(f) Freezer Locking

(i) The freezer shall include padlock hasps as determined with Amtrak during design reviews.

(ii) The locking mechanism shall use an Amtrak supplied padlock to secure the selected cabinets.

viii). Countertop Heights

(1) Countertop at point of sale shall be 42" maximum.

(2) Countertop at ADA height shall be 36" maximum.

ix). Color Material and Finish (CMF)

(1) Please refer to the attached CMF document for exact color, material, and finishes desired in this food service area.

(2) Please also refer to Materials and Workmanship in Chapter 19.

(3) General expectations are listed below.

(4) CMF will be finalized with Amtrak after the mockup review.

(5) Stainless Steel Modules

(a) Stainless Steel Modules shall be created from sheet metal that is sized to prevent denting, oil canning, or otherwise non-sturdy structures.

(b) The modules shall be constructed from 304 stainless-steel with a #4 finish (320 grit) or as approved during design reviews with Amtrak.

(6) Carshell Walls

(a) Carshell walls shall be lined to create interior walls for the café. Sidewall liners shall be made from molded thermoplastic with an easy to clean surface finish.

(7) Partition Walls

(a) Partition Walls shall be created from a composite structure such as aluminum honeycomb or HPL skinned honeycomb panels.

(b) The finish of the wall and material of the outside skin shall be inspired by the CMF document and meet all structural requirements for crashworthiness based on mounting and attached loads to the panel.

(8) Ceiling Panels

(a) Ceiling Panels shall be created from a composite structure such as aluminum honeycomb or HPL skinned honeycomb panels.

(b) The finish of the passenger facing side of the ceiling panel and material of the outside skin shall be inspired by the CMF document and meet all structural requirements for crashworthiness based on mounting and attached loads to the panel.

(c) The finish of the material on the non-passenger facing side shall be coated such that there is no risk of corrosion from moisture from steam or humidity within the car.

(9) Café Area Countertops

(a) Countertops within the cafe area shall all be made from solid surface material at the service counter and from stainless-steel at the LSA workstation area.

(10) Café Area Flooring

(a) Flooring within the café area shall be made from rubber flooring with a friction, no-slip texture.

16.8 Reference Information

a). Planned Dishware

i). Please refer to the attachment regarding dishware China storage needs

ii). The following dimensions shall be used for estimating storage provisions:

(1) 10.25” diameter dinner plates and entrée bowls

(2) 7.5” diameter bread and butter plates

(3) 16 oz bowl with 7.25” diameter

(4) 10 oz bowl with 6.25” diameter

b). Passenger Flow

i). The Contractor shall diagram expected passenger flow through/past food service areas for Amtrak agreement and approval.

(1) This shall be presented by the Contractor at the IDR phase. **[CDRL 16-06]**

c). Hotel Pan Sizing Information

i). Hotel pans shall be used and placed in many appliances including the warming drawers, steam/induction table, convection ovens, and refrigerated cabinets. Reference information on the sizing of the hotel pan is included below.

(1) Size of hotel pan: 21” L x 12 ¾” W

(a) (this includes the outer flange that holds the pan in the well)

(2) Size of half hotel pan: 10 3/8” L x 12 ¾” W

(a) (this includes the outer flange)

16.9 CDRLs

CDRL	**Description**	**Due**
CDRL 16-01	FDA Approvals	Prior to revenue service
CDRL 16-02	Food Service Layouts	During PDR, IDR, FDR
CDRL 16-03	Type Tests for Refrigeration and Freezer systems	During FDR
CDRL 16-04	Type Tests for all Warming Equipment	During FDR
CDRL 16-05	Ventilation Plan	During IDR
CDRL 16-06	Passenger Flow	During IDR

* End of Chapter 16*

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

17. Water and Waste System

Revision 1

Table of Contents

17.1 Overview

a). General

i). Each car shall have a water supply system and toilet rooms consistent with the arrangements and requirements in Chapters 1 and 11.

(1) For rooms and cars having an Accessible Toilet Room (ATR), the layout shall meet the requirements of 49 CFR Parts 27, 37, and 38 or latest regulation, and U.S. Department of Transportation Section 504 covering the barrier free transportation of the elderly and handicapped.

(2) The Food service car shall have systems of larger water capacity for food preparation needs, as detailed in Chapter 16.

ii). All water, waste and sanitation systems on all cars within the trainset shall comply with:

(1) All applicable Federal regulations, including:

(a) the most recent edition of the US Food and Drug Administration (FDA) Food Code,

(b) the requirements of the US Public Health Service (USPHS), and

(c) the applicable Code of Federal Regulations for the FDA and the Environmental Protection Agency (EPA) concerning general sanitation, water, toilets and interstate conveyance sanitation, including 21 CFR Part 1250.

(2) The latest edition of the Amtrak Food Service Sanitation regulations and the Amtrak Public Health Standards.

iii). The Contractor shall work with Amtrak to arrange for an FDA inspection of the design and completed installation of the water and waste system of the trainset to ensure that it meets all requirements, in accordance with 21 CFR Part 1250.41.

(1) Documentation of compliance shall be submitted to Amtrak. **[CDRL 17-01]**

iv). All materials and workmanship shall comply with Chapter 19 requirements.

v). The water and waste system shall be able to operate without damage or failure under all specified environmental temperatures and elevations per Amtrak Specification 963.

(1) All components selected by the Contractor shall be designed to withstand the railroad environment from a durability and debris damage perspective especially with respect to freeze protection.

(2) All freeze protection components shall have a complete and automatic draining function for all fresh water from the system whenever water

temperature approaches freezing with a minimum of specialized hardware being required.

(3) Means for alerting train crew in advance of automatic draining shall be provided to avoid nuisance activation of this feature.

(4) Any undercar water and waste piping and systems shall be housed within undercar protective enclosures and shall not be exposed.

vi). It is required that the water supply piping systems be designed to provide gravity drainage with a minimum of automatic freeze protection valves, manual drain valves and vacuum breakers being required for complete drainage in freezing conditions when power is not available.

vii). Ease of servicing and maintenance, rapid repair, reliability, resistance to winter freezing conditions, and safety shall be major design considerations.

(1) Where servicing of consumable items is required, such as filters, accessibility shall be gained from the interior of the car.

(2) The design of the water system on all car types shall incorporate means to easily sanitize and flush the entire water system, as periodically required by the FDA.

(3) All potable water lines shall be isolated from flush water lines through appropriate valves or by alternate means.

viii). Each water consuming device on the car, such as each sink, drinking water dispenser, shower, toilet, coffee maker, etc., shall have an individual stainless steel quarter-turn supply line shutoff valve located adjacent to the device that can be accessed by the train crew without the use of tools, to deal with in-service failures during train operation.

(1) This device shall not be accessible to passengers.

(2) Servicing and shutoff valves shall be stainless steel quarter-turn ball valves unless otherwise specified.

(3) Each shutoff valve, drain valve, reset switch or other control device for the water and waste systems shall have an exterior locker identification label and shall have identification and operating instructions on the valve or device itself.

ix). Complete details of the water and waste systems on all car types, including Food service car appliances and restrooms, shall be presented to Amtrak for approval during design review.

(1) This shall include maintainability analysis and access provisions, and winterization details.

b). Capacity

i). In all but the Food service cars, the water supply system shall have sufficient capacity to serve a fully seated passenger load for the trainset configurations described in Chapter 1 for a 144-hour period without replenishment for all water consumption needs, including showering, hand washing, and toilet flushing operations.

(1) The car providing the greatest water capacity demand shall be used in determining water capacity. This size tank shall be applied to all passenger car types other than the Food service cars.

(2) In the Food service cars, the water supply system shall have a capacity sufficient to supply all food service functions along with normal restroom and drinking water requirements for a full passenger car load for at least 144 hours.

ii). The waste retention system capacity shall be based upon providing 0.05 gallons of volume for each car passenger seat per hour, (excluding sleeping accommodations with toilet), for 144 train operating hours, with sufficient tank capacity to permit a toilet servicing cycle of five days.

(1) The car requiring the greatest waste retention shall be used in determining waste capacity, with this same size tank applied to all passenger car types which contain toilet facilities.

17.2 Water System

a). General

i). Each car shall be provided with a water system which will supply hot and ambient temperature potable running water for various crew and passenger needs. The water shall be provided for shower, drinking, hand washing, food service car galley requirements and toilet system operation.

ii). Particular emphasis shall be placed on meeting the winterization and maintainability requirements.

iii). Refer to Chapter 16 for additional galley requirements.

iv). The water system shall include:

(1) water tanks,

(2) fill system,

(3) drain system with freeze protection valves,

(4) protective heaters,

(5) water pressurization equipment (if used),

(6) filter,

(7) water distribution piping with service valves,

(8) water heater and thermal insulation

v). The water system shall be pressurized or gravity fed.

(1) If pressurized, it shall use filtered air derived from the main reservoir system using a governor system, with adjustable water system pressure, or pressurized system by means of an electric pump.

vi). The potable water supply shall have a particulate filter and an antibacterial filter to purify the water to Public Health Service (PHS) standards.

(1) These filters shall be located between the freshwater tanks and the dispensing equipment and shall be located for easy cleaning and replacement.

(2) All filters shall be easily replaced.

vii). Means for complete freeze protection, system drainage, maintainability and periodic sanitation shall be included.

viii). The entire water system shall conform to FDA and USPHS regulations and shall use lead-free components.

ix). Plans for construction of the water system shall be submitted to the FDA for review for conformity with FDA requirements. **[CDRL 17-02]**

x). The design and materials shall be approved by Amtrak.

xi). The water system shall be designed to allow complete drainage of all equipment by gravity.

xii). Potable water piping shall be designed to allow periodic sanitization by an Amtrak approved process.

b). Storage Tanks

i). Storage tanks shall be stainless steel or other approved materials having equal durability and include internal baffle plates.

ii). The tanks shall be located in a protected equipment enclosure and fully covered with water resistant fiberglass insulation and supplied with protective heating for winter operating conditions.

iii). All storage tanks shall be constructed in accordance with the latest revision of Section VIII of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code for Unfired Pressure Vessels designed to withstand a static water pressure of 110 psig.

iv). Each storage tank shall have a manual drain valve, a manual shutoff valve, an ASME pressure relief valve and a freeze protection automatic drain valve or approved alternate design.

v). A permanent sign shall be installed on the inside face of the electric locker door identifying the total car freshwater tank capacity.

vi). A manual drain valve shall be provided to permit the water tanks to be flushed and drained.

vii). All water tanks shall be located and designed to allow full accessibility for servicing, removal and replacement. All tanks shall incorporate lifting/supporting points for handling by maintenance personnel.

viii). Water storage tanks shall be implemented with safe and reliable Ozone water treatment system to minimize the requirement for regular cleaning of water tanks.

c). Water System Fill Stations

i). General

(1) The water fill point itself shall be a barbed male nozzle, which shall be enclosed in a blue painted metal housing with a self-closing cover.

(2) The water fill point shall be compatible with existing Amtrak wayside filling equipment and shall use a minimum 0.75 in. diameter fill piping.

(3) All water fill stations shall be easily cleanable, and so located and protected as to minimize the hazard of contamination of the water supply.

(4) Complete identification signage and refill instructions shall be provided.

ii). Fill Station Locations

(1) A water fill point for the car's water system shall be provided on each side of the car at approved locations, at a sufficient distance to prevent contamination from the waste tank drain stations.

(2) The fill points shall be located and self-protected to minimize contamination hazards arising from wastewater system discharge, dust, dirt and debris.

iii). Fill Station Enclosures

(1) Each fill station shall be mounted in a recessed corrosion resistant enclosure and covered with a spring loaded, top hinged, weather-tight, corrosion resistant, gasketed cover.

(2) The cover shall be labeled and equipped with over-center springs to securely keep the cover either open or closed.

(3) The bottom surface of the shall be designed to allow complete drainage of fluid from the enclosure interior

(4) The design of the water fill point shall be adequately dimensioned for ease of use by maintenance personnel wearing heavy winter gloves. The water fill point itself shall be a male nozzle, which shall be enclosed in a blue painted metal housing with a self-closing cover.

iv). Water System Pressurization Valve

(1) If required for pressurization, adjacent to the fill point shall be a three-way water system pressurization valve in compliance with the requirements of Amtrak AAMPS catalog number 22 946 70710.

(a) This valve must have the enlarged vent port design to permit rapid venting of the water tank within seconds.

(2) The valve shall have two positions, FILL and WATER.

(a) In the FILL position, the valve shall cut off tank pressurization air, if used, rapidly vent the water tank and permit filling the tank. This will allow the tank to be filled via a check valve located immediately behind the fill nozzle.

(i) The system shall permit complete filling from one side of the car, without requiring access to the other side of the car.

(ii) A means shall be provided to indicate when the water tanks are completely filled.

(iii) Any excess water shall be directed to the bottom of the car and easily visible from the side of the car.

(b) When the valve is placed in the WATER position, the vent will be closed, and air pressure applied to the water in the tank, if used.

(c) The air valve and check valve shall be enclosed behind sheet metal, easily serviceable from the front, with only the valve operating handle exposed.

d). Hot Water

i). Each car shall be capable of producing hot water.

(1) One hot water tank shall be provided for each car with the capacity of the tanks dictated by the car with the most demand on the longest long distance route. The water heater shall operate from 480 VAC, 3-phase and shall be rated at 9kW. Hot water temperature shall be maintained at approximately 180° F in the tank.

(2) An active mixing valve shall deliver hot water at 118° F to the hot water distribution system. A temperature and pressure gauge shall be provided at the tank and a temperature gauge downstream of the mixing valve.

(3) The water heater shall include, but not be limited to the following features: electric immersion heater, a factory installed thermostatic control, and low water protection. Tank shall be well insulated thermally. The tank shall be located to permit removal of the heater elements without disturbing the tank. Elements shall be replaceable in one hour or less.

(4) Control voltage to the electric water heater system shall be 120 VAC from car power supply.

(5) Status, faults, errors, and diagnostics (overload contactor switch, heating elements, water level, etc.) for the hot water heater shall be communicated to the CDU. Details to be discussed during FDR.

ii). Hot Water Delivery

(1) The water heating system shall be capable of providing continuous water heated to 100°-105°F at every faucet and shower.

(2) The water heating system shall be capable of providing continuous water heated to 110°-119°F in the food service areas.

(3) Wherever hot water is dispensed, the system shall be designed to deliver heated water immediately.

(4) The water heating system design, potentially using a mixing valve, shall be capable of delivering water at the required temperatures while minimizing the volume of water used.

iii). Hot Water Storage Tanks

(1) All hot water storage tanks shall be stainless steel or other corrosion resistant approved material and suitably insulated.

(2) They shall be constructed in accordance with the latest revision of Section VIII of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels at a setting pressure of 75 psig.

(3) Gravity drainage provisions shall be incorporated into the design.

(4) The storage tanks shall have an easily accessible manual drain valve, a manual shutoff valve and a freeze protection automatic drain valve.

iv). Water Heater Protection

(1) Each water heater shall be equipped with an accessible thermostat, an ASME temperature and pressure sensitive relief valve piped to drain under the car and be equipped with low water protection.

(2) No damage shall result to the water heater and related devices and wiring if the water supply is cut off causing it to run dry, or if electrical power is disconnected in freezing conditions.

(3) Information labels shall be installed on all doors where reset switches are located.

v). Maintainability

(1) The water heater elements shall be easily replaceable with the tank installed in the car.

e). Drinking Water Dispenser

i). Each dispenser shall be constructed of stainless steel, have a touchless or otherwise self-closing dispenser spigot, include a drain system for any spillage, and be dimensioned to permit 1-quart containers to be refilled. It shall dispense filtered water from the supply system.

ii). Water Cooler

(1) Locations of water coolers and dispensers is detailed in Chapter 11.

(2) The water cooler shall be capable of producing at least 5 gal of 50°F chilled drinking water per hour and be capable of chilling water from 80°F to 50°F within ten minutes.

(3) The cooler shall use an environmentally acceptable refrigerant and meet USPHS regulations.

(4) It shall be unitized for quick removal and replacement, with suitable piping and electrical connectors.

(5) The water-cooling system shall allow for easy access for cleaning, sanitization and servicing.

