by radiographic methods; if determined by the Customer that radiographic methods are not practical for some areas, then the inspection in these areas shall be performed using both ultrasonic and magnetic particle inspection methods approved by the Customer. Castings shall be radiographed in accordance with requirements. Radiographs shall be made in accordance with either AWS Standard D1.1 or ASTM Standard E94-04. The radiographic inspection quality level shall be selected by the truck manufacturer to be consistent with the truck design, but shall not be of lesser quality than that required by Appendix F of AWS Standard D1.1. If the first truck fails the radiographic/ultrasonic inspection, then the second shall be inspected, and this process shall continue until a truck passes the inspection. The production variables for the succeeding trucks shall duplicate those for the truck which passes the above inspection.

After qualification in accordance with the preceding, all exposed welds and entire castings of all steel castings used for succeeding trucks shall be subjected to magnetic particle or dye penetrant inspection. Magniflux shall use a no-yoke probe only. All critical welds, and critical areas of all castings, shall be inspected using radiographic methods on 15 percent of the trucks, chosen at random by the Customer. If determined by the Customer that radiographic methods are not practical, then all critical welds, and critical areas of all castings, shall be inspected on all trucks produced by using both ultrasonic and magnetic particle inspection methods approved by the Customer. Magnetic particle inspection shall be in accordance with ASTM Standard E709-08 or approved equal. Dye penetrant inspection shall be in accordance with ASTM Standard E165-02 or approved equal. Critical welds shall be as identified by the truck manufacturer and approved by the Customer, and shall include, as a minimum, all assembly welds and welds or portions of welds which, based on the results of the stress analysis and/or truck tests, are expected to be critical in fatigue. Critical areas of castings shall be identified in a similar fashion. Critical areas of each truck frame and truck bolster shall be inspected as required.

19.6.2.2 Truck weight

Each completed truck assembly shall be weighed, and the weight of the truck assembly recorded on a truck weight certificate, prior to installation of the trucks under the carbody. The completed truck shall include all truck-mounted equipment, including handbrake linkage if so equipped, but shall not include secondary suspension components or truck-to-carbody air hoses. The serial number of the truck frame shall be included on the truck weight certificate.

19.6.2.3 Carbody leveling and floor height

Each completed car shall be leveled and measured to verify correct truck setup adjustments, that the car is level, has the correct floor and diaphragm buffer plate heights and diaphragm curtain heights. Measurements shall be taken with the car on calibrated track.

19.6.2.3.1 Truck attachment, leveling and coupler height tests

All mechanical, electrical, pneumatic and hydraulic connections between the trucks and the carbody shall be checked. The AWO car floor height/car level and the coupler height shall also be verified.

The height of each corner of the carbody shall be measured from the top of rail on a level section of track to check for proper carbody level with all suspension components at proper design height. Side-to-side differences in height shall not exceed 0.25 in. End-to-end differences in height shall not exceed 0.5 in.

19.6.3 Couplers

Coupler height and operation of each car shall be verified, including clearance and operation of the uncoupling rods and full opening of the knuckle by the uncoupling rods.

19.6.4 Brakes

19.6.4.1 Single car brake and pneumatic system operation

The brake system and auxiliary air system of each car shall be tested for leaks. The AAR S471 Ball Test shall be conducted on the Brake Pipe. A functional test that exercises each function of all brake system valves and components shall be conducted in accordance with the OEM recommendations. Pneumatic brake applied indicators and the brake applied/released indicators shall be tested. Tests shall include auxiliary air system functions, such as the governor and regulator for water rising (if equipped). In addition, all requirements of APTA Standard SS-M-005-98 (current revision on date of test) shall be met.

The Contractor shall perform on its test track a complete functional test of the friction brake system prior to shipment of each car. This shall include, as a minimum, a single-car air test, in compliance with FRA requirements, as well as, a test of brake cylinder pressure settings, control and indicator checks, leakage tests and handbrake test.

19.6.4.2 Hand brake operation

The hand brake of each car shall be tested to verify that, when applied, the brake shoe is in contact with the wheel and that the hand brake indicator properly displays the hand brake status.

19.6.4.3 Wheelslide control system operation

The wheelslide control system shall be tested on each car to verify correct speed sensor air gaps, correct end-for-end wiring of sensors and dump valves, and self-test functions of the controller, with the car on air to actually exercise the brakes. Speed signal interfaces for the door system shall also be tested.

19.6.5 Door System Tests

All doors and their operating systems shall be checked and adjusted on all cars to assure smooth functioning, proper fit, attainment of the specified speed of operation and proper functioning of controls, signals and interlocks. This shall also include all body end doors, except the F-end frame door. All power operated side doors shall be operated a minimum of 800 consecutive, separate successful cycles. Initiation of the cycling shall be through the trainline external from the car. Proper adjustments for opening and closing shall be checked on every door before and after the above test. Improper adjustment at the end of a test shall require the test to be repeated. Any door or door control failure occurring prior to completion of the test will nullify the test, requiring that it be repeated from the beginning following correction and documentation of the failure.

19.6.5.1 Door safety systems

All doors shall be individually tested to confirm correct operation, including all indicators, audible signals and interlocks, from the cab, from the individual local door pushbuttons, and when obstructions are placed in the door. Tests shall also be performed to confirm correct operation of all interior and exterior manual door opening/passenger emergency facilities, interlock bypass switches and crew door switches.

19.6.6 Interior

19.6.6.1 Interior doors and hardware

- All interior doors and hatches shall be functionally checked on each car to verify: smooth movement, latching, locking, unlocking from external side of door, correct latch engagement/release, proper operation of detente, non-interference, freedom from sticking or excessive looseness (rattles) and proper switch activation. Force to overcome the detente used on sliding toilet room doors shall be measured.
- Proper engagement of the ceiling hatch safety catches shall be checked.

19.6.6.2 Seats

Operation of each movable function of each seat on each car shall be tested to verify:

- Recline, foot rest, tray table, etc. Tray table shall be level when in the fully extended position.

19.6.6.3 Overhead luggage storage bins

Each overhead luggage bin shall be tested to verify:

- Proper door alignment
- latch operation
- hinge operation

19.6.7 HVAC**19.6.7.1 Heater circuit tests**

Each heater circuit shall be high potential tested in accordance with IEEE Standard number 16.

19.6.7.2 Heating tests

The heating system, including cab, doorway and protective heaters, shall be functionally tested in all cars. The operation of the thermostatic control system and layover heating shall be demonstrated by test. Controls shall be checked and adjusted for even distribution and proper volume of heat.

19.6.7.2.1 Duct heater operation

Duct heat of each car shall be verified for function, uniform temperature distribution and correct current draw.

19.6.7.2.2 Duct heater shunt trip operation

Proper operation of each safety interlock of the duct heat control system shall be verified on each car. In addition, operation of the shunt trip feature of the circuit breaker shall be exercised by applying heat directly to the high limit thermostat of each heater assembly.

19.6.7.2.3 Floor heat operation

Floor heat of each car shall be verified for function, uniform temperature distribution and correct current draw.

19.6.7.3 Air conditioning unit tests

Each refrigerant compressor shall be given an air pressure test. Each evaporator and condenser coil shall be proof pressure tested and each complete unit shall be vacuum tested, leak checked with an electronic sniffer, and pressure tested to the requirements. All pressure vessels shall have ASME certificates. Compliance to the random starting timing requirements in Chapter 10 shall be verified.

19.6.7.4 Air conditioning system tests

The air conditioning system shall be functionally tested in all cars. The thermostatic control system operation shall be demonstrated by test. All controls and dampers shall be checked and adjusted for even distribution and proper circulation of air. Refrigerant charge and compressor oil levels shall be verified. The initial fine mesh liquid line strainer shall be replaced with the proper mesh at the conclusion of testing.

19.6.7.4.1 Air conditioning system operation

The air conditioning equipment on each car shall undergo an evacuation and leak test. For package units, this may be done at the supplier plant; however, a “sniff” type leak test shall be

done on the car to verify no leaks have occurred as a result of shipping damage. The equipment on each car shall be checked to verify proper control response and function for all operational modes (partial cool, full cool, partial heat, full heat, etc.). In addition, motor currents shall be recorded for:

- Blower fan
- Condenser fan(s)
- Compressor
- Exhaust fan(s)

19.6.8 Lighting

19.6.8.1 Lighting operation

Proper function of all interior and exterior lighting fixtures and all their controls shall be verified on each car. This shall include operation in each lighting mode: normal, quiet car, standby, load shed and emergency modes as well as night. Adjustment of all limit switches controlling lighting shall be included. Test shall include verification operation of Independent Power Source functions.

19.6.8.2 Marker lights

Proper operation of marker lights shall be verified.

19.6.9 Communication/OTIS

19.6.9.1 Communications system tests

The entire communications system and components shall be tested for proper operation. During the testing all functions of the PA, Intercom (IC), AVL, wireless LAN and all other communications equipment shall be exercised. The Contractor shall provide as approved by the Customer a suitable simulation of the wayside as necessary to test all communications systems.

19.6.9.2 PA and IC system operation

The proper operation of the PA and IC system on each car shall be verified, including system selector switches and indicators, PA speaker volume, IC communication between stations, trainline communications into and out of the car, and integration of the PA/IC system with the CCU and passenger information system.

19.6.9.3 Destination sign operation

All modes of trainline operation shall be demonstrated, as well as interaction with the PA/IC system. The function used to advance the sign reading to the next message shall be demonstrated, using the actual input message to the system. Trainline functions of this system shall be verified.

19.6.10 Electrical**19.6.10.1 Electrical apparatus tests**

Each component that is separately assembled, housed and wired into a package unit prior to installation shall be tested at its point of manufacture and a certified test report, signed by the responsible Quality Assurance representative of the manufacturer, shall be furnished to the Contractor with a copy to the Customer. Tests shall be in accordance with IEEE Standard number 16 for control apparatus as appropriate.

19.6.10.2 Battery tests**19.6.10.2.1 Battery and battery charger operation**

The overall DC power system of each car shall be tested to verify correct operation. This shall include battery charger self test, verifying correct charge voltage and current of the charger, operation of the temperature sensor, load shed and all external indicators. The test shall include operation in which the battery supports the car loads for a minimum time, (i.e. 30 minutes)

19.6.10.2.2 Battery capacity

Verify battery meets 5 hour name-plate rating.

19.6.10.2.3 Battery/battery charger performance

The performance of the battery charger connected to the battery and a simulated car load, shall be tested to verify correct operation. This shall include battery charger self test, verifying correct voltage control and current control modes of the charger, operation of the temperature sensor, load shed and drive to any external indicators. This shall include: 24 hour charge with DC loads active; discharge to load shed; recharge for 24 hours. Strip chart or das-type instrumentation shall monitor battery voltage and car load and battery current over the entire interval. The test shall also verify proper operation of the equipment during:

- Sustained low input voltage
- Loss of input phase
- Reversed phase rotation
- Overload or shorted battery charger output
- Battery ground fault
- Temperature sensor fault
- Reversed battery connections
- System overload
- Fault coordination between battery charger system, battery and main DC circuit breakers
- Ability to support large step loads on car, such as door operators cycling

Each battery shall be given a capacity test at the point of manufacture in accordance with APTA Standard RP-E-007-98R1.

19.6.10.2.4 Battery and battery charger operation

The overall DC power system of each car shall be tested to verify correct operation. This shall include battery charger self test, verifying correct charge voltage and current of the charger, operation of the temperature sensor, load shed and all external indicators. The test shall include operation in which the battery supports the car loads for a minimum time, (i.e. 30 minutes)

19.6.10.3 Car wiring tests

19.6.10.3.1 Continuity

On each car, all wiring shall undergo a continuity test in which wire labeling, continuity of conductor and proper connection point are verified.

On each car, all wiring shall undergo a continuity test in which wire labeling, continuity of conductor and proper connection point are verified.

19.6.10.3.2 Power distribution

Power distribution of each car shall be tested including phase rotation, correct voltage of each transformer-derived voltage, polarity of DC at the load and correct feed by the respective bus.

19.6.10.3.3 Electrical insulation testing

Electrical insulation tests shall be conducted on all applicable electrical components to verify the state of the insulation to the case, between wiring of different voltage classes, and between the input and output circuit of high voltage line switches and circuit breakers. Semiconductor devices may be protected against the test voltage by means of shorting jumpers if they are not inherently protected by the circuit in which they are used.

19.6.10.4 Insulation testing

All wiring on each car shall undergo a megger and high potential test, in accordance with APTA Standard SS-E-001-98.

Insulation resistance tests shall be conducted before high potential tests are conducted.

On items with double insulation, such as grid resistors mounted on an insulated frame, each set of insulation shall be individually tested. (i.e., resistors to frame and frame to carbody.)

19.6.10.5 Trainline tests

The Contractor shall verify the accuracy of the trainline connections by use of a test panel which is connected to the trainline connectors at each end of each car. The test panel shall use the illumination of lights or other appropriate means to confirm that only the proper trainline wires are energized when the various car controls (public address system, doors, etc.) are operated, and that there are no shorted, crossed, incorrect or open circuits. This test shall exercise the controls in the cab cars, as well as all door control panels, PA controls, etc. All spare trainline circuits shall also be tested.

19.6.10.5.1 480V HEP trainline

The 480V trainline wiring shall be tested on each car to verify continuity of each power and control conductor and grounding of control contacts.

19.6.10.5.2 27-Point communication trainline

Through the use of a test fixture, the 27-point communication trainline shall be tested on each car to verify continuity of each conductor, freedom from unintended cross-connections and shorts. Proper operation of any device which interrupts a circuit, such as pressure switches or relays, shall be demonstrated. Operation of end-of-train relays shall be verified. Transmit/receive functions of equipment that is controlled by the trainline, such as side doors, shall be demonstrated by the respective system test.

19.6.10.5.3 27-Point MU trainline

Through the use of a test fixture, the 27-point MU trainline shall be tested on each car to verify continuity of each conductor and check for unintended cross-connections and shorts. Transmit/receive functions of equipment which is controlled by the trainline shall be demonstrated by the cab system test.

19.6.10.6 Convenience outlets

All 120VAC receptacles shall be tested for proper polarity, grounding and the trip action of any associated GFCI devices on each car. Operation of DC receptacles shall likewise be verified.

19.6.10.7 Auxiliary circuits and equipment tests

All auxiliary circuits and equipment shall be tested for proper operation, and adjusted or corrected as required.

19.6.11 Food Service**19.6.11.1 Doors and hardware**

All food service doors, hatches and ¼ turn latches shall be functionally checked on each car to verify: smooth movement, latching, locking, correct latch engagement/release, non-interference, freedom from sticking or excessive looseness (rattles) and proper switch activation. Secure gates and latching mechanism shall be tested for correct operation.

19.6.11.2 Food service appliance operation

Each appliance shall receive a functional test to verify operation. Coffee makers shall operate through a complete brew cycle.

19.6.11.3 Elevator

The unit shall be tested to verify proper operation of all controls, limit switches, timing and safety functions.

19.6.11.4 Refrigeration/chiller

Refrigeration equipment shall undergo testing to verify:

- Freedom from refrigerant leaks (evacuation and “sniff test” if split system)
- Operation/calibration of each control device: pressure switches, thermostat, etc - operation of each device in the defrost function: thermostats, heaters, timer, etc -correct superheat setting
- No-load pull down time for each refrigerated space
- Correct thermostat settings for each refrigerated space
- Correct tracking of chiller thermometer with chilled space
- Correct operation of environmental controls for the condenser (if split system): damper, room exhaust fan, etc.

19.6.12 Water and Waste**19.6.12.1 Water piping**

All car water piping shall be pressure tested for leaks on all cars. Testing may be done in sections if desired. Movement of all valves and freedom from interference shall be checked. All faucets and drinking water spigots shall be tested for correct temperature adjustment range, water flow rate and freedom from splashing. All sinks and drinking water alcove shall be tested for proper operation.

19.6.12.2 Water raising and distribution operation

The water raising system of each car shall be tested, including the correct operation pressure of each regulator in the distribution system.

19.6.12.3 Water cooler operation

Correct operation shall be verified, including chilled water temperature, and operation of the circulation loop and controls, if equipped.

19.6.12.4 Water heater operation

Correct operation of each water heater shall be verified, including thermostat and hot water delivery temperature. If a mixing valve is used, correct adjustment shall be verified with input supply water at two different temperatures. Poly phase water heaters shall have the correct current value of each phase verified.

19.6.12.5 Toilet operation

Correct operation shall be verified on each toilet of each car. This shall include verification that each control device is calibrated and operates correctly: pressure switches, level controls, switches, water and air pressure regulators, solenoid valves and indicators. Timing of each step of the flush sequence shall be checked. Operation of the collection tank controls,

including drain and rinse cycles shall be tested. Freedom from vacuum leaks shall be verified to OEM recommendations. Cab and Controls

19.6.13 Cab and Controls

19.6.13.1 Alerter performance

Tests shall verify proper timing, operation of each input and output, including at various simulated vehicle speeds. They shall demonstrate all modes of operation, including self test.

19.6.13.2 Speedometer/overspeed performance

Tests shall verify all modes of operation, including self-test. Each input and output shall be demonstrated. Calibration at zero, mid scale and maximum speed shall be shown. Calibration and action at each overspeed set point shall be verified.

19.6.13.3 Event recorder performance

Tests shall verify operation of the entire integrated system hardware and software. They shall show correct interpretation of each input, including combinations (such as throttle). Resolution, set point and calibration of all analogue inputs shall be shown at zero, midscale and maximum values, which will include applying pneumatic pressure to those inputs. All modes of downloading shall be demonstrated. Software demonstration shall include validation of inputs and their calibration as a "real time" display as well as data analysis software playback, both graphic and tabular. Comparison of the graphic and tabular values must be included. Operation of self-test and health monitoring functions shall be demonstrated.

19.6.13.4 Event recorder-video performance

Tests shall verify operation of the entire integrated system hardware and software. They shall show correct interpretation of each input. Video focus and resolution, and other inputs shall be demonstrated. All modes of downloading shall be demonstrated. Software demonstration shall include validation of inputs and their calibration as a "real time" display as well as data analysis software playback. Operation of self-test and health monitoring functions shall be demonstrated.

19.6.13.5 Positive train control system

Perform a test of the PTC system in accordance with manufacturer and railroad requirements. Tests shall verify all modes of operation, including self-test. Each input and output shall be demonstrated. Calibration of pickup and drop out of each parameter of the carrier shall be demonstrated. Interaction with the brake system to produce a penalty brake application, with associated PCS shall be demonstrated, along with the inability to suppress it. Overspeed, failure to acknowledge and overspeed with failure to acknowledge shall all be demonstrated. Permanent suppression shall be demonstrated. Diagnostics and data-logger shall be demonstrated.

19.6.13.6 Locomotive and air brake control

Tests shall verify performance of the integrated system of cab controls, including traction and braking. They shall include complete demonstration of all interface signals between the brake equipment and other vehicle equipment. All inputs and outputs shall be exercised. Calibration and resolution of all analog signals at zero, midrange and maximum values shall be demonstrated.

19.6.13.7 Brake control operation

Note: All compressed air which is connected to the car or its air components shall meet the air quality requirements of APTA Standard SS-M-011-99.