(6) It shall be supplied from the potable water tank after the filtering system.

iii). Water dispensers and coolers shall have an easily accessible manual drain valve, a manual shutoff valve and a freeze protection automatic drain valve.

iv). Supply piping shall be arranged to facilitate gravity drainage.

v). Alternate designs can be submitted for review and approval by Amtrak.

f). Water Piping

i). All water system piping and fittings, unless otherwise approved by Amtrak, shall be seamless stainless-steel tubing, piping or other approved materials having equal durability.

ii). Layout and installation shall be accomplished with a minimal number of connections.

iii). Anti-water hammer air chambers shall be provided as required.

iv). Waterproof plastic identification labels shall be applied to all piping where connections are made to valves or devices.

v). All water supply piping and components shall be of lead-free construction and shall comply with the requirements of Chapter 19.

g). Water Backflow Checks

i). The water system shall be configured to prevent water backflow into the water raising system under all conditions, in compliance with USPHS regulations.

ii). If points of connection between potable and non-potable water exist, backflow and back siphon protection devices meeting American Society of Sanitary Engineers (ASSE) standards shall be installed to protect against mixing of potable and non-potable water.

iii). These devices shall be located to also protect against potential backflow or back siphon conditions may occur.

iv). They shall be arranged to allow easy replacement if necessary.

h). Water Raising

i). If a water raising system is required, it shall use compressed air supplied by the trainset main air reservoir pipe through an approved governor and regulator valve to pressurize the water system, per Chapter 9, or pressurized system by means of an electric pump.

ii). Particulate and desiccant type air filters with an automatic drain and an oil removal filter shall be provided to remove all contaminates and moisture from the air supply to the system.

(1) The arrangement shall easily allow replacement of the filters.

iii). All air regulation valves shall be mounted above the top of the water level in the storage tanks.

iv). An ASME pressure relief valve shall be provided.

v). The potable water supply to the sinks and drinking water dispenser shall be provided through a check valve and adjustable pressure reduction valve.

vi). The potable water supply used for toilet rinse water shall be separately taken from the water supply tanks through a check valve and adjustable pressure reduction valve.

vii). All pressure adjustment settings shall be easily accessible for inspection with pressure test ports being provided, and backflow protection shall be provided.

i). Restroom Sink Supply

i). Hot and cold water shall be piped to each sink faucet.

ii). Water supply for all faucets shall be 0.5GPM

iii). In all cases where there is a toilet, a sink is expected to be provided next to or within close proximity.

iv). The faucet shall be touchless.

v). Power for the faucet shall be hard wired. Battery replacement arrangements are prohibited.

vi). All exposed parts shall be stainless steel.

vii). All fixtures, dispensers and appliances shall be constructed in accordance with the requirements of USPHS.

viii). The faucet design shall be approved by Amtrak.

ix). Wastewater shall be drained to the gray water tank to be used for toilet flushing water supply.

x). See Chapter 11 for additional details.

j). Shower Supply

i). Hot and cold water shall be piped to each shower

ii). Water supply flow shall be 1.5GPM in all showers

iii). All fixtures, dispensers and appliances shall be constructed in accordance with the requirements of USPHS.

iv). The shower design shall be approved by Amtrak.

v). Wastewater shall be drained to the gray water tank to be used for toilet flushing water supply.

vi). See Chapter 11 for additional details.

k). Galley Supply

i). The Café, Diner and Lounge cars shall draw filtered, potable water from the car supply, and distribute it to the hand sink, utility sinks, coffee brewers, ice makers and other water consuming appliances in accordance with the requirements of Chapter 17.

ii). All water system exposed parts shall be stainless steel.

iii). All fixtures, dispensers and appliances shall be constructed in accordance with the requirements of USPHS.

iv). The galley hand wash sink shall provide 110°F-119°F water per FDA requirements.

17.3 Freeze Protection

a). During Operation

i). The freeze protection system shall consist of automatic water drain valves, insulation, protective heaters, manual drain valves, self-draining pipes and similar devices configured to provide the required protection.

ii). The system shall have sufficient capacity to permit train operation without damage or failure under all operating and environmental conditions specified by Amtrak Specification 963.

iii). There shall be sufficient excess capacity of insulation to allow for time-related deterioration over the design life of the equipment.

iv). The freeze protection system shall be designed to permit pipes and fittings to be disassembled for maintenance and repair without removing the entire protective system.

v). The freeze protection system shall be fully automatic in operation, and not require any train crew or maintenance personnel action to activate or reset.

vi). All freeze protection valves shall meet the requirements of Amtrak Specification 1004, latest revision or approved equal.

b). Out of Operation

i). The water system shall be freeze protected to enable it to be disconnected from Head End Power (HEP) indefinitely in subfreezing temperatures, with no damage resulting to any component of the water system under any condition.

ii). Complete manual means shall also be provided to permit the system to be fully drained when desired.

iii). The entire water system, including its piping and all appliances, shall be free-draining and shall avoid arrangements where water may become trapped.

iv). Automatic vacuum breaker valves shall be installed at all elevated points and other locations as necessary to permit complete venting of the system when draining.

v). The system shall be designed and geometrically arranged so as to require the absolute minimum of drain valves.

vi). All pipe insulation shall be water resistant.

vii). A permanent sign shall be installed on the inside face of the electric locker door providing instructions for the manual draining of the car's water system.

c). Drain Valves

i). The freeze protection system shall make use of an Amtrak approved automatic, self-contained drain valve which will automatically open when sensing an adjacent ambient air temperature of approximately 38°F (temperature falling) and close at 40°F (temperature rising) when there is no electrical power on the car.

ii). All drain valves shall be equipped with a quick warm-up heater to close the drain valves when HEP is available, to allow a car in freezing temperatures to be immediately watered when placed on electrical power.

d). Electrical Protective Heat Tape

i). The water storage tanks and all water supply components exposed to ambient temperatures shall be protected against freezing by electrically powered self-regulating heat tape and thermal insulation.

ii). To prevent unnecessary electrical consumption, all heat tapes shall be supplied electrical power only when the exterior ambient temperature is below 45°F.

iii). All electrical protective heat tape shall be of an automatic self-limiting 120VAC design which can be cut to length from bulk rolls for replacement.

iv). All connections shall be made using the manufacturer's watertight splicing kit, and each individual length shall be terminated with a power monitoring system.

v). Such heat tape shall be of a design that can withstand the application of live steam at 225°F without damage, as this is often the only method available in an Amtrak maintenance facility for thawing a frozen car.

e). Electrical Heat Tape Monitoring System

i). An approved system shall be provided in the electrical locker inside the car to indicate the operating status of all heat tape systems.

ii). To verify the proper operation of all antifreeze protective heat tapes for the water and waste system, the Contractor shall arrange a monitoring system and associated indicators to verify that electrical power is present at the far end of every heat tape segment when power is being supplied to the system.

iii). A logical, organized system layout shall be provided, with each indicator labeled for ease of maintenance personnel quickly identifying an individual defective heat tape.

iv). A POWER ON test pushbutton shall be located on the panel to allow electrical power to be supplied to all of the heat tapes on the car when ambient temperature is above the setting at which the system would be energized.

v). Monitoring of the current or ground fault circuit breaker status, as well as the presence of voltage at the end of each heat tape, shall be provided.

vi). Alternate methods for detecting and reporting the failure of any heat tape segment may be employed subject to Amtrak approval.

f). Maintainability

i). Maintainability aspects of the system shall be demonstrated on the interior mock-ups.

g). All details of the freeze protection system shall be submitted to Amtrak for approval during design review. **[CDRL 17-03]**

17.4 Waste Retention System

a). General

i). All waste collection fixtures and components shall be constructed in accordance with the requirements of 21 CFR Part 1250 and USPHS.

ii). The system shall have previous successful application in rail passenger service.

iii). The "gray water" drain water from all sink drains, showers, drinking water dispenser drains, food service area equipment drains, coffee brewer and server drains, and all other drains not handling human waste shall be piped to a gray water retention tank.

iv). All toilet system piping, the waste tank and all associated fittings, drain piping and serving valves, unless otherwise permitted by Amtrak, shall be manufactured from acid-resistant stainless steel suitable for sewage service.

v). All waste retention system servicing valves shall be quarter-turn stainless steel ball valves with full diameter port openings.

vi). The WCRS shall be a positive/negative pressure type system with sufficient useable capacity to collect and retain all toilet waste generated on the car during a 144-hour period in a single tank, for discharge at a wayside dumping facility. Minimum waste capacity shall be per Section 17.1.b.

vii). Electrical and plumbing connections shall be designed so that components can readily be installed, removed and exchanged.

viii). Modular construction shall be utilized in the design of all components and subassemblies.

ix). No special tools shall be required for maintenance or replacement of system components.

x). As there are frequent foreign object blockages of the toilet system encountered in toilets, sufficient easily accessible leak-tight access caps and cleanout ports shall be provided in all waste system piping to permit rapid and easy removal of clogs by maintenance staff during servicing stops.

xi). The waste tank, all waste piping, and waste system components shall be designed to prevent accumulation of mineral deposits and scale and provide a procedure for their removal.

xii). The waste system shall be designed to operate over all operating and environmental conditions specified by Amtrak Specification 963 and avoid damage from freezing.

xiii). Plans for the toilet and waste retention system shall be submitted to the FDA for review for conformity with FDA requirements. **[CDRL 17-04]**

(1) Complete details on the system design shall be presented to Amtrak for approval during design review.

b). System Requirements

i). The system shall be designed for failsafe operation and protection of passengers, crew, service personnel and equipment.

ii). Ease of servicing and maintenance, reliability and safety shall be major design considerations.

iii). Flush water shall be provided for toilet flushing through an independent line.

iv). Gray water may be considered for use as flush water.

v). Compressed air shall be supplied by the main reservoir trainline pipe.

(1) This system shall be kept separate from any compressed air supply system which may be required for the water supply system.

(2) Air lines and valves shall be sized for air pressures up to 150 psig.

(3) Any use of pressurized air for the WCRS or a water raising system shall not impact the functionality of the air brake system under any scenario.

vi). Designs shall incorporate features to limit the amount of air consumed during flush cycles or leaks or failures within the system.

vii). The toilet system shall automatically recover from loss of power (including interruptions of HEP and/or compressed air) without nuisance alarms.

c). Toilet Operation

i). A toilet flush cycle shall be initiated by the passenger by operating a touchless, ADA-compliant flush actuator, which shall be mounted on the wall, unobstructed by a raised toilet lid, and easily apparent to the passenger.

ii). Signal indicator lights may be provided for passenger information on system status and any delay in mechanical flushing action shall be supplemented with visual feedback of a flush request.

iii). Rinse water shall be sprayed into the toilet bowl during the flush cycle to adequately clean the bowl without allowing water to exit the bowl.

iv). The toilet waste shall be drawn by vacuum and / pressure from the toilet to the waste tank, for later discharge at a collection facility.

v). Filtering shall be provided to protect the pressure generating device from blockage due to waste debris, waste fluid or water.

vi). It is desired that the water consumption during the flush cycle be minimized.

vii). The toilet shall not flush if the waste tank is full, or if system logic determines that a complete flush cycle is not possible and shall protect against excessive air consumption created by unnecessary multiple flush requests or multiple flushes on cars with multiple toilet rooms.

viii). The flush control unit shall be approved by Amtrak during design review. **[CDRL 17-05]**

d). Toilet

i). All toilets shall be ADA-compliant.

ii). The toilet shall be designed as a service-proven, self-contained unit, interchangeable between all car types.

iii). The shroud shall be coordinated with the toilet module design.

iv). The toilet shall be securely mounted to the restroom, using stainless steel or approved corrosion resistant mounting fasteners.

v). The toilet bowl shall be easy to maintain and clean.

vi). It shall be designed to prevent waste matter and mineral deposits from adhering and shall not rust or corrode.

vii). Bowl surfaces shall curve in a continuous fashion and shall be free of recesses and inaccessible areas.

viii). The sides of the bowl shall be steep and sloped toward the discharge to allow waste to accumulate for evacuation.

ix). To prevent downstream blockage of waste system piping, the bowl outlet shall be a smaller diameter than the piping to serve as the most restrictive point in the piping system.

x). Overflow protection shall be provided to prevent the bowl from flooding should the outlet be plugged.

xi). Rinse water shall be injected into the bowl with sufficient force and distribution to push all waste matter toward the bowl outlet and completely clean the bowl unless otherwise approved by Amtrak.

xii). The bowl shall be easily and completely cleaned with ordinary cleansing agents and tools.

xiii). The flush-drain valve shall be a self-contained unit which provides a zero-leakage seal at the bowl outlet after operation.

xiv). The toilet system shall be designed to retain a hermetic seal over the opening of the waste pipe when closed to prevent odors from entering the restroom.

xv). The valve design shall be self-cleaning and prevent waste material from being trapped in it.

xvi). The design shall be robust and survive severe abuse including closing on solid objects without damage.

xvii). Cutout valves shall be easily accessible, without tools, for operation en route from inside the car.

xviii). The toilet assembly and its components shall be mounted so as to be accessible and removable for service and maintenance.

xix). Special attention shall be given for ease of clearing foreign object clogs from the piping system, and additional piping cleanout ports with suitable maintenance access should be provided in the toilet to waste tank piping to facilitate rapid cleanout.

e). Waste Tank Assembly

i). The waste tank assembly shall be designed as a self-contained unit. Waste tanks shall be located and designed to allow full accessibility for servicing, removal and replacement. Waste tanks shall incorporate lifting/supporting points for handling by maintenance personnel.

ii). The waste tank assembly shall be constructed to withstand debris damage (if undercar).

iii). The waste tank shall be constructed of acid resistant stainless steel.

iv). The tank design shall prevent sloshing during normal train operations but shall not impede normal tank drainage nor flushing operations and shall not retain excessive sludge deposits during operation.

v). The tank design shall allow all internal portions of the tank to be cleaned by maintenance personnel.

vi). Suitable interlocks shall be applied to prevent system operation when draining the waste tank. Waste tank drainage shall be readily possible from either side of the car, through a 4 in. diameter Amtrak standard Andrews 400A style quick-disconnect adapter. The 4" waste drain handle shall be ergonomic requiring less than 50 LBF to operate.

vii). The hose connection and any necessary valve handle to operate shall be easily accessible without the need to open any covers but shielded from debris damage.

viii). A hose connection to the adapter shall interface with the wayside servicing facility.

ix). Only one person shall be required to drain and service the waste tank from a single point outside of the car without needing to crawl under the equipment.

x). The drain connection arrangement shall minimize the amount of possible waste spillage when the drain hose is disconnected.

xi). All waste tank assembly exposed surfaces which are liable to waste spillage during servicing shall be sealed as water resistant and as nonporous as practical and shall be easily sanitized by Amtrak maintenance forces without damage.

f). Vent

i). The exhaust from any waste tank system device shall be routed to the top of the car or underside of the car, and designed to prevent passengers, both inside and outside the car, from being exposed to objectionable odors from waste gases, or from odors being ingested by the car fresh air intakes.

ii). The Contractor shall investigate use of easily replaceable filters or other such methods.

g). Waste System Piping

i). All waste system piping shall be seamless acid resistant stainless steel or approved alternative materials suitable for sewage service.

ii). All piping shall be installed with generous radius sweep bends and elbows to avoid blockages.

iii). Cleanout access ports shall be provided throughout the waste piping.

iv). The system shall be designed to facilitate the clearing of any line blockage.

v). All piping and tubing shall have a smooth interior finish.

vi). Any pneumatic system piping used shall comply with Chapter 19.

vii). All drain piping not connected to the WCRS shall be seamless stainless steel.

(1) This shall include the piping from all restroom sink drains, drinking water dispenser drains, food service car sink drains, coffee brewer and server drains and all other drains not handling human wastes.

(2) Such drains shall be piped using a suitable penetration through the car floor to discharge under the car, well clear of the track rails and adjacent undercar apparatus.

viii). All waste system drain piping shall be installed with positive gravity drainage slope, and have generous radius sweep bends and elbows to avoid blockages.

(1) The piping shall be designed to facilitate the clearing of any line blockage between the toilet and waste tank.

(2) Ice shall not be allowed to build up at the drain point.

(3) Kazoos or approved alternate shall be placed on all through floor gray water drains to prevent insect intrusion into the car.

17.5 Status Indicators

a). The status of the water and waste system, including the volume of water in the water tank, and the volume of waste collected in the waste tank, shall be monitored continuously, and displayed on an indicator panel or screen inside the car. Water and waste tank fill levels shall be provided in no less than four even increments.

b). A separate system shall provide the diagnostic status of the antifreeze protection heat tapes on the car when HEP is present.

c). The design of all status indicators shall be approved by Amtrak. **[CDRL 17-06]**

d). Water and waste tank fill levels shall also be displayed on the car exterior in close proximity to the water fill stations.

e). An OUT OF SERVICE indicator shall be located on the outside of each restroom, which shall indicate if the control system has determined the toilet to be out of service due to a full waste tank or other malfunction, or if the train crew has locked the restroom.

17.6 Waste System Controls

a). An Amtrak approved control system shall be supplied to provide proper control and maintenance diagnostics for the WCRS.

b). Design and materials shall comply with all applicable requirements of this specification.

c). The system shall be designed for the railroad passenger car environment and shall not be affected nor need to recycle itself due to interruptions of the HEP, trainline air pressure, en-route waste tank system servicing or other normal aspects of intercity train operation per this Specification.

d). All controls, switches and sensors shall be unaffected by the environment, and be maintenance free for a six-year period. All diagnostic information for the waste system shall be available to the car diagnostic system and shall be available remotely.

e). The Contractor during design review shall present for Amtrak approval a matrix of all normal, abnormal and fault conditions, and the water and waste system response to each condition. **[CDRL 17-07]**

f). All logic parameters shall be designed for ease of future adjustments and reprogramming by Amtrak, with complete software provided to Amtrak to make such adjustments.

g). All limit switches shall be environmentally sealed, nonadjustable, keyed to ensure proper installation and permanent setting, provided with one wiring configuration, color coded and labeled.

17.7 Emergency Operation

a). As an option, the toilet system shall be designed for emergency service during extended loss of HEP and main reservoir trainline.

b). The toilet system must provide equivalent usage rate as specified in Section 17.1 for a minimum of 8 hrs.

c). At the start of the 8-hour emergency condition the train will be fully considered fully operational with all fluids on board, car batteries charged to 100% and main reservoir trainline pressure at 140 psi.

d). Lighting requirements for the toilet room space are to be controlled by the lighting supplier and emergency light requirements of Chapter 13.

e). Usage of load shedding such as disabling sub-systems, disconnecting water heaters, reduced flow or flushing speed etc., maybe proposed.

f). Local storage of power via integrated batteries is acceptable subject to Amtrak approval.

g). Batteries must meet all requirements of Chapter 15 and be replaceable.

h). Local storage of pneumatic pressure is preferred but an auxiliary compressor maybe proposed if its usage provides a better energy management and is subject to Amtrak approval.

i). Operation of emergency mode maybe key selectable such that a conductor must enable emergency mode operation, to be determined by Amtrak during the design review process.

j). Emergency toilet operation shall be provided for all ADA accessible spaces and a select number of additional units up to 100% of on-board toilets to be determined during design review process.

17.8 CDRLs

CDRL	Description	Due
CDRL 17-01	Documentation of FDA Compliance	Prior to system Qualification Testing
CDRL 17-02	FDA Approval of Water System Construction	30 days before IDR
CDRL 17-03	Details of Freeze Protection System	30 days before IDR
CDRL 17-04	FDA Approval of Toilet and Waste Retention System	30 days before IDR
CDRL 17-05	Flush Control Unit Details	30 days before IDR
CDRL 17-06	Status Indicator Designs	30 days before IDR
CDRL 17-07	Matrix of all Conditions (normal, abnormal and fault) and the Water and Waste System response.	30 days before IDR

* End of Chapter 17 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

18. Emergency Equipment

Revision 1

Table of Contents

18.1 Overview

a). Each car shall be equipped with emergency equipment per the requirements of 49 CFR Part 239.101.a.(6) as well as outlined in this chapter.

b). Emergency equipment provided shall include fire extinguishers, pry bars, sledgehammers, first aid kits, chemiluminescent snap lights and seat-back passenger safety information cards.

c). Two storage containers for an Automated External Defibrillator (AED) shall be provided in two strategic locations throughout each consist arrangement to be determined during the design review process.

18.2 General Requirements

a). Emergency equipment as provided shall meet all applicable regulations, standards and specifications.

b). Equipment provided shall be located and installed in a manner that facilitates identification and access of the emergency equipment when needed by passengers and crew members without the use of keys or tools, unless otherwise specified.

c). 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.

d). All emergency equipment shall be new and shall be qualified for use for a minimum of one year after delivery of the car.

e). Each car of the trainset shall be shipped with a full complement of emergency equipment unless otherwise specified by Amtrak.

18.3 Emergency Equipment Lockers

a). General

i). An emergency equipment locker shall be provided on each car of the trainset; in a location approved by Amtrak.

ii). The location of the locker shall be in compliance with all applicable ADA requirements.

iii). The emergency equipment locker shall be recessed into the wall and shall have a clear polycarbonate hinged front panel, equipped with sealing provisions.

iv). The polycarbonate panel shall be mounted in an equipment locker door equipped with a non-lockable paddle latch, so crewmembers can access the emergency equipment without breaking the seal.

v). There shall be a light fixture located inside the equipment locker that will always be illuminated regardless of door position.

vi). Alternate emergency equipment locker designs can be submitted for approval by Amtrak.

vii). The 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.

viii). At a minimum, the emergency equipment locker shall be designed to include emergency tools, a fire extinguisher, a first aid kit and snap lights.

ix). The equipment shall be securely attached to the interior of the locker and shall not be loose nor rattle within the locker but shall be easily removed in the event of an emergency.

x). Emergency locker shall be equipped with a car emergency light.

b). Emergency Tools

i). Each emergency equipment locker shall include the following emergency tools:

(1) A 6 lbs. sledgehammer with an 18 in. handle

(2) An 18 in. pry bar

ii). The tools shall be installed in a manner that will prevent vibration and rattling and be readily available for emergency use.

iii). The Contractor shall incorporate the same tools currently in use by Amtrak. Vendors and part numbers shall be provided during Design Review.

c). Fire Extinguisher

i). The fire extinguisher shall be securely mounted in a manner that will prevent vibration and rattling and allow its prompt removal in case of fire.

(1) The installation shall conform to the requirements of NFPA Specification No. 10.

(2) The fire extinguisher shall be clearly marked with instructions in accordance with NFPA Specification No. 10.

(3) The extinguisher shall be installed so that the pressure gauge can be easily seen for inspection without opening the locker cover.

ii). A dry-chemical, 10-pound fire extinguisher, UL rated 2A-40 type B/C shall be included in the emergency equipment locker of each car.

iii). A dry-chemical, 2.5 lbs. fire extinguisher, UL rated 1A-10 type B/C shall be included in all Food service cars. See Chapter 16.

iv). Fire extinguishers shall have all required certifications prior to shipment of the car and be within their current annual inspection date.

v). The Contractor shall incorporate the fire extinguishers currently in use by Amtrak. Vendors and part numbers shall be provided during Design Review.

d). First Aid Kit

i). A first aid kit, compliant with the requirements of 49 CFR Part 239.101a.(6).(ii), Pac-Kit model 6311AMT or approved equal, shall be included in the emergency equipment locker.

ii). First aid kits, identical to those specified above, shall be located in the emergency equipment locker, and in the galley area of the Food service cars (see Chapter 16).

iii). The Contractor shall incorporate the first aid kit currently in use by Amtrak. Vendors and part numbers shall be provided during Design Review.

e). Snap Lights

i). Each emergency equipment locker shall include one package (quantity of 10) of 6 in. yellow 12-hour chemiluminescent snap-lights, Cyalume model 9-01360 or approved equal.

ii). Snap lights shall also be provided in the Food service car.

iii). The Contractor shall incorporate the snap lights currently in use by Amtrak. Vendors and part numbers shall be provided during Design Review.

f). Trauma Kits/Stretchers

i). The Contractor shall provide two trauma kits and two stretchers in accordance with Transport Canada “Railway Passengers Car Inspection and Safety Rules” Section 21.5.

ii). A dedicated storage location for these items shall be provided.

iii). Location of the trauma kits/stretchers will be reviewed and approved during Design Review.

iv). The Contractor shall incorporate the trauma kits and stretchers currently in use by Amtrak. Vendors and part numbers shall be provided during Design Review.

18.4 Automated External Defibrillator (AED)

a). Two storage containers for an Amtrak-provided Automated External Defibrillator (AED) shall be provided in two strategic separate locations within the consist that is accessible to crewmembers, in accordance with Amtrak AED installation specification.

i). The containers 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.

ii). 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.

iii). The containers shall securely retain the AED under all trainset accelerations. Appropriate signage shall identify the locations of the AED units.

b). Details of location and installation of the defibrillator shall be submitted for Amtrak review and approval. AEDs shall be placed in an optimal locations to minimize the distance needed to travel to obtain an AED in the case of an emergency.

18.5 Seat-Back Safety Information Card

a). The Contractor shall develop the artwork for a passenger 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.

b). Only a single safety information card shall be provided, which shall adequately describe all car types in a possible consist.

c). This safety card shall be designed in the format of Amtrak's "Passenger Safety Instructions" and shall include a clear Braille overlay.

i). Artwork is to be provided for Amtrak review and approval.

d). Electronic artwork, suitable for printing, shall be provided to Amtrak prior to the delivery of the first trainset. **[CDRL 18-01]**

e). The Contractor shall be responsible for the printing and delivery of the first 10,000 copies of the seat-back safety card prior to the delivery of the first trainset.

f). Seat-back safety cards shall be shipped to a location to be determined by Amtrak.

g). Seat back safety cards are required for all potentially occupied seating locations in each car.

h). Additionally, a dedicated seat back safety card holder shall be included at each seating location.

i). In the event of interference with assemblies such as workstation tables, alternate holder locations and designs shall be the responsibility of the Contractor.

j). The holder design for all locations should be identical unless otherwise approved by Amtrak.

18.6 CDRLs

CDRL	Description	Due
CDRL 18-01	Seat-Back Safety Card Electronic Artwork	30 days prior to PDR

* End of Chapter 18 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

19. Materials and Workmanship

Revision 1

Table of Contents

19.1 Overview

a). This Chapter defines the requirements for materials and workmanship that shall apply to the design and manufacture of systems and subsystems for assembly into Amtrak's passenger vehicles.

b). This Chapter shall apply to all phases of the project.

c). It shall be the responsibility of the Contractor to inform its suppliers of the requirements of this Chapter as well as enforce them.

19.2 Sustainability

a). The Contractor shall consider environmental responsibility throughout the performance of this contract.

b). By emphasizing sustainable measures and materials, the goal is to minimize the overall environmental impact, surpassing standard alternatives and contributing to a more resilient and eco-friendly future.

c). When selecting materials, the Contractor shall evaluate and prioritize materials with lower environmental footprints, considering factors such as resource extraction, production processes, and end-of-life recyclability. The Contractor shall prioritize the use of renewable and recycled materials over non-renewable alternatives wherever feasible.

d). The Contractor shall consider throughout the design review process initiatives to optimize energy usage throughout the project's lifecycle, from construction and operation to decommissioning.

19.3 General Requirements

a). Applicability

i). This Chapter 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.

ii). All materials and methods of assembly shall be in conformance with the applicable requirements of this Chapter, and all applicable standards, specifications, and references.

(1) 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.

(2) The revision of these references that are current at time of issuance of Notice To Proceed (NTP) shall apply unless a specific revision of a given specification or standard is referenced.

b). Marking and Storage

i). 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.

ii). 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.

iii). 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.

iv). 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 Amtrak.

v). Rejected material shall be clearly marked and stored in an area specifically designated for that purpose.

vi). Carshells stored outside shall have open cavities covered to prevent water and dirt ingress. Covers should be inspected weekly to check for damage.

c). Prohibited Materials

i). The following materials shall not be used in the construction of the vehicle:

(1) Polyvinyl Chloride (PVC)

(2) Asbestos

(3) Cadmium (except for batteries) and cadmium plating

(4) Lead (excluding solder used on safety-critical electronics or in brake shoes)

(5) Urethane foam

(6) Carcinogenic materials as listed by current publication of the American Conference of Governmental Industrial Hygienists (ACGIH):

(a) Where there are materials that contain trace amounts of carcinogenic substances, they shall be clearly identified in the Safety Data Sheet

(b) Exposure to classifications A1, A2, and A3 carcinogens shall be carefully controlled to levels as low as possible below the TLV (Threshold Limit Value) set by the ACGIH

(7) Materials in the List of Highly Hazardous Chemicals, Toxics and Reactives, 29 CFR 1910.19, Appendix A

(8) Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)

(9) Materials that, in their normal installed state, emit products that are known to be toxic or irritants

(10) Magnets, unless approved by Amtrak. Magnets for transformers and proximity switches that do not exceed IEC 60601-2-23 are acceptable.

d). Material Reporting Requirements

i). 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 along with independent laboratory test results of material being tested per 49 CFR Part 238 requirements for approval at the intermediate design review. **[CDRL 19-01]**

ii). The Contractor shall keep on file Safety Data Sheets (SDSs) for all chemical materials (paints, solvents, adhesives, lubricants, etc.) used in the manufacture, maintenance, operation or repair of the vehicles, and shall provide a copy of each SDS in the appropriate maintenance manual. SDSs shall comply with 29 CFR Section 1910.1200 (g).

iii). The Contractor shall maintain records that trace all materials to their manufacturers and production specifications and methodologies.

(1) The Contractor shall propose a digital material passport for all materials to track data involved in its life cycle and can facilitate data mining in supply management during the production process.

19.4 Joining and Fastening

a). General

i). 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.

ii). The Contractor shall submit joining and fastening data, specifications and standards for all types and methods of fastening and joining used to Amtrak for review and approval at the design review. **[CDRL 19- 02]**

iii). All hinges shall be stainless and piano hinge style.

(1) The use of any other hinge must be submitted to Amtrak for review and approval on a case-by-case basis.

iv). The Contractor shall submit to Amtrak 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. Merely treating a surface with primer, anodization, or coating may not be acceptable if it is likely to be compromised during maintenance and handling over the life cycle of the equipment. These methods shall be subject to review and approval by Amtrak. **[CDRL 19-03]**

b). Joint Fitting

i). Joints shall be properly fitted, whether exposed or concealed. When not otherwise specified in drawings or specifications, materials between 0 and 0.5 inches of thickness shall have gaps between joints held to a dimension not greater than 10% of the thinner material being joined, or 0.002 in., whichever is greater. Materials with thickness greater than 0.5 inches shall be held to a maximum gap of 0.06 inches. Gaps shall be uniform in width. The edges of panels shall have a smooth, finished appearance.

ii). Where excessive gaps (greater than those permitted by approved drawings or standards) are found to exist at the faying 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 Amtrak. Shims, if used, shall be mechanically fastened to one of the base parts being joined. The use of epoxy or other plastic filler at such locations is prohibited.

iii). Cut-to-fit, match drilling, filing, and other hand-fitting practices are prohibited.

iv). Location and process for implementing seams must be submitted for approval.

v). All seaming plans must be submitted for Amtrak acceptance.

c). Metal-to-Metal Connections

i). 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-base primer that conforms to GSA Federal Standard TT-P-664D or alternate coating technology meeting or exceeding the applicable performance requirements noted in TT-P-664D. Metal primer may be omitted for like-stainless steel to like-stainless steel joints.

d). Wood-to-Metal Connections

i). Where wood and ferrous metal surfaces are placed together, except as bonded surfaces in plymetal, the exposed wood shall be coated with two coats of aluminum paint conforming to GSA Federal Standard TT-P-3E, that prevents moisture intrusion, and the metal shall be coated appropriately with an Amtrak approved primer that conforms to GSA Federal Standard TT-P-664D.

ii). Additionally, all bolts or rods passing through wood shall be coated with aluminum paint conforming to GSA Federal Standard TT-P-38E.

e). Wood-to-Wood Connections

i). Where wood and wood are placed together, both abutting surfaces shall be coated with two coats of aluminum paint conforming to GSA Federal Standard TT-P-38E that prevents moisture intrusion.

19.5 Fasteners

a). General

i). 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.

ii). Fasteners used throughout the vehicle shall be metric 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.

iii). 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 Amtrak. A fastener is safety related if a single fastener failure will create an unsafe condition.

iv). The following are prohibited:

(1) Self-tapping and self-drilling screws, Velcro/dual lock and, double sided tape shall not be used without approval by Amtrak.

(2) Protruding screws, mounting bolts, or similar items on the vehicle interior or exterior, except for those appointments that cannot be built into the structure in any other manner.

(3) Tapped holes in structure, brackets, and other vehicle assemblies. Tapping plates shall be used when installing fasteners into vehicle structure or subassemblies.

(4) Fasteners installed into blind holes, unless specifically approved by Amtrak.