- Calibration of air pressure gauges shall be verified and values recorded
- Verify operation of each mode of operation shall be demonstrated, in accordance with OEM brake supplier test code, including but not limited to:
 - Passenger mode, freight mode, cutout, test (if equipped)
 - Parking brake, including effect of cutting out automatic brake and penalty brake
 - Calibration of brake valve settings of release, min, suppression, full service and
 - Emergency measured on brake pipe and brake cylinder. Values shall be recorded.
 - Penalty application; non-suppressible and suppressible
 - Emergency application; local and remote (all sites on car + remote in consist)
 - PCS function
 - Operation of pressure switches

19.6.13.8 Cab indicator operation

The test shall verify proper operation of all indicator lights and audio alarms.

19.6.13.9 MU and COMM trainline function operation

The test shall verify the correct transmit/receive function, including controls, indicators and alarms of each trainline wire. Interaction of PCS/PCR shall also be included.

19.6.13.10 Windshield wipers operation

The test shall verify proper operation of each wiper unit, including: smooth movement, sweep over the required area of the windshield, speed control, parking position, noise and freedom from air leaks. Also test proper operation of washer.

19.6.13.11 Defroster/heated windshield operation

Proper function of the defroster and heated windshield, their controls and indicators shall be verified.

19.6.13.12 Horn and bell operation

The test shall verify proper operation of devices and all controls, including automatic sequencer and speed input to it.

19.6.13.13 Cab radio tests

Each cab radio shall be tested and adjusted to meet all technical parameters, and the proper certificates supplied in the vehicle history book. Additionally, the antenna shall be verified for conformance with its specified radiation pattern.

19.6.13.14 Headlight and crossing light tests

The headlights and crossing lights on each cab/baggage car shall be tested and adjusted in accordance with 49CFR Section 229.125 for proper illumination, orientation, aim and operation.

19.6.14 Completed Car**19.6.14.1.1 Weighing**

The Contractor shall weigh each car at the time of shipment. All cars shall be measured empty and dry, with no fresh water, waste or consumables, and with no leftover tools or materials from the production process. All parts shall be properly installed on each car prior to weighing. Each car shall be weighed by measuring the weight on each of the car's eight wheels. A weighing device which provides a permanent printed record of the weight shall be used, and the weight tickets shall be submitted to the Customer and copies thereof included in the vehicle history book.

The weighing device shall be maintained within an accuracy of 0.2%. If the weighing device is electronic, it shall be calibrated at intervals of no more than 60 days. If mechanical it shall be calibrated immediately prior to weighing the first car and annually thereafter.

Any total car weight deviation of greater than 300 lbs from the weight of the pilot car of similar configurations, any car weight in excess of the maximum allowable weight specified in Chapter 4, or any car with a weight distribution not in compliance with the provisions of Chapter 4 must be documented on a nonconformance report and explained to the satisfaction of the Customer prior to shipment. The Customer may require that the Contractor reduce the weight of any cars exceeding the overall weight or weight distribution limits.

19.6.14.1.2 Clearance tests

Each car shall be measured to prove compliance with the Contractor's approved clearance diagram for the as-built car configuration, to verify that the car clearances while in operation will meet the requirements. In addition, the centering of the carbody with respect to the trucks shall be measured, and corrected if necessary. The completely assembled truck shall not exceed the clearance limits specified between the truck and the carbody, and the limits between the truck and the rail.

19.7 Acceptance Tests

19.7.1 Car Acceptance Tests

The tests specified in this section are to be performed by the Contractor on the Customer railroad, or as otherwise designated by the Customer. The tests shall be satisfactorily completed as a condition of acceptance. All tests shall be performed on all cars (including the pilot cars) unless otherwise specified by the Customer.

After receipt of each car at the Customer site and before it is operated, it shall be carefully inspected jointly by the Customer and the Contractor, and any part, device or apparatus which requires adjustments, repair or replacement shall be noted by the Contractor who shall make such adjustment, repair or replacement before acceptance testing is begun. All expenses and costs incurred in any necessary removal of cars from the designated delivery point and their return there for correction of defects shall be borne by the Contractor.

19.7.2 Functional Tests

A complete, orderly and comprehensive check of each and every vehicle system shall be made to verify its proper operation before commencement of revenue operation. A set of diagnostic test equipment owned by the Contractor of the same design provided to Customer shall be used for these tests to the extent possible, but devices bypassed by the use of the DTE's (door open and door close buttons for example) shall also be checked. All aspects of wayside communications shall be tested for proper operation. All software files required for the destination sign system, automatic vehicle location system, GPS and other communications systems shall be loaded and verified for proper operation.

19.8 Post-delivery Testing of Pilot Train with Other Equipment

After the Pilot Cars have been delivered to the Customer's facility and have undergone and passed all applicable acceptance inspections and tests, the three cars shall be combined with other rail equipment as designated by the Customer to verify car-to-car operational, compatibility and coupler tests with other car types that may constitute part of the Customer's existing rail service. The specific types of rail equipment with which the Pilot Train shall be tested for compatibility includes:

- P32, P40 and P42 locomotives, as owned by Amtrak
- F59PHI locomotives, as owned by Amtrak, Caltrans, North Carolina DOT and others and used in intercity rail passenger service
- *Surfliner* rail cars, as owned by Amtrak and Caltrans
- *Superliner* rail cars, as owned by Amtrak
- *California Cars*, as owned by Caltrans
- Other equipment as may be specified by the Customer

All trainline functions shall be tested and verified, including:

- Door control, door system status and traction inhibit
- Locomotive control
- PA, IC and PIS communications and data transfer
- HEP and power distribution
- Air brake application and release

The Pilot Train, combined with the other rail equipment as specified, shall be tested to confirm compliance with track geometry requirements, including curve and crossover negotiation. All car-to-car connections shall be verified as performing in compliance with the track geometry requirements, including:

- Carbody clearance
- Truck swing
- Coupler swing
- MU, COMM and HEP cables
- Brake pipe and main reservoir air hoses
- Diaphragms and diaphragm curtains

Requirements for successful completion of the testing between the Pilot Cars and the other rail equipment shall be the same as those specified for car-to-car testing of the Pilot Train.

19.9 Reliability and Post-Delivery Tests

The complete operational car fleet shall be monitored by the Contractor to demonstrate conformance with the reliability requirements. This test shall begin when five cars are in service and shall continue until the last full month during which four operating cars or more remain under the two year car warranty. All cars in the increasingly large fleet with greater than 5,000 miles of service shall be included in the data collection activity.

On a monthly basis, the Contractor shall issue a report detailing the performance of the car fleet and its equipment with regard to maintenance actions (which shall be detailed in an appendix by type) and the calculated period and cumulative Mean Distance Between Failures (MDBFs) and Mean Time Between Failures (MTBFs) as appropriate. Any component(s) or system(s) found to be causing and/or related subsystem and/or whole car MDBF/MTBF to fall below the required performance level shall be subject to redesign and modification. During the period such efforts are carried out, failures due to these component failures shall not be counted. However, upon completion, the modified car and/or subsystem shall be monitored for a period of no less than an additional 6 months or the remaining base period, whichever is greater, and the MDBF/MTBF shall be acquired. If the use or failure of the component or system is weather or temperature related, the 6 month period shall include those calendar months during which such use or failure is incurred. It shall be understood that the total test time period shall not be assumed to be 365 consecutive calendar days in the event that modification is required.

Following a satisfactory completion of the test for all subsystems, the Contractor shall issue a final report summarizing the results and with all interim reports appended for completeness. If

a satisfactory completion cannot be obtained before the end of the specified warranty period, the Contractor and the Customer shall resolve any outstanding issues in accordance with the Contract terms and conditions.

* End of Chapter 19 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee
Bi-Level Passenger Rail Cars

Chapter 20

Tools, Consumables and Spare Parts

Table of Contents

20.0	Tools, Consumables and Spare Parts	20-2
20.1	Overview	20-2
20.2	Specialized Tools	20-2
20.3	Consumables	20-3
20.4	Spare Parts	20-3

20.0 Tools, Consumables and Spare Parts

20.1 Overview

This chapter details the requirements for the Contractor to identify and provide the specialized tools, spare parts and consumables that will be needed to operate, maintain and repair the vehicles to be delivered to the Customer.

All information required in this chapter shall also be included in the appropriate operating and maintenance documentation as identified in Chapter 22, including:

- Operating Manual
- Running Maintenance Manual
- Heavy Maintenance Manual
- Illustrated Parts Catalogue
- Troubleshooting Guide

20.2 Specialized Tools

The Contractor shall provide to the Customer five sets of all specialized tools, gauges, meters, diagnostic equipment (including laptop computers), etc. that will be necessary to operate, maintain, inspect, test, troubleshoot and repair all configurations of the vehicles throughout their design life. These tools and equipment shall be delivered to the Customer at a specified location, and shall be delivered to the Customer prior to the acceptance of the first car. All specialized tools shall be included in the base warranty as specified. **CDRL**

As part of the design review process, the Contractor shall submit a list of specialized tools and diagnostic equipment that will be provided to the Customer. **DR**

This list shall identify the item description, manufacturer, part number and purpose, and shall include a cross-reference to the maintenance manuals as to the tasks that require the use of the tools. This list shall include all specialized tools and diagnostic equipment required to operate, maintain and repair the vehicles throughout their design life, and shall include:

- Specialized tools for inspecting, repairing, removing, installing, maintaining or measuring components and systems on the cars;
- Diagnostic equipment to troubleshoot problems, determine component or system status or condition, or interpret diagnostic information;
- Portable computer equipment required to view, change or monitor the operating parameters, downloadable recorded data, service history or digital programming for computerized or microprocessor controlled components or systems; and
- All cables, connectors, software, power supplies, carrying cases and peripherals as required for use with the portable computers. All diagnostic, download and programming software shall be provided in Windows operating system format with no use restrictions so that the Customer can install the software on additional computers as needed.