(5) Use of elastic stop nuts for electrical connections.

b). Threaded Fasteners

i). If approved by Amtrak, all inch-standard threaded fasteners shall dimensionally conform to ANSI Standard B1.1 or Industrial Fasteners Institute Fastener Standards. All approved inch-standard threaded fasteners shall conform to SAE J429 and J995, or ASTM F593 and ASTM F594 for both material and strength.

ii). Prevailing-torque type locknuts shall be nylon insert type, ESNA or approved equivalent, conforming to IFI Fastener Standards or NASM21044. Distorted thread locknuts shall only be used where the locknut may be exposed to temperatures above 200°F.

iii). 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.

iv). 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.

v). 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 Amtrak approval.

vi). 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.

c). Metric Fasteners

i). Metric fasteners shall be utilized on all components and assemblies in all cars. All components, control groups, or individual units that are supplied by a supplier or sub-supplier to the Contractor, shall be supplied with metric fasteners conforming dimensionally to ANSI B1.13M (ISO-metric) Standards. Metric fastener material and strength shall conform to ISO 898-1 and 898-2 or ISO 3506-1 and 3506-2. 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. Replacement, repair or maintenance parts supplied under this Specification shall contain all necessary replacement fasteners of the correct size and grade.

ii). Metric fasteners shall be marked as required in *Metric Fastener Standards*, Industrial Fasteners Institute, latest edition.

d). Structural Fasteners

i). All structural fasteners shall have documentation identifying manufacturer and purchase specifications available for examination by Amtrak 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.

ii). 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 (A2LA), 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 Amtrak. Tests conducted shall confirm that fastener material meets specified chemistry, strength and manufacturing method 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.

iii). All structural or safety-related fasteners that have been subjected to processes introducing the risk of hydrogen-embrittlement must have certification of hydrogen-embrittlement testing. The certification must be based on a representative sample of actual production fasteners that have been tested for hydrogen embrittlement following SAE USCAR 7 procedures. The plating process must be certified to ASTM F519 procedures. An ASTM F606/F606M wedge test sample may be used in place of the ASTM F519 standard samples. Test loads must be a minimum of either proof load or 80% of ultimate tensile strength and held for a minimum of 168 hours. If any failures occur the entire lot shall be rejected.

iv). All structural bolts, nuts and washers 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 plus an appropriate safety factor. Undercar mounted equipment shall be supported by brackets or other structures whenever possible. Bolts or screws used for structural connections shall have full size bodies in areas subject to bearing and/or shear loads.

v). Drawings containing all dimensions, standards, plating and any other requirements for the fastener shall be provided for all structural or safety-related fasteners. For fasteners of similar design with the same properties a schedule drawing showing each part number and its specific requirements maybe provided. Drawings for structural or safety-related fasteners shall be provided prior to delivery of the first cars to Amtrak.

e). Decorative and Appearance Fasteners

i). All interior fasteners exposed to view shall be limited whenever possible and be either bright or finished to match the surfaces being joined and installed such that the fastener head is flush with the mating surface. The fastener head shall be tamper-proof. Bright finished fasteners used for stanchions shall be austenitic stainless steel. Bright finished interior fasteners may be either austenitic or plated martensitic stainless steel. Type A sheet metal screws shall not be used. Amtrak reserves the right to approve all exposed fasteners in the customers view.

ii). All exterior fasteners visible to passengers shall be austenitic stainless steel for steel, High Strength, Low Alloy (HSLA) 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.

iii). 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 stainless steel draw-down latches. Quarter- turn fasteners shall have a minimum shank diameter of 0.25 in. and be of adequate strength.

iv). 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 Amtrak to review for a period of not less than the expiration of the warranty period of the last vehicle accepted.

f). Torquing

i). All safety-related fasteners, including truck and brake equipment bolts and all fasteners exposed to fatigue loads, shall be torqued to industry standard torque values for the size and grade of fastener 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.

g). Washers and Lock Washers

i). Appropriate grade flat washers, conforming to ASME B18.21.1 or ASME B18.22M, shall be used under the heads of all bolts and under all nuts where enlarged holes, slotted holes or soft mating metals are being fastened. Where high strength fasteners are applied, flat washers shall be hardened and comply with ASTM F436/F436M.

ii). Helical lock washers shall not be used. If applicable, prevailing torque nuts or standard nuts with the use of appropriate Loctite or equal thread locking compound shall be used for these applications.

iii). Other types of washers, including Belleville, NORD-Lock, or Nomel washers, may only be used for special applications with Amtrak's approval.

h). Rivets and Lock Pins

i). 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.

ii). Swage-locking (Huck bolt 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.

i). Plating of Fasteners

i). All carbon, alloy and martensitic steel fasteners shall be plated with zinc with clear or yellow chromate finish, unless specifically waived by Amtrak.

ii). Zinc plating shall conform to ASTM B633-07, Type VI, Hexavalent Chromium Free.

iii). Requests for alternative coatings must be submitted to Amtrak for review and approval.

iv). The Contractor shall submit qualification results for each process used at each subcontractor applying the proposed coating, as noted below.

v). Any request for alternative coating shall, as a minimum, include:

(1) 1) coating manufacturer's product data including required thickness,

(2) 2) ASTM B117 test results from an accredited third-party laboratory,

(3) 3) documentation of torque/tension characteristics, and

(4) 4) supporting documentation from the coating manufacturer regarding the propensity for the coating process to cause hydrogen embrittlement of the fastener during coating.

vi). Regardless of the coating's propensity for hydrogen embrittlement, each lot of high strength fasteners, including OEM zinc or yellow chromate plated bolts (Grade 5 or Metric Grade 8.8 or higher) shall be tested for hydrogen embrittlement. Each lot of lower strength fasteners shall be tested for hydrogen embrittlement if the coating has the possibility of causing hydrogen embrittlement. If the proposed coating results in a change in the K-value for the plated fastener to outside the range of 0.13-0.15, as defined by Industrial Fasteners Institute Standard IFI-543, the Contractor shall use the alternate coating on all fasteners within the particular LRU. The LRU shall contain an indelible label identifying the coating type used within the LRU and the required torque values for each size fastener used therein. Fasteners internal to a subcomponent within an LRU may use the standard coating system if they are not subject to removal during Amtrak's maintenance activities. Alternative coatings shall not be used unless specifically approved by the Project Manager.

j). Bolt Holes

i). All bolt holes shall be accurately located and aligned, and when necessary, during assembly, holes may be reamed round to a specified size in position, as approved by Amtrak. Bolt hole clearances shall not exceed the Industrial Fasteners Institute's requirements. Slotted hole size for length, width, and edge distance should follow industry standards.

19.6 Stainless Steel

a). General

i). Contractor shall provide structural stainless steel that complies with the following requirements:

(1) Austenitic stainless steel shall meet the Certification Provisions of ASTM A666.

(a) Structural applications: Contractor shall test for susceptibility to intergranular corrosion in accordance with ASTM A262:

(i) Practice A: Shall be used to accept material only.

(ii) Practice E: Required for final determination of acceptance or rejection of material that is not acceptable by Practice A.

(2) Any connected or abutting visible metal parts will be of a matching metal (aluminium or stainless steel) in single grade and should match in colour and finish, unless specifically called for to be contrasting in the specification.

(3) Sustainability

(a) As stainless steel is one of the most predominately materials over the car body the upmost efforts must be main to ensure sustainable sourcing.

(b) The stainless-steel supplier shall optimize the use of green energy and maximize the percentage of recycled material while maintaining all material composition and strength requirements.

(4) Duplex stainless steel may be used only with specific Amtrak approval:

(a) General requirements:

(i) As per ASTM A480/A480M

(ii) When CVN impact tested, based on lots, shall have minimum absorbed energy of 27 J (20 ft-lb) at -29 C (-20 F)

(b) Structural applications:

(i) Test for susceptibility to intergranular corrosion in accordance with ASTM A923:

1. Practice A: Use to accept material only.

2. Practice C: Required for final determination of acceptance or rejection of material that is not acceptable by Practice A.

(ii) Where duplex stainless steels are welded to other structural steels, paint the less-noble steel with weld-through primer.

(5) Structural components assembled by fusion or resistance welding:

(a) Specification and composition of austenitic stainless steel shall conform to:

(i) AISI type 201L, 301L, 301LN or SUS301L (with Nitrogen), 316L

(ii) ASTM A666 requirements, except that the carbon content shall not exceed 0.03% and type 301LN and SUS301L (with Nitrogen) shall not exceed 0.25% nitrogen.

(b) Austenitic Stainless steel used in structural applications covered by the Specifications shall also conform to APTA PR-CS-S-004-98.

(6) Other stainless steels conforming to ASTM A666 are acceptable for non-welded applications.

(7) Use:

(a) Contractor shall comply with uses as permitted throughout the Specifications.

(b) Austenitic and duplex stainless steels may be unpainted.

(c) Unpainted austenitic or duplex stainless steels exposed to passengers shall be a single grade in which both the color and surface finish of abutting pieces shall match, except where the design specifically calls for contrasting appearance.

b). Testing

i). 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.

c). Flatness Tolerance

i). 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.

d). Finishing Methods

i). Unless otherwise specified, all smooth surfaces exposed to passengers shall be given a medium-grit finish on the exposed side. Grain shall be in a direction to suit the decorative treatment in the interior of the car and shall be specified on the component drawings. Alternate finishes shall be submitted to Amtrak for approval.

ii). 120-180 grit finish on interior and exterior surfaces (#4 Brushed Finish), 30 Ra µin MAX.

e). Surface Treatment

i). All stainless-steel portions which contribute to the car aesthetics such as car shell or interior fittings shall be treated with a nitric or citric acid passivation bath.

(1) Passivation medium, concentration level and duration of treatment, as well as the rationale for selection, shall be proposed by the Contractor for review and approval by Amtrak. **[CDRL 19-04]**

(2) Waivers from passivation may be granted on a case-by-case basis excepting carshell components which cannot be exempted from passivation.

ii). Stainless steel shall be cleaned in accordance with American Society for Testing and Materials (ASTM) A380. Post passivation testing shall be performed in accordance with ASTM A967. Test results, as well as visual approval of the aesthetics of the FAI pieces, shall be subject to Amtrak review and acceptance. The approved FAI piece shall form the basis of pass-fail acceptance criteria of all future vehicles.

19.7 High-Strength Low-Alloy (HSLA) Steel

a). General

i). HSLA steels shall be more than twice as corrosion resistant to atmospheric exposure as plain carbon steels, as measured by the ASTM G101 corrosion index. It is preferred that HSLA 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, HSLA steels shall conform to ASTM A572, ASTM A588, ASTM A606 - Type 4, ASTM A1008 or A1011- Grade A or 70 or ASTM A710, Grade A, Class III.

ii). 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 Amtrak upon request and shall be submitted with the vehicle history book.

iii). Heat treated parts made of HSLA steel shall be certified. A record of this certification, including hardness test results, shall also be retained on file and available for inspection by Amtrak upon request.

19.8 Steel Castings

a). General

i). The Contractor shall be responsible for selecting casting grade, composition, strength, heat treatment, finishing, and design best suited for the intended application. As a minimum, steel castings for structural use, including cast-weld designs for truck frames and bolsters, shall comply with AAR M-201 Grade B plus 2% Nickel, with the following mechanical properties:

(1) Minimum tensile strength: 75 ksi (517 MPa)

(2) Minimum yield strength: 48 ksi (331 MPa)

(3) Elongation: Minimum 25% in 2 inches

(4) Reduction of area: Minimum 50%

ii). Design and testing of truck bolsters and side frames shall comply with AAR M-202 and AAR M-203, respectively. Cast steel to ASTM A27/A27M, grade 65-35, may be used for truck structure, bolster and center bearing arrangements as an alternative to the AAR M-201 material specified above.

iii). Coupler, drawbars, and anchors shall comply with AAR M-201, Grade "C", quenched and tempered.

iv). Pattern markings and serial numbers shall be applied in a manner that does not impair the casting strength. If castings are found to be non-conforming to requirements determined by the design qualification castings, the material shall be repaired, retested, and re-inspected or destroyed at the Contractor's expense.

v). Qualification Test: The quality of steel castings shall be checked in accordance with the requirements of AAR M-201. The contractor shall perform a Qualification Test on one casting, selected by Amtrak, from the first lot of production castings to verify the casting design. The Contractor shall have radiographic testing performed per ASTM E94 or E1030 using reference radiographs from , ASTM E446- or E186, as may be applicable.

The radiographic sensitivity shall be at least 2% (2- 2T) for sections >3/4 in. thick and (2-4T) for sections ≤3/4”. Acceptance levels for the radiographic testing shall be submitted to Amtrak for review and approval. The surface quality of the steel castings shall be evaluated in accordance with ASTM A 802/802M. Radiographs resulting from the Qualification Test shall be made available to Amtrak for review.

vi). Welding: All weld repairs shall be qualified in accordance with the requirements of AWS D15.1 or ASTM A488/A488M. 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 Amtrak. Castings requiring repair or modification by welding after completion of heat treatment may be stress relieved locally by using electrically controlled heating to not greater than 1,150°F, followed by slow cooling. Manual torch stress relief shall not be permitted. For cast-weld designs, the entire length of all welds on any welded assembly of several separate castings selected for design qualification shall be radiographically inspected to ASTM E94/E94M using reference radiographs from ASTM E390.

vii). The Contractor shall prove the quality of castings by either destructive or 100% radiographic inspection. 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 Amtrak, the Contractor and the subcontractor. This frequency shall be influenced by the critical requirements of the part.

viii). 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 Amtrak.

b). Heat Treating

i). 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.

ii). All steel castings used in the truck structure shall be made of electric furnace or controlled open hearth steel and shall be heat treated.

19.9 Aluminum

a). General

i). 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 B26, B85 or B108 for, respectively, sand, die or permanent mold castings. Aluminum alloy forgings shall conform to ASTM 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 Amtrak upon request and shall be submitted with the vehicle history book.

ii). Unpainted aluminum used for interior surfaces exposed to contact by passengers and the crew shall have 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.) to protect the material.

(1) Color and coating type shall implement the Customer Experience Vision and CMF requirements of the contract and shall be subject to Amtrak approval.

(2) Scratched or damaged anodized aluminum components may not be repaired and delivered to Amtrak as part of the assembly.

iii). 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 or approved-equivalent.

iv). Aluminum used for heat sinks shall be nickel plated to minimize contact corrosion and surface pitting.

v). All interior Aluminum components, trims, and finishes shall utilize 100% recycled Aluminum wherever possible. Where virgin grades are required production must incorporate the use of renewable energy.

b). Fabrication and Fastening

i). 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.

ii). 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.

iii). 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 polysulfide sealant, zinc chromate paste, silicone sealant or Amtrak approved equal 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.

iv). Wood shall not be placed in contact with aluminum alloy except with written permission from Amtrak.

v). 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 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.

c). Gauge

i). Aluminum sheet gauge size shall be in accordance with the American or Browne and Sharp Standard Gauge.

19.10 Elastomers

a). General

i). 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 Amtrak 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.

ii). All resilient mounts shall be of natural rubber. Synthetic rubber compounds may be substituted for natural rubber only when approved for a specific application.

iii). 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.

b). Tests

i). 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

ii). (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.

iii). Unless otherwise agreed by the Contractor:

(1) ASTM D412-06ae2 tensile strength shall be 1500 psi (min.)

(2) ASTM D412-06ae2 elongation for sheet material shall be 300% (min.)

(3) ASTM D412-06ae2 elongation for extruded material shall be 275% (min.)

(4) ASTM D573 loss in tensile strength shall be 15% (max.) when subjected to 168 hours at 158°F.

(5) 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%.

iv). 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.

v). 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.

c). Life Expectancy

i). 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.

d). Metal Parts

i). Metal parts to which elastomeric material is vulcanized shall be made of SAE 1020 or 1045 hot-rolled steel, except for air brake equipment.

e). Bonding

i). 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.

f). Truck Parts

i). Truck bumpers and snubbers shall be compounded to be resistant to abrasion, oil, grease and acid.

g). Air Brake Parts

i). Brake control system elastomer compounds shall be selected by the air brake supplier guidelines.

h). Glazing Strips

i). Glazing strips shall be of neoprene conforming to ASTM C542-05, or of rubber fulfilling fire safety requirements of this specification.

ii). The compounding of the rubber shall be such as to preclude discoloration or staining of neighboring areas, particularly from water drainage.

iii). Window glazing sections shall be service proven and constructed of high-quality elastomeric compounds containing neoprene subject to approval by Amtrak.

iv). 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.

19.11 Glazing Materials

a). General

i). 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 body side windows. The window glass shall meet Amtrak Specification 336 or be otherwise approved by Amtrak.

b). Safety Glass

i). All safety glass must meet the requirements of ANSI Z26.1, Table 1, Safety Glazing Material for Use Anywhere in Motor Vehicle. Where specified, safety glass must also meet the requirements for the following:

(1) FRA Type I as specified in 49 CFR 223 and 49 CFR 238

(2) FRA Type II as specified in 49 CFR 223 and 49 CFR 238

ii). Where FRA Type I or Type II glass is required, the glazing, its mounting to the vehicle, and the vehicle structure must meet the requirements for ballistic impact and large object impact as required by 49 CFR 238. All glazing performance requirements must be met both with and without the application of the glazing protective film. All safety glass must be of the laminated type.

iii). Flatness

(1) 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.

iv). Dimensional Tolerance

(1) The overall dimensions of any window supplied shall not exceed ± 0.060 in. dimensional deviation. The thickness of individual pieces must be held within 5% of the specified thickness.

v). Overlap Tolerance

(1) 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 J673, Edge No. 4.

vi). Color

(1) When new, there shall be no more than ± 4% variation in the color of individual windows of laminated sheet glass when examined over a white background.

vii). Haze

(1) 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.

viii). Internal Contamination, Dirt, Specks and Scratches

(1) Occasional specks of foreign material and scratches are permissible, provided such specks do not exceed

(2) 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. Amtrak reserves the right to determine which windows are to be rejected.

(3) The visual inspection criteria for laminated glazing shall be submitted for Amtrak approval as part of the glazing design review. **[CDRL 19-05]**

ix). Bond Separation

(1) 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.

c). Light Transmission

i). Average visible light transmission through clear safety glass must be a minimum of 85%.

d). Plastic Glazing

i). Plastic glazing must meet the requirements under ANSI Z26.1, Table 1, Item 4, Safety Glazing Material for use in Motor Vehicle only in Specific Locations.

Where specified, safety glass must also meet the requirements for the following:

(1) FRA Type I as specified in 49 CFR 223 and 49 CFR 238

(2) FRA Type II as specified in 49 CFR 223 and 49 CFR 238

ii). Where FRA Type I or Type II glazing is required, the glazing, its mounting to the vehicle, and the vehicle structure must meet the requirements for ballistic impact and large object impact as required by 49 CFR 238. Material must be selected from Sabic "Margard," Atohaas "Tuffak CM 2," or approved equal, meeting 49 CFR 223. The installation must meet 49 CFR 238.113, Emergency Window Exits, and 49 CFR 238.221, Glazing.

e). Material Physical Properties

i). Plastic materials used in the glazing of side windows and door windows must meet the following requirements.

f). Strength

i). Samples must be prepared and tested according to 49 CFR 223 and 49 CFR 238 and ANSI Z26.1, Section 5.10, Impact, Test 10 (Dart Drop, Table 2 Heights). Samples must not shatter or break when subjected to the falling dart impact requirements of Test No. 10. The dart tip must be no more than 0.5 in. radius. Denting or marring of the surface of the tested piece in this test is permissible.

g). Light Transmission

i). Visible light transmission through clear plastic glazing must not be less than 85% in 0.125 in. thickness, 82% in 0.25 in. thickness, 80% in 0.375 in. thickness, and 78% in 0.5 in. thickness.

h). Color

i). Materials must have UV stabilizer additives to inhibit fading and loss of properties due to extended exposure to direct sunlight. When new, there must be no more than 4% variation in the color between lights of plastic material of a specified color and thickness, when examined over a white background, and measured by the appropriate light transmission or colorimeter inspection and test instruments.

i). Abrasion Resistance

i). Plastic glazing materials must be silicone-coated on both sides to increase resistance to abrasion. The coated plastic must meet ANSI Z26.1, Section 5.17, Abrasion Resistance, Test 17 (Plastics). The change in percent haze after 100 cycles must be less than 6%. The glazing material supplier must perform the following test prior to qualification: The plastic glazing material after 300 hours of weatherometer testing must pass abrasion resistance

ANSI Z26.1, Section 5.17. This test must be performed for initial product certification and the results must be provided with drawing submittal.

j). Chemical Resistance

i). Samples must be prepared and tested per ANSI Z26.1, Section 5.19, Chemical Resistance, Test 19 (Non-stressed). The exposed fabricated edges of the test samples may be coated with the same material as the face surfaces by the manufacturer. In addition to the chemicals specified in this test, the test must include, but not be limited to, such cleaning solutions as dilute oxalic acid solution (3% by weight), half-strength Neleco Products Subway Soil Solvent – (one gallon Part 1 to 2 pounds Part 2, in 10 gallons water), and Electrosol. The exposure time of the test must be increased to 1-hour intimate contact with the test chemicals on the faces of the test sample. The contaminants must be either wiped or sprayed onto the coated faces of the test sample. Any tackiness, crazing, or apparent loss of transparency is cause for rejection. After immersion, a change in percent haze greater than 55, as measured by ANSI Z26.1, Section 5.17, Abrasion Resistance, Test 17, is cause for rejection.

k). Dimensional Tolerance

i). The overall dimensions of individual units as supplied must be within 0.030 in. of the nominal dimension specified. The thickness of the plastic materials must be within a tolerance of + 5% of the nominal thickness.

l). Flatness

i). When an individual piece is placed on a truly flat surface, such as a surface plate, the material must not indicate a bow of more than 0.030 inch per linear foot, in any direction.

m). Edge Work

i). All edges must be straight and perpendicular to the surface and must be sawed or routed and free of burrs in order to prevent cutting of the rubber glazing strips. Sharp corners must be removed around the entire periphery.

n). Optical Quality

i). Optical quality of the plastic glazing materials must be in accordance with ANSI Z26.1, Section 5.15.2.2, Visibility Distortion. No light and dark patches, existent over the entire area, may appear in the shadow of the unmasked area of the specimen before the specimen has been moved a distance of at least 14 in. from the screen.

o). Weathering

i). The plastic glazing material must pass the long arc Xenon lamp Weathering ANSI Z26.1, Section 5.16, Weathering, Test 16. No detectable cracks in the coating must develop when the specimen is strained 2%. Stress may be applied by imposing 6,000 psi loading, using a tensile testing machine.

p). Material Quality

i). Foreign Material and Inclusion Defects

(1) Foreign material and inclusion defects must not exceed the following limits:

(a) Less than 0.009 in.: Allowed to the extent that they do not constitute a severe defect such as clustering.

(b) 0.009 in. to 0.020 in.: Allowed up to 10 per square foot average over the area of the piece.

(c) 0.021in. to 0.050 in.: Allowed up to three per square foot average over the area of the piece.

(d) 0.051 in. to 0.065 in: Allowed one per square foot average over the area of the piece.

(e) 0.0651 in. to 0.15 in.: Allowed one per edge, only in the outer 25% of the piece.

(f) Above 0.15 in.: Not allowed.

(2) There must be no black speck clusters of three or more above 0.02 in. in a 1 in. diameter circle.

(3) Defects occurring in those areas of the lights that are covered by the glazing strips is not cause for rejection.

ii). Fibers and Scratches

(1) Fibers and scratches must not exceed the following limits:

(a) Less than 0.060in. in length: Allowed to the extent that they do not constitute a severe defect such as clustering.

(b) 0.061 in. to 0.125 in. in length: Allowed up to a maximum of two per square foot average over the area of the piece.

(c) 0.126 in. to 0.250 in. in length: Allowed up to a maximum of one per square foot average over the area of the piece.

(2) Greater than 0.250 in. in length: Not allowed.

(3) Fine scratches that are detectable only when viewed in bright back lighting are acceptable.

iii). Bubbles

(1) There must be no clusters of bubbles, no chain bubbles, and no bubbles larger than 0.030 in. in diameter. If present, bubbles 0.020 in. to 0.030 in. in diameter must have a minimum separation of 3 in.. In

any 2 in. diameter area of glazing material, there must be a maximum of four bubbles with diameter between 0.010 in. and 0.020 in..

iv). Apparent Runs

(1) Apparent runs must not exceed the following limits:

(a) Less than 0.125 in.: Allowed to the extent that they do not constitute a severe defect such as clustering.

(b) 0.125 in. to 0.250 in.: Allowed up to a maximum of four per square foot average over areas of piece but not to the extent that they constitute a severe defect.

(c) 0.251 in. to 0.500 in.: Allowed up to a maximum of one per square foot, if it does not constitute a severe defect.

(d) 0.501 in. to 1.00 in.: Allowed up to a maximum of one per edge, only in the outer 25% of piece area.

(2) Above 1.00 in.: Not allowed.

v). Orange Peel

(1) "Orange peel" in the surface is cause for rejection of the material.

vi). Marking

(1) All glazing shall be marked with proper identification in accordance with FRA 49 CFR Part 223 requirements. 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.

vii). Shipping

(1) 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.

q). Window Shades

i). Fire Resistance and Durability

(1) All shades, blinds and nets should meet the requirements for 14 CFR 25, Appendix F, Part 1, (Vertical test) Flame time ≤ 10 sec and Burn length ≤ 6 inches. As well as ASTM E 662-01 Ds(4.0) ≤200.

(2) The materials must display high dimensional nubility under extreme climactic conditions and fluctuations as well as high UV resistance and high degree of tear resistance and resilience.

ii). Certificates Required:

(1) GREENGUARD Gold

(2) STANDARD 100 Class IV by OEKO-TEX®

(3) Environmental Product Declaration (EPD)

(4) Health Product Declaration (HPD)

r). Sunshades

i). Quality and Composition

(1) Sunshades should block out glare and solar heat, while having a excellent rate of visibility in order to enjoy the view with the shade down, aiming for a visible light transmittance (vT) of 10%. Composition should be made up of 100% knitted polyamide or rPET with a metalized backing.

s). Blackout Blinds

i). Blackout Blinds should be constructed of a weave with 1-2% openness and aim to have a vTlevel of 0%, by using a laminated back layer to block out visible light.

19.12 Luggage nets

a). Luggage nets should be made up of knitted polyamide with open round geometry and intergraded edging.

b). The material should have a level of dimensional stretch to allow for easy access storage by customers.

c). Material must meet all flammability, smoke and toxicity requirements of this specification.

19.13 Rubber Floor Covering

a). General

i). The rubber flooring shall be made of a synthetic rubber compound mixed with multi-colored speckles of the same material dispersed throughout the material thickness, with a semi-matt finish.

ii). Rubber floor 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 with both rubber and leather soled shoes.

iii). Rubber floor covering shall be non-staining, non-discoloring, and 100% non-oil extended.

iv). Only high-quality hard clay shall be used as filler.

v). 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.

vi). 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.

vii). The flooring shall meet TRRL Pendulum Dry 91 Wet 29

b). Sustainability

i). The raw material should be sourced from suppliers who adhere to ethical and sustainable practices.

ii). The rubber flooring must contain a minimum of 15% recycled content.

c). Thin Skinned Blister

i). 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:

(1) Maximum Size - 0.030 in. (0.8 mm) height, 0.80 in.^{2} (5.2 cm^2) area with longest dimension of 2 in. (51 mm).

(2) 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.

(3) Repair Method - using a hypodermic needle, apply just enough Super Bond 420 or Bostik 1685 to bring to a flush surface.

d). Thick Skinned Blister

i). 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:

(1) Maximum Size - 0.030 in. (0.8 mm) height, 0.80 in.^{2} (5.2 cm^2) area with longest dimension of 2 in. (51 mm).

(2) 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.

(3) Repair Method - no repair authorized.

e). Lumps

i). 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:

(1) Maximum Size - 0.030 in. (0.8 mm) height, 0.80 in.^{2} (5.2 cm^2) area with longest dimension of 2 in. (51 mm).

(2) 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.

(3) Repair Method - no repair required.

f). Holes

i). 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.

g). Thin Area

i). 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:

(1) Maximum Size - 0.030 in. (0.8 mm) deep at the lowest point, 3 in.^{2} (19.4 cm^2) area with the longest dimension of 5 in. (127 mm).

(2) 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.

(3) Repair Method - rub with #00 steel wool to blend this area into the normal thickness material and then buff to a normal surface finish.

h). Color and Marbling Distribution

i). Tolerances for color and marbling variation shall be submitted to Amtrak 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.

ii). Additives should provide UV resistance to prevent fading or discoloration from sunlight exposure through windows. Pigments must withstand cleaning chemicals without bleeding or loss of color.

19.14 Paneling

a). Plymetal

i). The term "plymetal" as used in this Specification covers metal-faced plywood and shall conform to the following requirements when tested per ASTM D2718 and ASTM D3930:

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) – Flat, non-textured sheet 60 lbf/in.^{2} (0.4 MPa) – Textured sheet
Soak shear, 48-hour soak wet at room temperature	150 lbf/in.^{2} (1 MPa) – Flat, non-textured sheet 60 lbf/in.^{2} (0.4 MPa) – Textured sheet
Creep or cold flow, under static load for 48 hours, at room temperature	250 lbf/in.^{2} (1.7 MPa)
* **MPa** = Megapascal	

ii). 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 Chapter. 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 hardboard (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.*

iii). All exposed edges of the panels shall be covered in a fireproof manner.

iv). Plymetal prohibited for use in flooring.

b). Plywood

i). All plywood shall be manufactured to conform to the requirements of NIST PS 1, 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.

c). Honeycomb Panels

i). 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 core material shall be commercial-grade meeting the requirements of MIL-C-7438G per AMSA-81596 and shall meet the requirements of AMS-C-7438. 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 MSFC-SPEC-445. 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 Amtrak review and approval.

(1) Core shear yield at 200°F (93°C) 250 lbf/in.^{2} [1.72 Megapascal (MPa)]

(2) Flatwise tension at 200°F (93°C) 250 lbf/in.^{2} (1.72 MPa)

(3) Beam flexure at 200°F (93°C) 75,000 lbf/in.^{2} (517.13 MPa)

(4) Core shear fatigue at R.T. 150 lbf/in.^{2} @ 106 cycles (1.03 MPa)

(5) Flatwise tension at R.T. 250 lbf/in.^{2} @ 106 cycles (1.72 MPa)

(6) Beam flexure at R.T. 50,000 lbf/in.^{2} @ 106 cycles (344.75 MPa)

ii). Honeycomb panels meet the relevant flammability and smoke emission requirements. Results shall be subject to Amtrak review and approval. No other honeycomb materials will be permitted.

d). Melamine-Faced Aluminum

i). 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. The melamine and the required binder sheets shall be 0.020

ii). ± 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 ensure full, permanent, acceptable adhesion.

iii). 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 106 lbf/ in.^{2} (19.3 GPa) crossgrain: 3.1 x 106 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)

e). Melamine Panels

i). Unbacked melamine panels may be used in the vehicle interior. The panels shall be a minimum of 0.125

ii). ± 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. Sidewall panels shall be of unbalanced melamine. However, ceiling panels located under air ducts must be balanced melamine to prevent warpage from duct condensation.

f). Phenolic Composite Floor Panels

i). 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.

(1) 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. mm^2) surface area, with a 0.0625- in. (1.6 mm) radius on bottom edge of test dowel.

(2) 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 Chapter 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.

(3) Static Load Test – Maximum Loading – Using the identical floor panel-mounting configuration as described above, a uniformly distributed load

of 200 lb/ft^2 (976 kg/m^2) shall be applied to both sides of the joint (butt or shiplap).

(4) 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

(5) 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.

(6) Small Object Impact Test - Using the identical floor panel mounting configuration as described above, a 16 lbs. (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).

(7) 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.

(8) Rolling Load Test - Using the identical floor panel mounting configuration as described above, a four-wheel 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.

(9) Flammability and Smoke Emission Tests – Floor panels meet the relevant flammability and smoke emission requirements.

g). Acoustic Wood Paneling

i). Acoustic wood paneling provides a premium experience in the luxury suite, mitigating the high volume of auditory disturbance experienced within the train. The acoustic dampening properties combined with the real wood veneerers elevate this space to a luxury choice, reflecting the on-cost of ticket purchase and manufacture.

ii). Acoustic wood paneling structure should be made up of:

(1) Real wood decorative surface with an FR treatment (matching the wood used across the train)

(2) Laminated onto 16 mm MDF substrate (natural color)

(3) Balancing + black 100% PET felt paneling.

iii). Design details of spacing will be determined during design reviews.

iv). The material shall meet all flammability, smoke and toxicity requirements of this specification.

v). All wood must be FSC certified, backing materials will be comprised of recycled materials.

vi). Acoustic Performance

(1) The panels shall demonstrate sound absorption coefficients (αw) of at least 0.95, determined through accredited lab testing in accordance with ISO standards.

(2) Absorption values for common frequency ranges shall meet or exceed specified targets.

vii). Panel thickness shall be approximately 16-18mm. Weight shall be kept to a minimum while maintaining acoustic performance and durability.

viii). The panels shall stand up to common impacts and surface wear. Their decorative finish shall resist scratching, abrasion, and scuffing. Panels shall be repairable if damaged.

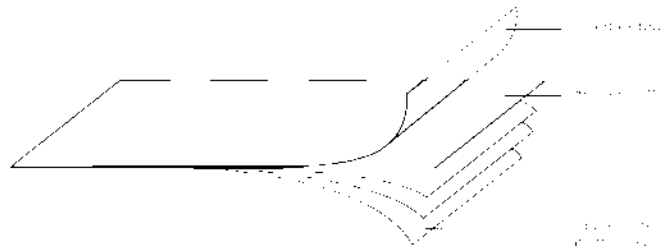
h). Real Wood Laminate

i). The laminate shall have a decorative real wood veneer surface with a satin finish, protected with a Tedlar Cap layer.

ii). The material shall meet all flammability, smoke and toxicity requirements of this specification.

iii). The laminate shall utilize FSC certified wood from responsibly managed forests. Adhesives and resins shall have low VOC content. It shall be recyclable at end of life.

iv). The application of the Tedlar cap will provide good abrasion, chemical and UV resistance to the material.