The Contractor shall provide drawings, schematics, specifications, part numbers and prices for all special tools and maintenance equipment to enable the Customer to purchase additional quantities.

20.3 Consumables

The Contractor shall provide a list of all service consumables needed to support the vehicle throughout its service design life. Consumables are identified as those items replaced as a function of normal operation, whether the replacement is on a periodic basis or as they wear out. This list shall be provided as a component of the final design review. **DR**

This list should include items such as:

- Brake pads
- Filters - Heating, Ventilation and Air Conditioning (HVAC), air, water
- Windshield wiper blades
- Lamps/Light Emitting Diodes (LEDs)
- Fuses, Diodes and Resistors
- Air hoses
- Rubber seals and Gaskets

This list shall include the following information as it relates to these parts:

- Contractor part number
- Part description
- Manufacturer name
- Manufacturer part number
- Quantity required by car type
- Frequency of replacement

20.4 Spare Parts

As a part of final design review, the Contractor shall provide to the Customer a list of strategic spare parts that the Customer should acquire and maintain to support the fleet of equipment after the end of the warranty period. **DR**

This list shall include, but is not limited to the following:

- Parts that are critical to the safe operation of the equipment;
- Parts with a high failure rate, based on the Contractor's reliability analysis (see Chapter 19);
- Parts located on the vehicle exterior and therefore subject to damage from debris strikes or accidents;
- Parts installed in a high-wear environment; and

- Parts that require troubleshooting and repair off of the car, such as electronic components.

This list shall include the following information as it relates to these parts:

- Contractor part number
- Part description
- Manufacturer name
- Manufacturer part number
- Quantity required by car type
- Shelf life/maximum storage period
- Recommended quantity to have on hand

The Contractor shall be responsible to provide replacement parts for those failing under the terms of the warranty. The Customer shall not be responsible to supply replacement parts to the Contractor for the purposes of fulfilling warranty provisions.

* End of Chapter 20 *

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Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 21

Shipping Preparation

Table of Contents

21.0	Shipping Preparation	21-2
21.1	Overview	21-2
21.2	Requirements for Shipping Vehicles	21-2

21.0 Shipping Preparation

21.1 Overview

This chapter describes the requirements for preparing completed vehicles for shipment to the Contractor's field site where vehicle acceptance will take place.

All vehicles must receive approval for shipment from the Customer before they can be shipped to the field site.

The Contractor is responsible for all costs and arrangements associated with the shipment of the completed vehicles to the Contractor's field site.

21.2 Requirements for Shipping Vehicles

All completed vehicles shall be prepared for shipping as follows:

- All hoses and inter-car cables shall be connected between vehicles, if more than one car is shipped at a time.
- Brake control valve selector plate shall be set to graduated release if being moved in passenger service (see Chapter 7).
- Cab/baggage car brake valve shall be in the cutout position (see Chapter 16).
- Automatic Equipment Identification (AEI) tags shall be properly programmed and installed. The Contractor is responsible for ensuring that the car's technical data is entered into the Umler/EMIS (Equipment Maintenance Information System) system prior to the release of the car (see Chapter 4).
- New air filters shall be installed in Heating, Ventilation and Air Conditioning (HVAC) system (see Chapter 10).
- All required inspections must be complete, including inspections and approvals from the FRA, the FDA and Amtrak. The following documents must be completed and signed, and be installed in the document holders in each car and in the cab of each cab/baggage car as applicable (see Chapter 16):
 - Amtrak MAP 816/FRA F6180-49, *Locomotive Inspection and Repair Record* ("Blue Card")
 - Amtrak MAP 100, *Equipment Condition Report*
 - Amtrak MAP 101, *FRA Rule No. 229 Inspection Record*
 - Amtrak MAP 1173, *Class 1 Brake/Calendar Day Test*
 - Amtrak MAP 10C, *Passenger Car Daily Inspection*
- Waste system shall be drained (see Chapter 15).
- All doors and windows shall be closed.
- All equipment room doors shall be locked.
- The Contractor shall perform other shipping-related tasks as required by the Customer.

The following shall be set up at the discretion of each Customer in accordance with the requirements for each shipment of cars:

- Fresh water may be supplied from the potable water tank for use of the toilet system while in transit. If no water is needed, the tank shall be drained and all water supply lines shall be blown dry and tagged.
- All circuit breakers shall be on. The main 480VAC Head End Power (HEP) breaker may be on if power will be needed while the car is in transit, or shall be off if no power will be required.
- Diaphragms shall be removed if necessary. If removed, diaphragms shall be properly prepared for shipment by the Contractor to the Contractor's field site, where they will be reinstalled by the Contractor prior to Customer acceptance of the car.

* End of Chapter 21 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 22

Training and Documentation

Table of Contents

22.0	Training and Documentation	22-2
22.1	Overview	22-2
22.2	General Requirements.....	22-2
22.2.1	Contractor Responsibility	22-3
22.3	As-Built Drawings	22-3
22.3.1	Drawing Availability	22-4
22.3.2	Drawing Originals.....	22-4
22.3.3	Compact Disks (CDs).....	22-4
22.3.4	Photograph Book.....	22-4
22.3.5	Photographs of Completed Cars.....	22-4
22.3.6	Digital Format	22-5
22.4	Conformed Specification.....	22-5
22.5	Manuals.....	22-5
22.5.1	Manual Review and Availability	22-6
22.5.2	Manual Updates	22-6
22.5.3	Work Management System	22-6
22.5.4	Operator's Manual.....	22-6
22.5.5	Service and Inspection Manual.....	22-8
22.5.6	Troubleshooting Guide	22-9
22.5.7	Running Maintenance Manual.....	22-10
22.5.8	Heavy Maintenance Manual.....	22-11
22.5.9	Integrated Schematic and Wiring Manual	22-12
22.5.10	Illustrated Parts Catalog (IPC).....	22-13
22.5.11	Manual Quantities to be Provided.....	22-14
22.6	Vehicle History Books	22-14
22.7	Training	22-16
22.7.1	User Training	22-17
22.7.2	Training Requirements	22-17
22.7.3	Training Materials	22-20

22.0 Training and Documentation

22.1 Overview

This chapter describes the requirements for the development and delivery of project documentation, including manuals, drawings and photographs, and for the implementation of a post-delivery training program to familiarize operating, mechanical, supervisory and administrative personnel with all aspects of the operation, inspection, maintenance, repair and supply of parts for the fleet of cars.

The Contractor shall be fully responsible for the completeness, accuracy and readability of the manuals, drawings and schematics, and to ensure that these documents meet the requirements for all systems, subsystems, components and operations to perform as intended for the duration specified.

The Contractor shall develop and provide a training program that accurately and completely reflects the requirements of the manuals, and be structured and implemented so that the Customer and its designated maintenance and operations provider have access to all necessary resources to properly and successfully operate, maintain, repair and administer the vehicles as required by the Contractor, the FRA, Amtrak and others.

22.2 General Requirements

The material in the maintenance manuals and the illustrated parts catalog shall be organized and sequenced with a standard numbering system or alternative numbering system as approved by the Customer. Sharp, clear drawings shall be used throughout the documents for illustration. Photographs may be used only where explicitly approved by the Customer. The operator's manual binder shall be lightweight plastic, which can be easily opened for page revisions. The operator's manual shall use a page size of 6.75 in. tall by 3.875 in. wide, vertical format. All other documents shall be 8.5 in. wide by 11 in. high, vertical format, unless specified otherwise. A complete table of contents shall be given at the beginning of each publication, and a complete page-numbered index at the end. Plastic coated tabs shall be used to segregate sections within each publication.

All publications must be reviewed in detail by the Contractor to ensure completeness and accuracy of information and quality prior to any submittal to the Customer for approval. Chapter numbers shall be consistent for all documents.

Manual information shall be kept up-to-date to the car configuration and operation during the full period of the Contract. As information becomes available and changes occur, the Contractor shall incorporate the changes and supply the information in updated electronic editable and Portable Document Format (PDF) files in an organized, timely manner based on a regular schedule to be approved by the Customer. Each updated information submittal shall be accompanied by a file containing a revised list of effected pages for the manual set being changed.

Engineering changes that affect any potential safety issue, or may significantly affect car operation in scheduled service, shall be published in the form of an Engineering Change Service Bulletin (ECSB). ECSBs shall be used in the interim until the official changes in the

maintenance manual and illustrated parts catalog have taken place. The creation of ECSBs shall be included within the Contractor's engineering change procedures and engineering change proposal system. ECSBs shall be stand-alone documents, provided in both editable document and PDF formats. Each ECSB shall detail the reason, instructions and illustrations to make the change. Associated parts information shall also be included. A system to control ECSBs shall be developed between the Contractor and the Customer to control ECSBs, such as using note tools on the existing electronic PDF versions and/or the development of master lists of outstanding ECSBs.

22.2.1 Contractor Responsibility

The Contractor shall provide documents such as drawings, 3-D Computer-Aided Design (CAD) models, photographs and a family of operating and service manuals which shall provide the Customer with the information necessary to properly operate and provide all maintenance functions for the given fleet of vehicles. These include drawings and manuals to safely and properly conduct:

- Operation
- Service and inspection
- Troubleshooting
- Running maintenance
- Heavy repair/overhaul (vehicle and system/component level)
- Part identification (to the lowest repairable level)
- Wreck repairs
- Modification of equipment (documenting as-built configuration)

22.3 As-Built Drawings

The Contractor shall provide the Customer with a full set of component, system, arrangement and installation drawings, schematics and specifications for all parts and assemblies as provided on each type of car. These drawings shall be in a Customer-approved 3-D CAD format and shall meet the requirements of Amtrak Specification 700. This also includes providing a complete set of all as-built drawings for top assemblies, subassemblies and detail drawings used to manufacture all equipment used therein. Outline drawings of boxes, components and devices will not be sufficient. Each assembly, subassembly and arrangement drawing shall include a complete bill of material and parts list describing all items (including weight, original component manufacturer name and part number of the actual supplier of the part.) that form a part of the assembly. All assemblies and subassemblies are to be fully detailed. The drawing package shall also include drawings of every special gage, tool, jig or fixture used to correctly install these items.