19.15 Woven Fabrics

a). The texture of fabrics on trains should be soft and comfortable to the touch, while also being durable and easy to clean. Woven fabrics for Amtrak long distance trains must be breathable, moisture-wicking, temperature regulating, and comfortable to the touch. A composition of 60% Wool and 40% cotton is recommended to provide breathable, moisture wicking and natural antibacterial properties.

b). Sustainability

i). All raw materials should be sourced from suppliers who adhere to ethical and sustainable practices.

ii). Natural materials should be sourced organically, while synthetic materials should be made from recycled or renewable sources.

iii). Where possible OEM and suppliers should prioritize non dyed coloring to minimize processing and impact on the environment.

c). Fabrics must be fire-resistant, passing NFPA-130 seat upholstery, BSS 7239 FAR 25.853 (a) Appendix F, part 1. FR should not effected by when exposed to liquids or conventional cleaning methods (wet shampooing or dry cleaning).

d). Woven fabrics must pass the abrasion ASTM D3884 test, passing <50% wear with 150 cycles of wear with a CS-10 wheel under a 1000 gram load. Tear resistance is defined by ASTM D2261 by applying a force of 15 lbf to a tear in the material in both the warp and fill directions. The test passes if the material does not tear completely in either direction.

e). Burst/puncture resistance is defined by FTMS 191A Method 5122 and tested by applying a force of 200 lbf to the material. The test passes if the material does not burst or puncture under the applied force.

f). Anti stain treatment should be applied to ensure longevity and cleanability

g). Dyes and finishing treatments must ensure UV resistance and color fastness

19.16 Non-Woven Fabrics

a). Microfibre Cloth

i). The faux suede fabric shall have a soft, plush, supple texture and handle. It shall be made from a non-woven structure of fine microfibers to ensure it is lightweight, draping, stain resistant, and exceptionally durable. The composition should be made up of the following layers, totaling a minimum weight of 27 ounces per linear yard:

ii). FACE: 100% recycled polyester microfiber 0,15d

iii). INNER SCRIM: 100% recycled polyester 150d

iv). BACKING: 10% recycled polyester microfiber 0,15d and 90% polyester FR 0,50d.

v). Sustainability - As above, the composition of the cloth should come from predominantly recycled polyester with >60% over the finished article.

vi). The fabric shall meet all flammability, smoke and toxicity requirements of this specification.

vii). The fabric shall have a thickness of 1.2mm +/- 20% and demonstrate breathability.

viii). The fabric shall withstand 200,000 double rubs per Wyzenbeek method and have a minimum breaking strength of 115 lbs. warp and 118 lbs. fill per ASTM D5034. It shall be resistant to sagging, crocking, pilling, and shrinking. The fabric shall be spot cleanable and machine washable for easy maintenance. It shall achieve grade 4.5 minimum for colorfastness to light and crocking per AATCC 16.3 and 8.

b). Acoustic Felt

i). Acoustic felt should be made up of 90% wool and 10% Nylon or 100 percent Trevera

ii). Acoustic felt shall meet the same performance characteristics as microfiber.

iii). The fabric shall meet all flammability, smoke and toxicity requirements of this specification.

19.17 Seat Cushion and Upholstery

a). Cushion Material

i). The bottom seat cushion shall be molded polyurethane foam with an approved fire barrier material or silicone. It shall meet Amtrak Specification 665 or be otherwise approved by Amtrak. 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 or be otherwise approved by Amtrak.

ii). The back cushion shall be molded polyurethane foam meeting Amtrak Specification 665 or be otherwise approved by Amtrak.

iii). 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. or be otherwise approved by Amtrak.

iv). The Engineer's and Assistant's seat in the Engineer's cab shall be silicone or a molded polyurethane foam with an approved fire barrier material.

v). Approved fire barrier fabrics are Tex Tech Industries TTI 8174 and DuPont Nomex 17253. Alternative fire barrier materials will be considered. Approval is contingent upon submittal of the following tests to Amtrak's Industrial Design group for review and written approval.

Test Identification	Test Description	Test Pass/Fail Criteria
ASTM D3884 (CS-10 wheel, 1000 gm wt.)	Abrasion Resistance	150 cycles @ 50% wear through
ASTM D2261	Tear Resistance	15 lbf (in both the warp and fill directions)
FTMS 191A Method 5122	Burst/Puncture Resistance	200 lbf

b). Lamination

i). All visible surfaces must be made from a tri-laminate panels. The laminate is a heat set polymer web adhesive (Min 0.9 OZ/SQ YD) that allows the fabric to bend and breathe easily. The durability of the laminate is a key performance requirement for Amtrak and each vendor submitting a bid must be able to demonstrate that they have at least two years of experience in manufacturing laminated textile panels, they have a quality control system to ensure repeatable performance, and their lamination panels have been tested under jounce and squirm conditions to 100,000 cycles with no visible delamination, puckering, crack marks, bubbles, or blisters. Tests must be conducted to Daimler Chrysler Test Specification PF-10254 Change A, S6.4 Jounce and Squirm or approved equivalent. Additionally, the laminate must meet the 12 second vertical burn flammability requirements of 14 CFR Part 25.853(a) Appendix F, Part I(1)(a)(ii) as defined in FRA 238.103 appendix B.

ii). Alternate materials may be suggested and must be submitted to Amtrak Industrial Design for initial approval.

c). Synthetic Leather

i). The grain of synthetic leather shall complement traditional top grain leather.

(1) It shall be a soft organic texture which shall approximate a top grain finish but without an animal hide appearance.

ii). The synthetic leather shall have a weight of approximately 410 Grams Per Square Meter and a thickness of approximately 1.15 Millimeters.

iii). Synthetic leathers should be comfortable and sustainable over the product lifetime, both in their material composition and longevity.

(1) All synthetic leathers should be primarily bio-based and where possible sourced from agricultural waste as opposed to potential food sources.

iv). Backcloths to be 100% bio-based, constructed of rayon along with a bio-based PU layer, achieving an overall bio-based content of >60%.

v). Requirements

Test Identification	Test Identification	Test Pass/Fail Criteria
ASTM D-3884	Abrasion	1000 cycles, 500g H-18 wheels. No wear through
AATCC 8	Colorfastness	Dry/Wet grade 5
ASTM D-4705	Stitch tear strength	23.85 lbf. Warp/Weft average
ASTM D-4157		300,000 Double Rubs
ASTM D-2261	Tear strength	

vi). Synthetic leather shall have the cushioning foam laminated to the back to achieve a soft feel.

vii). Material must meet the flammability, smoke and toxicity requirements of this specification.

viii). Color Accuracy

(1) The color differences between any measured production component and the accepted color sample for that component shall be less than ± 1 dE.

d). Top Grain Leather

i). All upholstery leather applications shall have a top-grain finish, ensuring a consistent color and texture devoid of any defects or imperfections. The thickness of the hide will be between 1.0 and 1.2 mm. Leather strap applications must use belting leather at a thickness of 2.8-3.2 mm

ii). Leather should be sourced from suppliers who adhere to ethical and sustainable practices (i.e. minimize impact on water scarcity, run on renewable energy, reuse of waste material, etc.). The tanning process used to treat the leather should also be environmentally friendly.

iii). The leather must comply with smoke, toxicity, and flammability requirements of this specification.

iv). The leather should offer a superior and comfortable seating experience for passengers, with excellent breathability to ensure comfort during long journeys. It should withstand 60,000 cycles on the BS EN ISO 5402-1 (FlexometerMethod) without cracking of the finish.

v). The color differences between any measured production component and the accepted color sample for that component shall be less than ± 1 dE.

vi). Durability and Maintenance

(1) The leather must exhibit resistance to regular wear and tear, as well as fading when exposed to sunlight. It should pass a 72-hour UV light exposure test with a score of 4 or better on the AATCC greyscale for color change.

(2) The leather should also have anti-stain treatments and anti-soiling properties to ensure easy cleaning and maintenance.

(3) The leather's color fastness will be tested according to ASTM D5053 (50 cycles wet & dry), and it must achieve a score of 4 or better on the AATCC greyscale for color change. The following standards must be met:

(a) Flex ASTM D 2097: 70,000 Flexes

(b) Elongation: ASTM D 2211: 30-50% at 50lb

(c) Slit Tear ASTM 2212: 15lb

(d) Tear strength: ASTM D 4705: 40 lb.

(e) Abrasion ASTM D 7255: 4000+ cycles (CS-10 wheels), 300+ cycles (H-18 wheels)

19.18 Carpet

a). All carpets shall meet all flammability, smoke and toxicity requirements of this specification.

b). The carpets should be easily maintained with regular vacuums and cleaning products. The final construction of all carpets should work towards durability without significant wear for 8 years +. Anti stain

c). Wherever possible suppliers should use non-dyed yarns to minimize processing and use of dye, by utilizing naturally occurring colors such as natural whites, light and dark greys. All polyamide (PA) to be Econyl® 100% recycled material.

d). Location and process for implementing seams must be implemented for approval.

e). All seaming plans must be submitted for Amtrak acceptance.

f). High Traffic Areas

i). Carpets for use in corridors, aisles and any other high traffic areas should be highly durable and easy to traverse with a suitcase, food cart or wheelchair.

ii). Quality and Composition

(1) Four color, yarn dyed carpet with a square woven, level loop pile construction, 100% PA Econyl®, with a low pile hight (approximately 0.106 inches). Total weight

(2) 49.95 oz. Per yd². Backing material to be 100% synthetic yarns, from recycled feedstock where possible.

iii). The carpet should be installed directly on to the floor surface, without an additional underlay.

g). Low Traffic Areas

i). These areas, such as sleeper cabins should have a luxurious feel and maintain a 'new' appearance over repeated use.

ii). Four color, yarn dyed carpet with a square woven, level loop pile construction, high quality 90% wool, 10% PA Econyl®, with a medium pile height (approximately 0.177 inches). Backing material to be 100% synthetic yarns, from recycled feedstock where possible. To be used with an additional pad or underlay for comfort with a weight of 17.0 oz. Per yd².

iii). Total carpet weight minimum 66.5 oz. Per yd²

h). The carpet will have a stain resistant chemical applied.

i). 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.

j). The carpet shall be easily removable without extensive labor while eliminating the likelihood of damaging the floor paneling.

k). Carpet adhesive shall be submitted to Amtrak for approval.

l). Alternate carpet types may be submitted for review but must meet or exceed the performance requirements of this Chapter.

19.19 Counters

a). All counter surfaces shall be made from Amtrak approved materials. All countertop material shall be made from FDA and NSF approved non-porous material.

b). All stainless-steel 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 do not flex, deform, rattle or "oil can".

19.20 Welding and Brazing

a). Responsibility

i). The Contractor shall be responsible for the quality of all welding and brazing. 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.

ii). All welding practices shall be according to requirements of AWS D1.1, *Structural Welding Code – Steel*; AWS D1.2, *Structural Welding Code – Aluminum*; AWS D1.3, *Structural Welding Code – Sheet Steel*, AWS D1.6, *Structural Welding Code – Stainless Steel*, AWS D15.1 Railroad Welding Specification for Cars and Locomotives, and the AWS Handbook. AWS Standard D1.1 shall apply to steel of ⅛-in. and greater thickness, and AWS Standard D1.3 shall apply to steel less than 0.125 in. thickness. Requirements for cyclically loaded structures shall be applied. Cast steel welding shall be according to AWS D15.1 or ASTM A 488/488M, *Steel Castings, Welding, Qualification of Procedures and Personnel*. Resistance welding shall be in accordance with AWS D17.2/17.2M, *Specification for Resistance Welding in Aerospace Applications*. Laser welding, if used, shall comply with AWS C7.2, *Recommended Practices for Laser Beam Welding, Cutting, and Drilling*.

iii). All welding practices not specifically covered in this Chapter shall be in accordance with the applicable requirements and recommendations of the American Welding Society (AWS). Should the Contractor propose an alternate standard, it shall be subject to Amtrak's approval.

iv). All arc 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 Amtrak and a Certified Welding Inspector, welding engineer, or other individual qualified to review said documentation. The use of WPS qualified per AWS B2.1 shall not be permitted in their original form. WPS and PQR originally qualified per AWS B2.1 may be rewritten to conform to the requirements of the applicable structural welding code and used within the limitations of that code. Resistance welding schedule certifications and machine qualifications shall be submitted for review and approval by Amtrak along with the arc welding WPSs and PQRs.

v). Welders shall make only those welds for which they have been qualified according to the requirements of the applicable AWS code, ASTM A 488/488M, or other approved qualifying procedures. Records of welder qualification tests shall be made available for review.

b). Test Welds

i). Amtrak shall have the right to require an operator to make test welds to determine their ability to produce satisfactory welds of any given type. Amtrak 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.

ii). Fatigue allowable stresses shall not exceed the lesser of fatigue limits in AWS D1.1, , 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.

c). Cleaning

i). 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.

d). Welding Rod

i). 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 which shall be marked with the Manufacturer's name and the specification, diameter, and net weight of the material.

ii). 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.

iii). The ferrite number for austenitic stainless-steel welds shall be between WRC4 and WRC10, or as proposed by the Contractor and approved by Amtrak.

iv). 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.

e). Control

i). 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.

f). Penetration

i). 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 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.

g). Warpage

i). 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.

h). Intermittent Weld Spacing

i). 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. Exceptions may be granted, for example to avoid warpage in thin sheet, where the design exhibits sufficient strength with welds applied on larger spacing, subject to Amtrak review and approval.

i). Fusion Welding

i). Manual fusion welding by the gas process may only be used on sheets more than 3/32 in. (2.38 mm)in thickness. Any other application of this process must be approved by Amtrak.

j). Resistance Welding

i). 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. Production witness testing requirements shall be followed unless specifically waived or modified by Amtrak in writing.

ii). Stainless steel parts shall be joined, insofar as possible, by resistance welding. Procedures 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.

iii). 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.

iv). 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.

k). Special Welding

i). 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. Welding PQRs for these dissimilar welds shall include a Vickers microhardness traverse spanning both base metals, the weld metal and both Heat Affected Zones (HAZ) and shall demonstrate that the hardness does not exceed 400 HV.

ii). Austenitic stainless steel electrodes or wire specifically intended for welding of dissimilar metals, such as 309L or 312L, shall be used to join carbon or HSLA steels to stainless steels.

iii). 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*.

iv). Standards that may apply to selected processes include:

(1) AWS Standard D17.3/D17.3M, Specification for Friction Stir Welding of Aluminum Alloys for Aerospace Applications.

(2) ANSI/AWS Standard C7.2, Recommended Practices for Laser Beam Welding, Cutting, and Drilling.

(3) ANSI/AWS Standard C7.4/C7.4M, Process Specification and Operator for Laser Beam Welding.

(4) ISO/DIS Standard 15609-4, Specification and Qualification of Welding Procedures for Metallic Materials - Welding Procedure Specification - Part 4: Laser Beam Welding.

v). 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.

l). Toughness of Welded Assemblies

i). 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 (CVN) specimens shall be 20 ft-lbf of absorbed energy at the lowest specified operating temperature. CVN test results shall be submitted along with Procedure Qualification Records (PQRs) for all structural steel welding procedure specification (WPS) qualifications.

m). Torch Brazing

i). 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*.

n). Torch Soldering

i). All structural (not electrical) soldering, characterized by heating below 840ºF, 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*.

19.21 Exterior Marking Films and Graphics

a). General

i). Graphics shall be transportation grade materials, printed on opaque background with clear, vandal resistant overlayment. All graphics materials are to be approved by Amtrak. Application techniques shall be in accordance with manufacturer's recommendations.

b). Physical Properties

i). Shall be able to withstand long-term exposure to all environmental and operating conditions specified in Amtrak Specification 963.

ii). Lettering film shall be sufficiently opaque so that, when applied, films shall completely hide any contrasting background and shall be readily legible.

iii). There shall be an initial 60-degree gloss value of 40 when tested in accordance with ASTM Standard D523-08.

iv). Films shall retain adhesive properties after one week of continuous exposure to a temperature of 66°C (150°F).

v). 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.

vi). Overall thickness of processed film shall be between 0.10 mm and 0.20 mm (0.004 and 0.008in.).

vii). 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.

viii). Marking films shall withstand effects of detergents and brushes used in vehicle washing procedures for removal of graffiti.

ix). Films shall use a removable grade adhesive that upon removal does not require use of solvents or secondary operations.

x). Square or rectangular graphics shall have rounded corners of suitable radius.

19.22 Paints and Coatings

a). Materials and General Requirements

i). Painting of the car shall serve to protect the vehicle from corrosion.

ii). Paint is prohibited on the interior of the car at customer facing areas, unless otherwise approved by Amtrak on a case-by-case basis.

iii). 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. Interior surfaces shall in general not be painted, with specific approval being required during Design Review.

iv). 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.

v). 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.

b). Paint Process Documentation

i). The Contractor shall prepare a paint coating and application document containing procedures for surface cleaning and preparation, priming, surfacing, repairing, and painting for the car body and all equipment that is painted or powder coated.

(1) A detailed paint schedule showing the equipment painted, paint type and manufacturers, recommended thickness, and other pertinent information shall also be included.

(2) The document shall meet Amtrak Specifications 353 and 354.