All dimensions shall be shown in standard imperial units of inches and decimals, with a metric equivalent shown in parentheses adjacent to the imperial dimension. If a component or subassembly uses metric units as the primary system of measurement, then imperial equivalents shall be provided in parentheses.

22.3.1 Drawing Availability

Preliminary drawings needed to perform maintenance, repairs, testing or measurements shall be supplied prior to the delivery of the first completed car of each type. **CDRL**

A complete set of as-built drawings shall be delivered within 30 days after the delivery of the first car of each type. **CDRL**

A complete bill of material for the car, in standard 8.5 in. by 11 in. size, and on Compact Disk (CD), covering all major components and hardware, shall also be provided within 30 days after the completion of the last car of the base order. **CDRL**

The Contractor shall make available, for the life of the equipment, and without charge, hard copy drawings or electronic files that are required by the Customer to conduct equipment modifications, conduct overhauls or make extraordinary repairs, such as those arising from accidents, etc.

22.3.2 Drawing Originals

The Contractor shall submit to the Customer for review and approval, within 30 days after completion of first car of each base type and then again after completion of all modifications as-built drawings and 3-D CAD models of all assemblies, sub-assemblies and arrangements in accordance with this section. If the Contractor decides not to maintain the drawing originals, they shall be supplied to the Customer at no cost. Likewise, if the Contractor terminates operations, all drawings pertaining to this project CAD files or any other Customer approved media, shall be provided to the Customer free of charge.

22.3.3 Compact Disks (CDs)

Within 30 days of the delivery of the last car of the base order of equipment, the Contractor shall provide four sets of CDs of all the drawings, 3-D CAD models and Finite Element Models (FEMs), the bill of material, as-built specification training materials and operation and maintenance manuals. **CDRL**

22.3.4 Photograph Book

The Contractor will furnish, within 30 days of the delivery of the first car of each car type, two bound volumes of not less than 50 different color photographs, 8 in. by 10 in., showing the progression of construction of the first car of each type. The images shall also be supplied in digital format. **CDRL**

22.3.5 Photographs of Completed Cars

The Contractor shall furnish, within 30 days of the delivery of the first car of each car type, 10 sets of un-mounted color and 10 sets of un-mounted black and white photographs, at least 8 in. by 10 in., in size, of the first completed and painted car of each type of equipment, showing at least four different views of each car of equipment, including full front, 3/4 side, top and rear views. **CDRL**

22.3.6 Digital Format

All photographs shall be taken in digital format (jpeg), at high resolution (2400 x 3000 pixels). All photographic prints and files will be submitted to the Customer within 30 days following completion and acceptance of the first car of each base type.

22.4 Conformed Specification

Within 30 days after completion of the last pilot car, the Contractor shall revise this Specification to provide an as-built specification and contract document. The revised document shall require Customer review and approval. One reproducible hard copy and four CD copies of the approved version shall be provided. **CDRL**

The conformed specification shall include all changes to the specification made via approved waivers, variances and change orders. Subsequent changes to the specification made prior to the end of the warranty period shall require the conformed specification be revised.

22.5 Manuals

The Contractor shall provide a complete family of operating and maintenance manuals. The following manuals are required:

- Operator's Manual
- Service and Inspection Manual
- Troubleshooting Guide
- Running Maintenance Manual
- Heavy Maintenance Manual
- Integrated Schematic Manual
- Illustrated Parts Catalog

The manuals shall include full descriptions of all systems and components requiring maintenance or servicing. The manuals to be supplied shall contain information required for effectively understanding operation of the car as well as performing scheduled maintenance including general servicing, lubrication and inspections, system equipment testing, troubleshooting and adjustments, and repair/replacement of components and major subassemblies.

The Contractor is responsible for ensuring that subcontractors comply with this Specification and that they also provide the appropriate manuals. Contracts between the Contractor and subcontractors shall include appropriate language to ensure these documents are provided as required.

All manuals shall have, at a minimum, the following information on the front cover:

- Contractor name
- Customer name
- Type of equipment

- Car numbers and reporting marks
- Date and level of revision

Contractor manuals shall be provided electronically in an editable word format or other Customer approved language.

22.5.1 Manual Review and Availability

The Contractor shall develop a master plan and schedule for the development and completion of the manuals. This manual development plan shall be submitted to the Customer no more than 180 days after NTP, and shall include the Contractor's plan for the development and acquisition of the manual content from suppliers and vendors, the schedule for the major completion points of the manuals, and a method to track the development of each manual that can be reviewed at the periodic project management meetings. **CDRL**

A full set of draft manuals, including those provided to the Contractor by suppliers, shall be submitted for Customer review no less than 90 days prior to the release of the first car. If the manuals require revision, as determined by the Customer, the Contractor shall revise and resubmit the draft manuals until all requirements are met. The first car shall not be released from the Contractor's facility until the Customer has approved the final draft of the manuals. The Contractor shall provide 10 full sets of manuals to the Customer prior to Customer acceptance of the first car. **CDRL**

22.5.2 Manual Updates

After delivery of the first car, and continuing through the end of the warranty period, should any changes to the car, components or maintenance requirements occur, the Contractor shall revise and update all affected manuals and shall submit hard and electronic copy manual updates to the Customer. Upon the completion of the warranty period, the Contractor will issue 10 sets of finalized manuals to the Customer, reflecting all changes made to the vehicles during production, delivery and operation, and the status of all cars at the time of warranty expiration. **CDRL**

Revisions to final draft and approved manuals shall be recorded on a control list in the front of each manual. The list shall be issued with each revision and shall show the date of each revision and the page reference. Updated lists and revisions shall be maintained in the manuals by the Contractor until the warranty period expires.

22.5.3 Work Management System

If specified by the Customer, the manuals will be used electronically in Amtrak's Work Management System (WMS). The Contractor shall work with the Customer and Amtrak to ensure that this is implemented successfully.

22.5.4 Operator's Manual

The Contractor will develop operating manuals for use by train operating personnel, including the Engineer, Conductor and food service Lead Service Attendant (LSAs). Operator's manuals shall contain all information needed for the operation of the car, including definitions giving nomenclature, function, location and operation of all indicators, controls, components and

subsystems utilized in the operation of the car. This shall include preparing the car for operation, securing the car from operation and operation of the car individually and as a train.

Emergency procedures and safety precautions of a specific nature applicable to the car shall be included. The manual shall give troubleshooting and diagnostic procedures sufficient to isolate faults and problems which are capable of repair by the operator and train crew, arranged in a format to allow ease of use under emergency and time-sensitive situations.

The operator's manual shall be divided into chapters as follows:

1. Introduction
2. Communications
3. Inspecting
4. Operating
5. Fault Isolation
6. On-the-Road Repair
7. General Description

The fault isolation and on-the-road repair sections of the operator's manual shall include, in summary form, all fault isolation and on-the-road repair procedures. These two sections shall include:

- Index
- Safety instructions
- Instructions for communications during fault isolation
- Authorized fault isolation procedures
- Authorized on-the-road repairs
- Equipment location diagrams

The operator's manual shall accurately portray and clearly illustrate all information required by the operator and train crew to correctly, efficiently and safely carry out their duties on the car in all possible consist configurations. Illustrations shall include layouts of the equipment, showing major components and controls referenced in the text and their locations on the car.

An alphabetical index of subjects and equipment not mentioned in the table of contents shall be provided. All operating conditions shall be taken into account by the manual's description of unit functions. A fault isolation section shall be provided to list all possible unit or system malfunctions that are detectable by the train crew without the aid of test equipment. This shall include fault codes and corrective information supplied by the diagnostic system. This information shall be presented in tabular format listing each symptom with corresponding potential causes, test, checks and corrective actions. The goal of these fault isolation tables shall be to allow the train crew to identify operational problems and, where possible, isolate faults from consists to car, car to system and, in some cases, from system to subsystem.

22.5.5 Service and Inspection Manual

The Service and Inspection (S&I) manual shall contain all pertinent information that operating and maintenance personnel will require in order to perform all periodic inspections on the vehicles as required by the Contractor, subcontractors, Amtrak and the FRA for all periodic inspections including those occurring daily, every 30 days, every 120 days and annually (every 368 days). Additional or differing intervals such as 92 days and 184 days shall be included if used by the Customer's maintenance provider. Inspections and servicing activities occurring on an interval that is not used by the Customer's maintenance provider shall be included in the tasks shown for the next more frequent interval.

The inspection tasks described in this manual shall include, but are not limited to the following:

- Item or system requiring inspection
- Frequency or period of inspection
- Inspection procedure, including location and description of system being inspected
- Pass/fail criteria for inspection
- Special tools, conditions or other requirements for inspection to be performed
- Source of inspection requirement (Contractor, Amtrak, FRA, etc)
- Reference for inspection requirement (CFR, maintenance manual, etc)

Inspection tasks shall be listed in order of frequency of inspection requirements, from daily to annual. A summary table shall be provided for quick reference that lists the item or system, frequency, source and reference for all required inspections.

This manual will also provide complete instructions for all pertinent maintenance activities for the routine operation of the cars that are required every 30 days, or more frequently, including:

- Fresh water filling
- Waste tank draining
- Removal of trash and recyclables
- Installation and replacement of consumables
- Inspection and replacement of filter elements
- Cleaning and lubrication
- Replacement of brake shoes and pads

This manual shall be provided in a comb-bound format approximately 5 in. wide by 8 in. tall. The cover of the manual shall reference the Customer name, car numbers, reporting marks and types, the Contractor name, issuance date and revision level.