(3) This document shall be submitted during IDR and FDR and shall be included in the maintenance manuals. **[CDRL 19-06]**

c). Painting Restrictions

i). 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.

ii). The following items shall not be painted:

(1) Wire and cable

(2) Copper tubing, piping, and fittings

(3) Conduit and fittings

(4) Heat transfer surfaces

(5) Grounding pads and straps

(6) Wheels

(7) Axles

(8) Brake rotors

(9) Brake shoes and pads

(10) Air hoses

(11) Pedestal liners

(12) Elastomeric parts

(13) Grease fittings

(14) Linkages

(15) Threaded parts used for adjustments

(16) Electrical equipment

(17) Couplers, drawbars, draft gears, and yokes

(18) Wearing surfaces

(19) Corrosion Protection

(20) Stainless steel carbody

d). Color Accuracy

i). The color differences between any measured production component and the accepted color sample for that component shall be less than ± 1 dE.

e). Corrosion Protection

i). 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.

ii). All exposed surfaces shall be suitably finished to prevent corrosion during storage and operation, in accordance with the following requirements:

(1) 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.

(2) 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.

(3) 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.

(4) Any corrosion protection removed for welding shall be replaced after welding is completed.

(5) Where arc welding is performed on joints between stainless steel and other materials.

19.23 Powder Coating

a). Powder coating shall have a smooth flow and uniform appearance with a particle size of <100 μm, and film thickness of 60 μm - 80 μm. For durability finished thickness will be between 1.5 and 2.5 mm.

b). Where like-anodize is specified. The powder coating shall have a silk gloss (satin) finish resembling anodized aluminum. Gloss level 65-85 R'/60°.

c). The powder coating shall be formulated to minimize environmental impact. VOC content shall be negligible. Waste powder shall be recyclable and reusable.

19.24 Durability and Maintenance

a). The coating shall exhibit anti-graffiti properties and excellent weather resistance, achieving over 50% gloss retention after 3 years Florida exposure per ISO 2810.

b). It shall pass 1000 hours xenon arc exposure with over 90% gloss retention per ISO 16474-2.

c). The coating shall show no infiltration or blistering after 1000 hours condensation water exposure and acetic acid salt spray testing per ISO 6270-2 and ISO 9227.

d). It shall demonstrate good hardness and flexibility, passing cross-hatch adhesion, impact, cupping, and bending tests per ISO 2409, 2794, 1520, and 1519. The coating shall allow mortar residue to be removed after 24 hours per ASTM D3260.

19.25 Insulation

a). Acoustical Insulation

i). 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).

ii). Korfund Vibrodamper Compound, Aquaplas DL-10-HV or Amtrak 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, however, if acoustic requirements can be fulfilled by car shell design (e.g., local stiffness) then a partial application of the compound would be sufficient.

iii). The material shall not contain any asbestos and shall meet the flammability and smoke emission requirements of Chapter 19.19. 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 acoustic requirements are fulfilled.

b). Thermal Insulation

i). 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.

ii). General

(1) 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.

(2) 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.

iii). Installation

(1) 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. Exposed insulation fibers is not allowed. The design should minimize the use of insulation tape.

iv). Materials

(1) The following materials are acceptable for use on the vehicle:

(a) Rigid insulation

(b) Glass fiber preformed board

(c) Non-rigid Insulation

(d) Spun glass fiber in flexible rolls or mineral wool batts

v). Insulation Performance

(1) 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.		

(2) The thermal conductivity of insulation materials shall be certified when tested in accordance with ASTM C177~~-04~~ <u>or ASTM C518</u> at 75°F [24°C] mean temperature.

(3) 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.

(4) Floor insulation material shall be compatible with the material used at locations in the vehicle structure and shall not mold, rot, or sustain vermin.

19.26 Flammability and Smoke Emissions

a). General

i). The vehicle and its components shall comply with the requirements of 49 CFR Part 238.103 Appendix B, NFPA 130 Chapter 8, and APTA

Recommended Practice PR-PS-RP-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 Amtrak for approval. For low-risk materials, test date 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 Amtrak.

ii). 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 Chapter. It is predetermined that use of materials defined by this Specification is acceptable.

iii). A Smoke, flammability and toxicity 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. This table shall include all items including items which are/ have been waived from testing or are considered small items with associated waiver numbers listed for approved waivers. **[CDRL 19-07]**

iv). Maximum limits for smoke emission shall be determined using the smoke propagation mode which generates the most smoke.

v). 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. Amtrak may, at its discretion, require that the current batch of material being provided for this Contract be retested for conformance with these standards.

b). Electrical Fire Safety

i). Electrical equipment shall conform to NFPA Standard 130, Section 8-6, except where more restrictive requirements are imposed by this Specification.

c). Combustible Content

i). The design of the vehicle shall minimize the total combustible material content of the vehicle.

d). Toxicity

i). Those materials and products generally recognized to have highly toxic products of combustion shall not be used.

ii). 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

iii). 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. The Toxicity test data shall be included in the Smoke, Flammability and Toxicity Matrix.

19.27 Piping

a). General

i). 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.

ii). 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 by the use of clamping and/or grommets. Air and water lines shall be assembled to allow sufficient slope to permit gravity drainage.

iii). 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. Steel braided hoses should be considered for connection of all faucets and small water heaters for ease of maintenance. Piping in storage or left open due to the installation shall be capped to prevent contamination.

b). Air Brake Piping and Fittings

i). Air brake tubing and piping shall be of good commercial quality, free of burrs and scale.

ii). Carbody air line which is 0.5 in. 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. Fittings for stainless steel pipe shall be approved by Amtrak.

iii). All air piping on trucks and carbody 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 where approved by Amtrak. 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.

iv). Hoses shall be allowed where relative motions are expected such as coupler to carbody, truck to carbody, between truck components, vibrating equipment to its mounting base, and other applications as approved by Amtrak.

v). 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 45º or 90º 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.

vi). 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.

vii). Flexible air lines utilized in toilet systems shall meet or exceed SAE J844.

c). Air Conditioning and Refrigeration System Piping and Fittings

i). Air Conditioning refrigerant lines shall be of annealed seamless copper tubing meeting the requirements of either ASTM B 280 or ASTM B 88 Type K copper tubing and the requirements of ANSI Standard B16.22 shall be used for 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.

ii). Piping shall be routed to keep the amount 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.

iii). 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 Amtrak- approved procedure.

iv). The discharge of condensate drains lines shall be directly to the roadbed avoiding car structure, electrical cables, and other undercar equipment.

d). Soldering of Piping and Fittings

i). Copper air brake and refrigerant tubing lines 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.

e). Water Piping and Fittings

i). Water piping shall be stainless steel or seamless copper tubing in accordance with ASTM Standard B75- 02 and sized for the service intended. Piping shall be clamped with necessary sound insulation to prevent rattle and be sloped to allow drainage. The use of color coded PEX water lines with crimped fittings may be acceptable but needs further approval by Amtrak.

ii). 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 <u>or stainless steel</u>.

iii). All piping, fittings and other wetted surfaces shall be of "lead free" composition.

iv). If copper piping is used, it 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, using a continuous purging with an inert gas during joining. 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.

v). After installation, the complete water system shall be sanitized using the sanitizing procedure currently used by Amtrak per SMP 47601.

vi). 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 Chapters), 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 38ºF. This shall be demonstrated during the climate room testing described in Chapter 20.

vii). To ensure 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. Manual drain valves shall be accessible without use of tools and location is subject to Amtrak approval.

viii). Drains from the water system shall be routed to discharge directly onto the ground, avoiding car structure, electrical cables and all other undercar equipment.

ix). 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 drainpipes, and water tanks. A blanket heater may be used to protect the water tank. All electrically powered freeze protection components shall be readily accessible for routine maintenance and repair. Provisions shall be provided, whether through current detection and/or LED indicators to alert on board personnel as to the function of the freeze protection components.

f). Sewage Piping and Fittings

i). Non-metallic Sewage Pipes and Fittings

(1) A non-metallic 2 in. diameter waste line shall be provided, conforming to Amtrak Specification 759, or an approved alternate.

(2) 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 holding tank in the equipment room or underfloor, based upon the car series design. The piping system must always be capable of holding a 15 in. vacuum through all possible atmospheric pressures the cars are likely to encounter, 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.

19.28 Fiberglass-Reinforced Plastic

a). General

i). 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, alkalis and cleaning solutions used by Amtrak.

ii). 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.

iii). FRP parts shall have a greater thickness at attachment points and edges. Exposed sharp edges will not be allowed on any parts. Fasteners used to secure sections of FRP assemblies if used shall not be removed or cutoff to facilitate fit-up during installation to the car.

b). Resin

i). 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.

c). Reinforcement

i). 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. FRP should be straight with out bowing and flexing. Additional supports may be required.

d). Gel Coat

i). 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 Amtrak. 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.

e). Additives

i). 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.

ii). Mineral filler shall not exceed 28% of finished weight for any preformed matched die molding process.

f). Color Accuracy

i). The color differences between any measured production component and the accepted color sample for that component shall be less than ± 1 dE.

g). Strength Requirements

i). 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

19.29 Thermoplastic Sheet

a). General

i). 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 963, and shall be resistant to Amtrak cleaning solutions. Thermoplastic sheet shall be used as extruded or vacuum- formed.

ii). All non-visible thermoplastics should be made up of 100% recycled content, and visible parts a minimum of 50% recycled content.

iii). 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.

iv). Unless otherwise stated in the specification, all visible plastic moldings should have a textured surface of VDI39 with a uniform surface appearance.

b). Quality

i). 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.

c). Strength Requirements

i). 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	7,000 lbf/in.^{2} minimum
Tensile Modulus	ASTM D638	450,000 psi
Flexural Strength	D790	10,000 lbf/in.$_2$ minimum
Flexural Modulus	D790	4.5 x 10^5 lbf/in.^{2}
Hardness Rockwell	D 785	90 to 120 ("R" Scale)
Heat Deflection (annealed)	D 648 @ 264 lbf/in.^{2}	190ºF minimum
Impact Strength (Fabricated Parts)	D 3029 Gardener Dart Drop 0.5" dia. ball at 73°F	320 in. lb minimum

d). Color Accuracy

i). The color differences between any measured production component and the accepted color sample for that component shall be less than ± 1 dE.

19.30 High Pressure Laminates

a). Flat Textured HPL

i). The laminate shall have a decorative melamine surface available in a variety of colors, patterns, and finishes. The backside shall be sanded smooth. The laminate shall have a uniform appearance free of defects. 0.375 IN thickness

ii). The laminate shall utilize sustainable materials with low VOC content. It shall be recyclable at end of life.

iii). HPL must meet ASTM E 162-98 for flammability index of less than 35 and BS 476 Part 7 Class 1 for flame spread. It shall meet ASTM E-662-01 with smoke emission of less than 100 in the first 1.5 minutes and less than 200 in the first 4 minutes.

iv). Thickness shall be approximately 0.030 to 0.050 inches to meet strength and fire performance requirements.

v). The laminate shall resist staining, impacts, boiling water, and other common exposures. It shall have wear resistance of 400 cycles minimum per NEMA LD3. Laminate shall be repairable or replaceable if damaged.

b). Pressed HPL

i). Pressed laminate will emulate a slatted wood effect, with a pressed texture design on a wood-grain HPL.

ii). This material should match as closely as possible the color and grain of the real wood laminate specified.

iii). Texture detail to be defined in the design review process.

iv). Pressed HPL will meet all performance criteria listed in 19.28.a).

19.31 Decorative Laminate Film

a). The decorative laminate film shall be a lightweight, glass fiber reinforced Tedlar-capped material suitable for application to thermoplastic substrates. The film shall be dimensionally stable yet flexible enough for application to flat and moderately curved surfaces.

b). The material shall meet all flammability, smoke, and toxicity requirements of this specification.

c). Multiple layers will be required to meet the Customer Experience Vision requirements as approved in Final Design Review.

d). Film materials must meet low toxicity standards set out in ABD 0031 for the following substances (ppm):

i). HF ≤ 70 *)

ii). HCl ≤ 120 *)

iii). HCN ≤ 10 *)

iv). NOx ≤ 10 *)

v). CO ≤ 300 *)

vi). H2S+SO2 ≤ 10 *)

e). Durability and Maintenance

i). The film shall demonstrate exceptional resistance to staining, solvents, chemicals, and abrasion for ease of cleaning with common cleaners.

ii). In high traffic areas film must be glass fiber reinforced.

iii). The film shall pass testing for adhesion, abrasion resistance, mar resistance, dimensional stability, graffiti resistance and detergent resistance. It shall demonstrate a tensile peel strength of at least 4.5 lbs/in after 168 hours when applied according to manufacturer specifications. Standard details:

(1) Adhesion of Surface Layer DMS 2291: Pass

(2) Abrasion Resistance DMS 2290: Pass

(3) Tensile Strength ASTM D 882 (psi / N/mm^2)

(a) long. d. ≥10.670 / ≥ 75

(b) tran. d. ≥ 9.960 / ≥ 70

19.32 Solid Polymer Surface

a). Solid surfaces will be a non-porous, fully sealed, homogeneous material maintaining the same composition throughout the part.

b). Composition shall be of acrylic polymer, natural minerals (aluminum trihydrate) and pigment, with a satin finish.

c). A thickness of no less than 1/2 inch must be approved by Amtrak on a case-by-case basis.

d). Material shall naturally resist damage from heat, mold, mildew and stains.

e). Material shall be assembled with non-porous, waterproof seams.

i). Location and process for implementing seams must be implemented for approval.

ii). All seaming plans must be submitted for Amtrak acceptance.

f). The material shall meet all flammability, smoke and toxicity requirements of this specification.

g). A minimum of 14% Pre-Consumer Recycled Acrylic should make up the composition of the material.

h). The material must meet GREENGUARD GOLD Certification for low chemical emissions and be ROHS compliant.

i). Solid surface should be repairable in situ for scratches, and the supplier should provide a 10-year commercial warranty for the material.

19.33 Air Filters

a). HVAC and Equipment Ventilation Filters

i). HVAC system air filters shall conform to Amtrak Specification 685 or as approved by Amtrak 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.

b). High Pressure Air Filters

i). 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 PR-M-S-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:

(1) Each air brake control assembly

(2) Waste system

(3) Horn

(4) Low pressure air filters

ii). Replaceable media type filters shall use resin-bound, spun-glass fiber materials. It shall be non-absorptive of fluids and gases.

19.34 Wire and Cable

a). General

i). All wire and cable used shall exhibit the physical and electrical properties for 110ºC rated wire and cable specified in Amtrak Specification 323. High temperature wire, used for heater circuits, shall be as defined as Amtrak Specification 323.

ii). 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 PR-E-RP-009-98 and applicable AAR, ICEA, ASTM or MIL Specifications. The Contractor shall submit to Amtrak 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.

iii). In no case shall wire smaller than the following sizes be used:

(1) Wire on electronic units, cards, and card racks - No. 22

(2) Wire in control compartment – No. 16, No. 18 with Amtrak approval

(3) Wires pulled through conduits and/or wireless – No. 12, No. 14 with Amtrak approval

(4) All other wire - No. 12, No. 16 with Amtrak approval

b). Wiring - General

i). All vehicle wiring shall be in conformance with APTA Recommended Practice PR-E-RP-002-98 and PR-E- RP-009-98, Chapter 3 of the National Fire Protection Association's Publication NFPA No. 70, and the AAR Manual of Standards and Recommended Practices, Section F, Specification 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 amperage capacity shall comply with the latest revision of the National Electric Code. When more than three current-carrying conductors are applied in a raceway or cable, the amperage capacity shall be derated. Circuit protection shall be in conformance with Chapter 2 of NFPA publication No. 70, Article 240.

ii). Shields used for audio and other wiring requiring EMI/RFI protection shall be grounded at one point only within the vehicle, and not at both ends of the shield.

c). Data Communications Wiring

i). All data communications (Ethernet) wiring shall be able to support EIA/TIA 568 Cat 6a 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, crosstalk, 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 undercar 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.).

ii). The cable shall have the following characteristics:

(1) Construction

(a) Conductors: Stranded silver-plated copper #22AWG (or .5mm2)

(b) Insulation: Radiation cross-linked data grade polyolefin 300V

(c) Component configuration: Wires are twisted or helically cabled to ensure electrical performance to Cat 6a standards (see table) – 100Z characteristic impedance on finished cable

(d) Shielding: Foil and TC braid designed to meet 200MZ/m transfer impedance

(e) Binders/tapes: As required to enhance integrity

(f) Jacket: Radiation cross-linked polyolefin (low smoke, complying with toxicity requirements) 0.8 mm minimum at thinnest point.