22.5.6 Troubleshooting Guide

This manual will contain detailed troubleshooting procedures, including those requiring the use of diagnostic test equipment and those that do not require such equipment, for all major systems, subsystems and components in the following categories:

- Carbody
- Trucks
- Coupler and Draft Gear
- Brakes
- Door System
- Interior
- HVAC
- Lighting
- Communications
- Electrical System
- Food Service
- Water and Waste
- Cab and Controls
- Emergency Equipment

This manual shall provide procedures for the identification, diagnosis and proper correction of car failures and malfunctions. Procedures shall be organized so that maintenance personnel can isolate faults down from consist to car, from car to system, and from system to subsystem, assembly, subassembly or component. These procedures shall include determination of the cause and isolation of the fault to replaceable parts, interface wiring or mechanical linkage. Diagrams of the relationships shall be provided to enhance comprehension. Troubleshooting procedural format shall include fault codes for each system with built-in diagnostics and fault information and corrective actions displayed by the diagnostic system. All fault codes are to be included, and diagnosed, in the troubleshooting manual. When there is more than one probable cause for a system or equipment malfunction, the most likely to have failed shall be considered first; however, consideration shall be given to accessibility and ease of replacement when the likelihood is equally shared by two or more causes.

Each chapter of the troubleshooting procedures shall contain the following sections:

- Introduction, including general information, safety precautions, and definition of warnings, cautions, and notes with specific details
- Operational and functional system descriptions
- Troubleshooting
- Corrective maintenance procedures

When there is more than one probable cause for a system or equipment malfunction, the most likely to have failed shall be considered first; however, consideration shall be given to

accessibility and ease of replacement when the likelihood is equally shared by two or more causes. The troubleshooting and corrective maintenance procedures shall contain:

- Identification of the system covered
- A concise explanation of the troubleshooting format and how to use the procedure
- Test equipment and tools required
- Safety precautions that must be taken
- A reference to the supporting block diagrams
- Preliminary tasks that must be performed prior to initiating troubleshooting

When applicable, each section shall indicate and list the applicable safety warnings and precautions, test equipment required, special tools required, and any consumables required. The manual format shall utilize diagrams and illustrations as required to enhance understanding. All procedures shall be proved out in the field on the pilot cars and shall be revised as necessary.

22.5.7 Running Maintenance Manual

The running maintenance manual shall contain an overview of the vehicle operation and a detailed description and analysis of the vehicle and its assemblies/subassemblies. The manual shall also contain, in a convenient form, all information required for on-car testing, troubleshooting, servicing and replacement of equipment down to the lowest level replaceable item. The running maintenance manual shall provide technicians with the maintenance procedures that are performed at the running repair level. Running maintenance is defined as that maintenance that can be performed on the inspection track or does not require taking the train out of service. The manual is to be divided into three volumes as listed below.

Running maintenance manual procedures shall be supported by illustrations. They shall be used to simplify, clarify or shorten the text. Illustrations shall be located on the same page or facing page of the text they support. A sequence of illustrations may be used in order to clarify or simplify a complex procedure. When one of several possible positions is described by text for a device, the position described shall be the same as the one shown by the illustration. Unless the location and access to the item is obvious, a locator view shall be included, or the assembly diagram provided at the beginning of the chapter may be referenced to ensure that the equipment orientation is clearly described.

Functional post-inspection testing and checkout test procedures shall be provided to verify serviceability or to detect failures of a system, subsystem, assembly, subassembly or component. Pretest setup instructions shall be included. Test procedures shall be used as a prerequisite for the generation of fault isolation procedures to fault isolate to a system, subsystem, assembly, subassembly or component. The types of tests that can be performed fall into the following categories:

- Operational Test - Procedure required to ascertain only that a system or equipment is operable. These tests should require no special equipment or facilities other than that installed on the car and shall be comparable to the tests performed by the Operator. It is not intended that the operational test of the unit meet the specifications and tolerances ordinarily established for overhaul or major maintenance periods.
- Functional Test - Procedure required to ascertain that a system or equipment is functioning in all aspects in accordance with minimum acceptable system or unit design specifications. These tests may require supplemental support equipment and

shall be more specific and detailed than an operational test. The test shall contain all necessary information to ensure system or unit operational reliability, without reference to additional documents.

- System Test - Procedure containing all adjustment specifications and tolerances required to maintain system and unit performance at maximum efficiency and within design specifications. The test shall be self-contained and may duplicate other tests.

22.5.8 Heavy Maintenance Manual

Heavy maintenance is defined as the maintenance that may be performed on the shop track or one of the heavy maintenance tracks if the train is taken out of service. Heavy maintenance tasks will generally require more than one 8 hour shift to complete. The Heavy Repair Manual shall contain a detailed description and analysis of all mechanical, electrical and electronic assemblies/subassemblies so that Caltrans overhaul facilities can effectively and safely service, inspect, adjust, troubleshoot, repair, overhaul and test these assemblies. Contractor and sub-suppliers shall provide all information needed for comprehensive repair and overhaul work at least as comprehensive as that used by the suppliers' own service and repair shops, whether the car parts were manufactured by them or purchased from others. The manual shall provide information for the test, repair and overhaul of each repairable component of the assembly. No component shall be considered disposable or deemed non-repairable except where agreed to by the Customer.

Installation and removal of equipment in full detail, down to the lowest level of replacement items (assembly, subassembly or component). The procedures shall clearly describe the step-by-step operation in a logical, work flow sequence to safely gain access to, and subsequently remove the item. Prerequisite operations, inclusive of access panel or plate openings, removal of other obstructing components, and deactivation of power and other pertinent safety precautions and/or warnings shall be included or appropriately referenced. Exact quantities of attaching hardware to be removed shall be included in the procedures. The statement "reverse of remove" may be used judiciously. Installation procedures that are basically the same as the removal procedure, but require some additions, such as torque values for bolts, replacement of O-rings and lubrication of a component, can be handled within highlight statements to that effect in the removal procedure. If this is done, the statement "reverse of remove" may still be used. Installation instructions for procedures that are complex and require additional step-by-step detail, or are significantly different from that removal procedure must be provided.

Exact quantities of hardware shall be identified. If, during the prove-out or validation of a "replace" task, the highlighted data do not enable the maintenance technician to correctly install the subject item, the highlighted information shall be deleted from the removal procedure. A step-by-step installation procedure shall be added to the "replace" task. Step-by-step procedures shall be provided for any adjustment or alignment required as a result of replacement of any equipment, or to determine that a system, subsystem, assembly, subassembly or component meets required standards. Detailed procedures shall be provided to determine the accuracy of, and to correct and adjust instruments, diagnostic equipment and test measuring devices used for precision measurement. Calibrations are to be performed with an instrument that is certified to a standard of known accuracy to detect and adjust any discrepancy in the accuracy of the instrument being calibrated.

The manual shall include descriptions of how each assembly/subassembly operates within the car system. Each shall include:

- Block diagrams
- Signal flow diagrams

- Simplified schematics
- Functional wiring and piping diagrams
- Completely detailed overhaul procedures
 - Test and evaluation procedures equivalent to that performed by the original manufacturer, including the requirements for specialized test equipment. The Contractor is to procure or fabricate and provide to Caltrans all such specialized test equipment.
 - Rewinding procedures in full detail for all rotating and wire-wound apparatus, except as agreed to otherwise by the Customer.
 - Disassembly/assembly procedures required for the disassembly and assembly of assemblies, subassemblies and components at the heavy repair level of maintenance shall be provided. Assembly instructions shall include all pertinent assembly criteria, including clearances, backlash dimensions, torque values and similar data. Final testing, with pass/fail criteria, of the end item shall be provided by reference.
 - For overhauls, the maintenance action required to restore an item to a completely serviceable and operational condition. Overhaul is not normally performed on the car and does not necessarily return an item to like-new condition.
 - Rebuilds include those services and actions necessary for the restoration of equipment to like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Caltrans equipment. The rebuild operation allows returning to zero those age measurements including, but not limited to, hours and miles, considered in classifying Caltrans equipment and components.
 - Complete instructions for use, drawings and parts information for all special tools that are required to be provided to Caltrans by the Contractor.
 - The weights of all components and assemblies that weigh more than 50 lbs. In addition, the weights of major component assemblies shall be supplied such as the truck, air conditioning compressor, air compressor, etc.
 - Maintenance, calibration and adjustment, repair and overhaul of all diagnostic test equipment.

22.5.9 Integrated Schematic and Wiring Manual

The integrated schematic manuals shall include all electrical, hydraulic, pneumatic, mechanical, refrigerant and waste water system schematic diagrams as used on each car type, broken down by major system. All schematic drawings will be provided electronically per Amtrak Standard 700. The manual shall provide schematic and wiring diagrams including (but not limited to) the following:

- Electrical power distribution
- Trainline assignments and connections to car-borne equipment
- Door control system
- Lighting system (interior and exterior, in normal, standby and emergency modes)
- Communications system, including PA, intercom and passenger information system

- HVAC system, including chiller units in the café-lounge car (electrical, refrigerant and air flow schematics)
- Brake system (electrical, mechanical and pneumatic)
- Main reservoir air distribution system
- Fresh water distribution and waste retention systems (electrical, pneumatic and water routing)
- Wheelchair lift (electrical and hydraulic, if used)
- Food service galley equipment, including the elevator and all galley appliances (electrical, water distribution)
- Cab and controls

The schematics shall include all required information for maintenance, troubleshooting and repairs, including specific identification of wires (size, type and label), circuits, components, junction boxes and termination points, locations of components, voltages and pressures, hoses and pipes (size, type and rating), filters, adjustment points, direction of flow, function, and other information as necessary.

The integrated schematic manual shall be supplied in tabloid format, 11 in. tall by 17 in. wide, horizontal format, spiral bound with a protective laminated cardstock front and back cover.

22.5.10 Illustrated Parts Catalog (IPC)

The Illustrated Parts Catalog (IPC) shall enumerate, illustrate and describe every item used on the cars, along with the diagnostic test equipment and special tools with its related parts, down to the Lowest Level Replaceable Unit (LLRU). The LLRU is defined as the lowest level of component assembly which consists of a separate individually fabricated part, including all hardware items required to assemble, disassemble, repair or overhaul the component. Each listing shall include the accepted generic modified noun name description, the original supplier, the original supplier's part number and name and the Contractor's part number. An appendix giving the original supplier's complete address and telephone numbers for their offices responsible for parts ordering shall be included. Each component that can be disassembled included all printed circuit board components and items which may have been purchased by the Contractor as a subassembly, must be broken down in illustrations to fully indexed parts. The Customer shall have the right to make direct purchase from the sources listed by the Contractor. If provided to the Contractor, all Customer part numbers will be included in the IPC.

Identical parts, regardless of where used in the car, shall use only one part number. Each part or other item shall be identified as being part of the next higher assembly. In the case of hardware such as nuts, bolts, washers, etc., information relative to material, coating if any, all dimensions and types shall be included. All assemblies shall be listed alphabetically by name with reference to corresponding figure number.

The IPC shall include two cross-reference lists that sort all listed parts as follows:

- Sorted alphanumerically by part number
- Sorted alphabetically by part name

These cross-reference lists shall include the part name, manufacturer part number, manufacturer or supplier, contractor part number, and the page and illustration number where found in the IPC.

Illustrations shall be located on the same page or facing page of the text they support. A sequence of illustrations may be used in order to clarify or simplify a complex procedure. When one of several possible positions is described by text for a device, the position described shall be the same as the one shown by the illustration. Unless the location and access to the item is obvious, a locator view shall be included, or the assembly diagram provided at the beginning of the chapter may be referenced to ensure that the equipment orientation is clearly described. If the same drawing is used in both the illustrated parts catalog and either the running maintenance or heavy repair manual, the reference index in both manuals must identify the same parts.

22.5.11 Manual Quantities to be Provided

Name	Quantity
Operator's Manual	200
Service and Inspection Manual	50
Running Maintenance Manual	10 sets
Troubleshooting Manual	10 sets
Heavy Maintenance Manual	10 sets
Illustrated Parts Catalog (IPC)	10 sets
Integrated Schematic Manual	10 sets

Manual quantities are subject to change.

22.6 Vehicle History Books

The Contractor shall produce a vehicle history book for each completed rail car. The vehicle history books shall be a specific record of production, testing, inspection and relevant documentation for each individual vehicle.

The vehicle history book shall contain original documents unless specified otherwise.

All documents shall be marked with the carshell serial number, the production sequence number or the road number for the completed vehicle.

The Contractor shall provide one electronic and three paper sets of the vehicle history book for each car; one that contains the original documents, and two copies. The volume with the original documents shall be appropriately labeled. Vehicle history books shall be provided in three-ring binders. Documents shall be copied double-sided where practical.

At a minimum, each vehicle history book shall contain the following:

- Table of contents
- Production control cross-reference sheet, listing:
 - Carshell serial number
 - Shop order/production sequence number

- Final car reporting marks and road number
- Production schedule for each car showing start and end dates for each major stage of manufacturing
- List of all production drawings by number and revision status (release date, current revision, and outstanding engineering change requests at time of production)
- List of all parts by supplier and part number (bill of material)
- List of all serialized components
- Truck records (separate set of records for each truck)
 - Inspection records
 - Truck assembly sequence
 - Truck assembly weight certificate
 - Wheel/axle pressing graphs
 - Truck to carbody attachment record
- Log of all non-conformances including status
- Component test certificates
- Test records:
 - Master test plan
 - Test procedures
 - Production tests
 - Acceptance tests
 - Record of measurements and results
- Critical dimensional inspection report
 - Carshell dimensional inspection (prior to production)
 - Carbody leveling, balancing and centering record
 - Carbody overall dimension measurement, including compliance with clearance diagram
 - Coupler height measurement
 - Scale certificate for completed car (dry weight)
- Records of all required inspections
- USPHS Certification
- FRA documentation
 - Copies of required cab/baggage car inspection forms (originals are to be installed in the appropriate form holders in the cab of the cab/baggage car)
 - Record of compliance with FRA regulations
- Completed pre-shipment checklist
- Shipping approval form
- Customer acceptance form

- Transfer of title of the car from Contractor to Customer (with original wet-ink signature of Contractor's representative).

The vehicle history book shall be produced in an electronic format as either as a Microsoft Word, Excel, FileMaker Pro or an Adobe PDF file on a CDROM. Procedures, electronic signatures and controls shall be established to ensure the validity of information in this document at all times.

Each vehicle history book shall be presented to the Customer prior to the car being released from the Contractor's facility.

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22.7 Training

The Contractor shall organize and present formal instruction programs for personnel who will operate, maintain, repair and troubleshoot the rail cars. In addition, the Contractor shall provide instruction and training materials for personnel who shall train others in the future.

The Contractor shall submit to the Customer for approval a minimum of 60 days prior to completion of the first of the pilot cars a detailed outline of the training program, and a schedule for its presentation. This submittal shall include the hours of classroom and "hands-on" training projected per subset, final course content, the qualifications of the instructors, a listing of training aids to be used and a description of the scope of instruction, on an individual subset level, to fulfill the program requirements.

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The Contractor may assume that maintenance personnel have the basic skills pertinent to their crafts. The manuals shall be used as the major element of the training program.

The Customer shall advise the Contractor as to how many individuals of each discipline are to be trained at each location.

The Contractor shall provide a program to train and educate personnel in all details of the equipment as required to enable the Customer to satisfactorily operate, service, and maintain the vehicles. The program shall include up to 300 Contractor hours of classroom training at each designated site, up to four sites; 160 of which shall be for operations and the remainder for maintenance. A primary objective of the program shall be to develop within the Customer the capability to perform similar training under its own training program subsequent to the Contractor's involvement. The training shall be designed to be delivered by an instructor in the classroom and, when appropriate, in the field or shop when actual equipment is used. The Customer shall have the right to videotape any classroom training sessions. The Customer will retain ownership of the videotapes, following a final editing as mutually agreed with the Contractor and will have the right to use videotapes for future training sessions.

The Contractor's program shall include formal and informal instruction, mockups, models, manuals, diagrams and component catalogs. All materials used in the programs, such as models, manuals, mock-ups, video cassettes and drawings, shall be of durable construction and shall become the property of the Customer. Training materials shall be updated as required during the course of instruction. The Contractor shall assume no knowledge of the features of the supplied equipment on the part of the Customer personnel. However, the Contractor may assume that maintenance personnel have the basic skills pertinent to their crafts.

The training programs shall take place at up to four maintenance locations as designated by the Customer. Field instruction may be provided in locations approved by the Customer using

actual cars or mockups to provide hands-on instruction in the maintenance and operation of the rail cars.

Before delivery of the first pilot car of each type, the Contractor shall provide the Customer with a proposed training plan incorporating the following elements:

- Description of the training program, including program goals and objectives, sequence of activities, course outlines, evaluation methods, required resources and time required for each part of the program.
- Schedule of instruction, based on 300 hours of instruction at each location.
- State of the Contractor's experience in organizing and delivering similar training programs and qualifications of the designated instructors.
- List of training materials to be provided by the Contractor to support the training program.
- Instruction guides for each course to be taught within each program.
- Student workbooks for each course, each workbook including a syllabus, objectives, schedule, outlines, figures, lesson summaries and any other appropriate instructional information.

All informative material, audio and video training aids and notes shall be supplied beyond that given in the instruction manuals to clearly explain all systems and subsystems that the work force will maintain. All instructional materials will become property of the Customer. **CDRL**

22.7.1 User Training

The Contractor shall provide a user training program, designed for Customer operating, maintenance and training personnel. This is to acquaint them with the equipment in order to provide sufficient working knowledge to safely operate, inspect, service and maintain it. The training program shall include formal classroom instruction, as well as practical demonstrations and activities on the actual new vehicles. The Contractor and/or suppliers shall provide appropriate training aid in the classes as required.

Class audience will be:

- Operating personnel
- Maintenance personnel
- Food service personnel
- Supervisors and management
- Training department personnel
- Customer representatives
- Others as required

22.7.2 Training Requirements

The courses listed below shall be accompanied with training manuals, guides, training aids, student and instructor workbooks, and operator and maintenance manuals. It is the desire of the Customer that the content and structure of the manuals be used as direct input into the training course materials where applicable.

22.7.2.1 System Operation Instruction Training Course (Course #1):**22.7.2.2 This course shall include:**

- General vehicle familiarization;
- Location, function, and operation of pertinent controls, gauges, indicators, and switches;
- Subsystem inspection, setup, and shutdown procedures;
- Trouble symptoms diagnostic and troubleshooting procedures for isolating and correcting minor faults including, at a minimum, techniques for the following:
 - Release of brakes;
 - Door isolation and cut-out;
 - Breaker and/or fuse reset or replacement;
 - Head End Power (HEP) failure recovery;
 - Any other techniques that would assist operators in quickly bypassing non-critical safety subsystems, allowing trains to safely depart the main line to a convenient service location.
- Towing
- Emergency Procedures including, at a minimum, techniques to respond to fire on board or emergency evacuation.

This class shall be conducted four times (twice for operations personnel, twice for maintenance personnel). The first class shall be conducted at the time of the arrival of the first pilot car. Subsequent classes shall be scheduled as approved by the Customer. This class shall include at least 40 hours of training.

22.7.2.3 Repair and Maintenance Training Course (Course #2).

Course #2 shall include and expand on the information furnished in course #1, and shall include basic schematic and block diagrams to provide fault diagnosis information and training appropriate for in-service maintenance.

Course #2 shall provide the training needed for the following:

- Troubleshooting in-service failures as described in course #1
- Performing running maintenance including:
 - General servicing
 - Lubricating
 - Inspecting
 - Adjusting

The training shall include maintenance instructions on the use of the integrated wiring diagrams.

Participation shall include up to 20 electricians, mechanics and foremen. This class shall be conducted twice. The first class shall occur immediately following course #1 and be attended

by maintenance personnel. The second class shall be scheduled as approved by the Customer. This class shall include a minimum of 80 hours.

22.7.2.4 Workshop Training (Course #3)

The workshop training course shall provide the training for in-shop repair and trouble diagnosis of each LLRU to the level of the lowest replaceable component. The training shall contain detailed explanation of flow charts, schematic drawing and detailed analyses related to each LLRU so that the Customer maintenance personnel will be able to effectively service, inspect, maintain, adjust, troubleshoot, repair, replace and overhauled the LLRU. The flow charts, schematic drawings and detailed analyses shall be included in the training manuals.

The training shall include maintenance instructions on the use of the integrated wiring diagrams and shall include reference to the manuals.

The major sections of the workshop training course will address, at a minimum the following subsystems and products, as defined above:

- Friction brakes
- HVAC
- Carbody
- Auxiliary electrical/Electrical/Power distribution
- Trucks
- Door controls and operators
- Coupler and draft gear
- Communications
- Waste and water
- Cab controls
- Microprocessor-based products

This course shall also provide Customer maintenance and stores personnel instruction on the use of the illustrated parts manual.

Participation shall include, up to 25 electricians, foremen, and purchasing/storekeepers. This class will be conducted twice. It shall follow the first course #2; others shall be conducted at dates to be scheduled as approved by the Customer. Each class shall include a minimum of 120 hours.

22.7.2.5 Diagnostic Test Equipment (DTE) and Special Tools Course (Course #4)

This course shall provide instruction on the proper use of DTE and special tools during application, operation, usage, adjustment, inspection, maintenance, troubleshooting, repair and storage instructions.

It shall be conducted twice. It shall be conducted upon the delivery of the test equipment and special tools and as agreed upon by the Customer. It shall be a minimum of 20 hours.

Subjects addressed shall include:

- Introduction
- General description of the equipment
- Description of controls and indicators
- Operation of equipment
- Operation of safety and emergency equipment
- Troubleshooting
- Introduction and use of operator and maintenance manuals
- Review

22.7.3 Training Materials

Draft copies of the training materials shall be provided for Customer review and approval, with sufficient time to allow review and Contractor revision. Open discussion is encouraged early in the development process between the Suppliers, Contractor and the Customer.

The Contractor shall provide materials to support each course in the training program, including; instructor guides, training aids, student workbooks, and operator and maintenance manuals. Instructor guides and student workbooks shall be submitted for Customer's approval 60 days in advance of the start of the first class for each category of training. All training materials shall become the property of the Customer. The instructor guides and student workbooks shall be submitted as camera-ready copy in a form that allows easy reproduction; such as, loose-leaf bound, black ink on 8.5 in. by 11 in. white paper, printed on both sides and numbered sequentially within units of training. Any viewgraphs used in training will be supplied along with camera-ready, paper copy. Master copies of slides and other audiovisual materials shall also be provided to allow for reproduction as necessary.

22.7.3.1 Instructor Guides

The Contractor shall provide an instructor guide for each training course. The guides shall include course agendas; course objectives; procedures for managing training sessions; resources and facilities required; guidelines for preparing for training; detailed lesson plans, including scripted or outlined presentations and discussion guides; training aids and job aids; pre-tests and post-tests; criteria and methodology for measuring performance in the classroom and in the shop/field; instructions for using any audiovisual support, mockups, and scale models; and detailed instructions for managing any on-the job training.

22.7.3.2 Training Aids

The Contractor shall provide training aids, such as mock-ups, scale models, overhead transparencies, videotaped demonstrations, diagnostic testing equipment and any special tools required. These training aids shall become the property of the Customer upon the completion of the training program.

22.7.3.3 Student Workbooks

The Contractor shall provide, for each course, a student workbook, which shall include course agenda, course objectives, schedule of sessions, paper copies of overhead transparencies, lecture outlines, lesson summaries and any other information that will facilitate the learning process.

The training program shall be conducted prior to the start of the new equipment in revenue service. The Contractor shall develop a training action plan and schedule and submit it to the Customer within 90 days of Notice to Proceed (NTP), and shall update it periodically, to be submitted with program meeting minutes. **CDRL**

Paper and electronic (editable and PDF) copies of all training materials shall be provided at the completion of the training program, and shall become the property of the Customer for unrestricted use for future training purposes.

* End of Chapter 22 *

Standardized Technical Specification

PRIIA 305 Next-Generation Equipment Committee Bi-Level Passenger Rail Cars

Chapter 23 **Customer Variables**

Table of Contents

23.0	Customer Variables	23-2
23.1	Overview	23-2
23.2	Supplemental Regulations, Standards, Specifications and Drawings	23-2
23.2.1	Specifications	23-2
23.3	Exterior Graphics	23-2
23.3.1	Paint and Styling	23-2
23.3.2	Car Numbers, Reporting Marks and Names	23-2
23.3.3	Decals and Exterior Arrangement	23-3
23.4	Seats and Interior Arrangement	23-3
23.4.1	Seat Specification	23-3
23.4.2	Seat pitch and interior configuration	23-3
23.5	Interior Décor – Additional Customer Requirements	23-3
23.5.1	Carpet	23-3
23.5.2	Curtains	23-3
23.5.3	Seat Fabric	23-3

23.0 Customer Variables

23.1 Overview

In order to accommodate the specific requirements of different customers that acquire cars using this specification, the features, components, systems and testing requirements described in this chapter shall be designated by each Customer for application to the vehicles being designed and built under this Specification, and may vary from one contract to another. These features, systems, components and requirements shall conform to all applicable specifications and references as contained in other chapters. All components, systems and requirements not specifically identified within this chapter shall be in conformance with the applicable requirements found elsewhere in this Specification.

23.2 Supplemental Regulations, Standards, Specifications and Drawings

The following documents and regulations pertain to this chapter and supplement the applicable regulations, standards, specifications and drawings identified in Chapter 2. This list is not all-inclusive and does not relieve the Contractor of its responsibility to conform to all requirements and standards that are applicable to the design and manufacture of the systems and components described below.

23.2.1 Specifications

[THIS SPACED RESERVED FOR SUPPLEMENTAL SPECIFICATION DOCUMENTS THAT MAY BE USED BY THE CUSTOMER FOR SPECIFIC VARIABLES.]

23.3 Exterior Graphics

The Customer shall supply all required details regarding the exterior graphics, styling, paint and decals. The Contractor may request minor modifications to the size, location and placement of decals, striping and paint application in order to accommodate carshell features, equipment, maintenance points or other obstructions that will affect the quality, appearance or longevity of the decals or graphics.

All decals, graphics and signage shall be specified and designed to function in the operational, environmental and climatic conditions specified in Amtrak Specification 963 with no fading, material degradation, delamination, discoloration, shrinkage or expansion, wrinkling or peeling.

All paint shall include, at a minimum, a primer coat, color coat and clear coat, applied in accordance with manufacturer specifications.

23.3.1 Paint and Styling

The exterior of the cars shall be painted and styled in accordance with **[CUSTOMER SPECIFICATION]**. The Customer shall provide paint chips to be USED for precise color matching for all paint application.

23.3.2 Car Numbers, Reporting Marks and Names

The Customer shall provide the reporting marks, road numbers and other car-specific identifiers to the Contractor no more than 45 days after Notice to Proceed (NTP).

23.3.3 Decals and Exterior Arrangement

Customer-specific decals and graphics shall be installed in accordance with the Customer's standards for service name, logo and identity.

All decals shall be retro-reflective unless specified otherwise.

Signage used to identify specific components, service-related items or maintenance points on the vehicles shall be designed and installed in accordance with Amtrak's signage manual.

Emergency-related decals and signage shall conform to all applicable APTA standards and FRA requirements.

23.4 Seats and Interior Arrangement

23.4.1 Seat Specification

Passenger seats shall be supplied that conform to the requirements of **[CUSTOMER SPECIFICATION]**.

23.4.2 Seat pitch and interior configuration

Seats shall be installed using a nominal seat pitch as specified by the Customer. Seats, workstation tables and intermediate windscreens shall be installed in the arrangement and orientation as shown on Figures 9-1, 9-2 and 9-3. Seats shall be located to match window pillars so that all seats are located at a window and do not have an obstructed view. No seat shall be located adjacent to a blank wall. Overhead reading light units shall be located over each seat.

23.5 Interior Décor – Additional Customer Requirements

The Contractor shall develop color palettes and storyboards as required by Chapter 9 to provide an interior décor that will be complementary to the interior décor of the fleet of cars owned by the **[CUSTOMER]**. The Contractor may propose alternate fabrics to those listed below, provided that the interior décor of the new cars presents a comprehensive package of interior components that complements the décor of both new and existing cars.

The major components of the interior décor of the existing Customer fleet are as follows:

23.5.1 Carpet

Refer to **[CUSTOMER CARPET SPECIFICATION]**.

23.5.2 Curtains

Refer to **[CUSTOMER CURTAIN SPECIFICATION]**.

23.5.3 Seat Fabric

Refer to **[CUSTOMER SEAT FABRIC SPECIFICATION]**.

* End of Chapter 23 *