(2) Electrical Requirements

(a) Impedance: 100Z+/-5Z

(b) Shielding effectiveness (30 MHz- 100 MHz): 40dB

(c) Voltage rating: 300V

(d) Shall comply with TIA Standard, TIA-568-C.2 for Balanced Twisted-Pair Telecommunications Cabling and Components Standards

(3) Environmental Requirements

(a) Cable jacket will withstand the following tests per AAR RP 585

(b) Tensile and Elongation Section 5.1 and 5.2

(c) Oil Resistance 5.3 and 5.4

(d) Thermal Shock 5.8.4

(e) Penetration 5.9.4

(f) Abrasion 5.9.8.2

(g) Corrosion resistance ASTM D2671-00(2007)e1

(h) Temperature -40°C- 90°C

(4) Mechanical Requirements

(a) Bending radius: 6x OD (fixed)

(b) 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.

(5) Smoke and Flame

(a) NFPA 130 (UL1685) or equal, i.e., UL 1581 (tray) or IEEE 383 1974

(b) Amtrak Specification 352, *Smoke Flame and Toxicity*

d). Wire Handling

i). 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.

ii). 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.

iii). 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.	

e). Wire Harness

i). 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 prefabricated 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 or approved connectors 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.

ii). Alternative methods for fabricating and installing wiring, which are standard carbuilder practice, may be submitted for consideration by Amtrak at the appropriate design review.

iii). Harnessed wires shall not be installed in conduit or wire ways. 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 at the time of trainset delivery. All conduits and wire ways shall be arranged to allow ease of replacement of individual wires between equipment enclosures after delivery.

f). Circuit Separation

i). Circuits shall be physically separated to reduce the possibility of unsafe conditions, electrical interference, or equipment damage.

ii). 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:

(1) 480VAC HEP trainline

(2) 27-point communications trainline

(3) 27-point MU trainline

(4) I-ETMS/PTC/Cab Signal circuits

(5) AC power circuits

(6) DC control circuits

(7) Communication circuits

(8) Unprotected wiring (e.g., battery or HEP trainline to circuit breaker)

(9) Data communications (Ethernet) wiring even though it might be in the same car to car 27-point communications trainline jumper

iii). 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 Amtrak approved otherwise.

iv). 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.

g). Wire and Cable Runs

i). 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.

ii). 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. Flexible Nylon or Sealtite conduit shall not be used on the exterior or underside of the carbody without Amtrak approval.

iii). 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.

iv). Conduit shall be attached to the carbody employing clamps; welding shall not be used under any circumstances.

v). Concealed wires, such as within conduits, raceways, 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.

vi). Wiring run in loom shall not be carried over a potential chafing hazard.

vii). Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

viii). 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.

h). Undercar

i). The 480VAC HEP trainline conductors shall be cleated in place; No. 6 AWG and larger may be cleated in place or installed in rigid conduit.

ii). 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.

iii). In addition to cleating of the 480 VAC trainline and NO 6 AWG and larger cables, they should be enclosed in a stainless-steel wire way as to not be exposed to the elements or debris strikes.

iv). Wires or cables shall not pass through or over the battery compartment and shall not pass overheat generating equipment, even if the wires or cables are in conduit.

v). Rigid galvanized steel conduit shall be run to all rigid-mounted enclosures. One Rigid conduit union shall be used in each run of conduit between rigid-mounted enclosures. The use of running threads is prohibited.

vi). 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. The use of flexible conduit shall be limited as much as possible.

vii). Open undercar wiring shall be protected over the trucks by running the wiring through RGS conduit, with suitable protective bushings applied at the ends.

viii). 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 possible. Drip loops shall be employed as appropriate.

i). Exterior of Roof

i). All wiring to roof-mounted equipment shall be run in rigid galvanized steel conduits within the carshell.

ii). Wires or cables exposed or in conduit shall not pass over or near heat generating equipment.

iii). 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 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 possibility of water incursion.

j). Interior

i). 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.

ii). 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. If used, flexible conduit must meet all Smoke, Flame and Toxicity requirements. 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 nonmetallic conduits shall be installed in protected areas only, unless specifically approved by Amtrak. In wire ducts, wire shall be secured at each entrance and exit point, to prevent chafing movement.

k). Cable Cleating and Support

i). Open-run cable shall be supported by using split-block cleats of molded neoprene or silicone rubber, spaced no more than 4 feet apart. Slack shall be allowed in the cable to accommodate both thermal expansion and contraction of cable.

ii). 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.

iii). 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.

iv). 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.

l). Wire Securement and Termination

i). 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.

ii). 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.

iii). 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.

iv). 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.

v). 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

vi). A drip loop shall be provided on all exposed wires and cables to prevent fluid runoff into connected equipment.

vii). 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.

viii). Wire tying devices shall not be used:

(1) For any external undercar application

(2) To support wire under its own weight

(3) To support/secure any type of conduit

ix). 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.

x). 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.

xi). All jumpers, jumper heads and jumper receptacles shall be sealed in an approved manner to prevent the entry of water at any operational speed.

xii). Any wiring needed to calibrate and test vehicle functions shall be a part of the permanent vehicle wiring to enable Amtrak to conveniently maintain the equipment. This wiring shall terminate in approved connectors in the respective control groups and cabinets.

xiii). Amtrak requires wiring and cabling to be accessible for repairs; the Contractor shall submit a complete wiring plan for evaluation at the appropriate design reviews.

m). Marking

i). All terminal 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 Amtrak in design review.

ii). Wires shall be marked with sleeve-type labels with permanent typed-on lettering, such as TE/Raychem TMS or approved equal, or with non-conductive hot stamping type markings. Both ends of each wire are to be identified. Wires smaller than 6 AWG should be labeled the length of the wire at intervals of 6" and the wire identification should be color coordinated as to voltage type. Wires 16 AWG or smaller may be color coordinated and tagged on each end with the sleeve type labels mentioned here.

n). Cable and Wire Identification

i). 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.

ii). 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 Amtrak equipment. This naming system will be employed on the following:

(1) Electrical Arrangement Drawings

(2) Electrical Schematics

(3) Wiring Diagrams

(4) Labels on hardware

(5) Car Electrical Panels, etc.

(6) Device names: circuit breakers, indicators lights, switches, relays, contactors, pressure switches, etc.

(7) Car Wiring

(8) The above categories on drawings provided by different vendors (for example, air brake schematic and electrical schematics)

iii). 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.

iv). 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.

v). It shall be the Contractor's responsibility to ensure that:

(1) All equipment suppliers conform to this Specification.

(2) A consistent numbering system is used throughout the vehicles; and

(3) Component device and wire names are not duplicated.

vi). At a minimum, the following major electrical system components shall be identified:

(1) Electrical panels

(2) Contactors and motor starters

(3) Relays and timers

(4) Switches and circuit breakers

(5) Electronic components

(6) Terminal blocks

(7) Connectors

(8) Each wire

(9) All labels shall be permanent and expected to be legible for the life of the vehicle.

(10) Labels shall be easy to read and observable without having to disturb wiring, especially for:

(a) Relay names

(b) Contactor/Motor starter names

(c) Terminal block and terminal identity.

(11) 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.

(12) 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.

o). Pulling Compound

i). Pulling compound shall be non-conductive, non-hygroscopic, non-odorous, and shall not attract vermin.

p). Solder

i). Wire connections or terminations by soldering shall not be permitted unless explicitly approved by Amtrak prior to application.

q). Tape

i). Use of electrical tape shall be minimized. Electrical tape shall not be used without the prior approval by Amtrak. If used, electrical tape shall be as specified in Section F, S-540 of the AAR Electrical Manual of Standards and Recommended Practices, or equivalent; UL Listed; and a minimum of 0.007 inch thick. Electrical tape shall meet or exceed the voltage rating of wire where the tape is applied.

19.35 Wire and Cable Connections

a). General

i). 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.

ii). 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.

iii). Conduit shall be attached to the carbody employing clamps; welding shall not be used under any circumstances.

iv). 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.

v). Wiring run in loom shall not be carried over a potential chafing hazard.

vi). Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

vii). 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.

viii). All equipment enclosures and junction boxes shall be fitted with terminal boards or connectors.

ix). The Contractor shall submit the proposed design and product line for all connections and terminations for approval as part of PDR. **[CDRL 19-08]**

(1) Number 6 and smaller type terminal boards and quick-disconnect terminals, other than those stated herein, will only be permitted with approval.

b). Terminal Boards and Terminal Points

i). 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 Federal Specification A-A-59125.

ii). 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 metal body shall contain a high strength spring steel spring element that will provide a gas-tight connection with the conductor.

iii). Spring connection shall be stainless steel. The terminal blocks shall come with carbody 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 screwdriver. Stranded wire of any size shall have a ferrule on its end

iv). 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.

v). 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.

vi). Jumpers between terminal board points shall be brass or plated steel. Wire jumpers between adjacent terminals of terminal boards will not be permitted.

vii). Terminal blocks will employ closed bottom blocks.

viii). 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.

ix). 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.

c). Wire Terminations

i). Terminals and connections used throughout the vehicle shall be the mechanical, solderless, crimp type made by TE Connectivity/AMP or other approved manufacturer with a comprehensive line of terminals, connector pins and application tools available.

(1) Terminals shall be tested to Military Specification MIL-T-16366F for temperature rise, voltage drop, vibration, current overload, and corrosion.

ii). All wire terminations shall be accessible to remove or replace. Wire terminations shall not be covered by other wires.

iii). All heater wiring terminations shall be Nickel plated and the terminal insulation shall be rated for high-temperature applications.

iv). 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 its suppliers shall employ a certification process to ensure that all tooling remains within calibration to properly crimp the lugs.

v). Spade (i.e., Fast-On) terminal usage is to be limited and shall only be used with Amtrak approval. Hook-type terminals shall not be used. Corrosive protection shall be provided for all base materials.

vi). 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.

d). Power Cable Terminations

i). 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.

e). Cable Connectors

i). All cable connectors shall conform to SAE AS50151 except for the screw coupling arrangement replaced with the ¼ turn quick disconnect bayonet lock. 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. The car-side piece of all cable connectors shall be rigidly mounted.

ii). 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. Reduced numbers of spare wires in a given connector may be submitted to Amtrak for review and will be approved on a case-by-case basis if 10% of the contact count is less than 4.

iii). 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.

iv). 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.

v). Plastic bodied connectors shall not be used.

vi). In waterproof interior locations, the use of non-weatherproof connectors will be allowed as approved. All other connector requirements specified in this Chapter which do not directly apply to weatherproofing shall be met.

vii). Alternative connectors such as Harting HAN™ Modular series may be used as approved by Amtrak.

viii). Ethernet connectors shall be M12 style connectors (per IEC 61076-2-101) as manufactured by Harting or approved equal. Ethernet connectors for intercar jumpers shall be housed in an environmentally sealed connector shell suitable for M12 connectors as manufactured by Harting, or approved service-proven equal.

f). Quick-Disconnect Terminals

i). Only Amtrak-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 Amtrak for that unique application.

g). Grounding/ Bonding Connections

i). Grounding and bonding shall be done in accordance with APTA Standard PR-E-S-005-98, unless otherwise approved by Amtrak. 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.

ii). 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.

iii). 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.

iv). 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.

h). Wire Splicing

i). Splicing of conductors shall be avoided and shall be permitted only with Amtrak approval, on a case-by-case basis.

ii). 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 SAE AS7928, 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 un-spliced portion by more than 40%. Splices shall be identified in the integrated schematic.

19.36 Conduit

a). Types

i). Thin-wall EMT type conduit shall conform to UL 797. Flexible metal conduit shall conform to Federal Specification A-A-55810. Flexible polymer conduit shall conform to SAE AS81914.

b). Size and Fill

i). 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 15º is used between enclosures, a maximum fill of 40% will be permitted.

c). Installation

i). General

(1) 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.

(2) 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.

(3) 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.

(4) All conduits 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. Open ended conduits are prohibited.

d). Conduit Fittings and Junction Boxes

i). General

(1) 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.

(a) The Contractor shall submit the proposed product line for approval. **[CDRL 19-09]**

(2) All conduit fittings and junction boxes shall be provided with gasketed covers.

ii). Boxes

(1) All exterior junction boxes shall be fabricated of material appropriate for exterior usage, such as stainless steel, or as approved by Amtrak. All exterior junction boxes shall be weatherproof and shall be connected in such a way that drainage from equipment groups will not pass through the conduit into the junction boxes. Interiors of all junction boxes shall be primed and then protected with a white, insulating epoxy powder coating. If electrical faults within the box can be detected, the interior of the junction boxes may be left unpainted. 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.

iii). Conduit Interface

(1) 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 or an alternate solution may be presented and used subject to approval. All conduit entries into removable equipment boxes shall be secured by means of a bolt-on watertight access panel or an alternative solution may be presented and used subject to approval

iv). Covers

(1) 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.

v). Wireways

(1) Wireways shall only be permitted in approved ceiling locations. They will not be permitted in the car body sidewall or under flooring areas. Only conduit will be permitted to run within the car body.

(2) All wireways shall be “Panduit”, meeting Amtrak Specification 352, or 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.

(3) Wireways shall be located to provide access to the harnesses contained within for maintenance action.

(4) Bends in wireways shall be avoided; however, if they are required, approved protection shall be provided to avoid insulation chafing at the bends.

(5) 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.

(6) All wire and cable shall be securely fastened within wireways to eliminate movement and resultant chafing.

19.37 Electrical and Electronic Designs

a). General

i). Except as otherwise indicated, electrical equipment and components shall conform to IEEE-16 (2020). Electronic equipment shall conform to EN 50155. Solid state power converters shall conform to IEC 61287-1. All mandatory type and routine tests shall be performed.

b). Reliability Standards

i). A standardized MIL-HDBK-217F reliability part stress prediction shall be performed on all electrical and electronic control systems. This reliability prediction shall be based on the "ground Mobile" environment. Use of alternative reliability database information and prediction methodologies or statistically meaningful filed failure data from comparable operating environments may be permitted with Amtrak approval.

c). Ability to Repair

i). All electrical devices including such items as PC boards, relays, contactors, and filters shall be capable of being repaired by Amtrak in its electronics laboratory. It is recognized that some equipment, due to its complexity, cannot be economically repaired by Amtrak. In preliminary design reviews, the Contractor shall identify all situations where this could be the case, for ruling by Amtrak, whose decision shall be final.

ii). Units shall not be sealed, potted, or constructed to prohibit repair by Amtrak. Units that must be potted or sealed by design other than Lowest Level Replaceable Units (LLRUs) shall have a minimum 10-year warranty.

d). Hardware

i). 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.

e). Wiring

i). 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.

f). Optical Fibers

i). Any application of optical fibers shall be approved by Amtrak. Samples of all fiberoptic cables and termination connectors shall be submitted for approval.

ii). Fiber optic cables shall be installed in accordance with the cable manufacturer's instructions, shall be adequately protected from damage of any kind, and shall be readily accessible for maintenance and inspection. Fiber optic terminations shall be of quick disconnect type, designed to prevent degradation due to the car environment, including vibration and variation in temperature, and shall be capable of inspection and repair without removal from the car.

19.38 Electrical Devices and Hardware

a). General

i). All electrical devices shall be service-proven. Electrical connections shall use either captive screws or captive nuts, with crimp terminals.

b). Suppressors

i). Suppressors shall be incorporated across inductive devices to minimize switching transients. All suppression devices shall be selected on the basis of their ability to absorb the amount of energy available in the connected circuit, for the number of cycles of operation expected in service, without requiring replacement prior to scheduled overhaul. All magnet valves and relay/contactor coils shall have free-wheeling diode or metal-oxide varistor voltage spike suppression, or other suppression means, except where this results in deterioration of performance. Coil suppression devices shall be located physically on or as close as possible to the coil it protects (preferably directly at the coil terminal). Wherever possible, the suppression of transients shall be at the source.

c). Contactors and Relays

i). 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 or Amtrak approved alternative solution.

ii). 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 or Amtrak approved alternative solution.

iii). Preference shall be given to solid state relays and contactors where possible.

iv). All contactor and relay coils shall be suppressed with a solid-state device to prevent transients being generated onto the low-voltage network.

v). 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.

vi). 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.

vii). 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.

viii). 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.

ix). 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.

x). Bifurcated contacts shall be used in low voltage applications whenever necessary due to dry contacts or low current switching requirements.

xi). 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.

xii). 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.

d). Switches

i). 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-DTL- 3950. Toggle and push button switches shall be per MIL-DTL-3950, MIL-PRF-8805, MIL-DTL-83731 or equal, as approved by Amtrak. All exterior switches and switches located in “wet” areas shall be IP66 rated or higher. All switches provided shall be of high quality and shall be fully suitable for the rigors of

Amtrak's service environment, including cycle life. The design and selection of all switches shall be subject to review and approval.

ii). Switches shall be provided with a "keying" feature such that after installation, the body of the switch will be constrained from mechanical rotation.

iii). Under no circumstances shall poles of switches be placed in parallel to carry currents in excess of the contact pole rating given by the manufacturer.

iv). There shall be a maximum of two wires connected to each terminal of the device.

v). Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

vi). 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 Engineer's control console, shall be environmentally sealed.

e). Circuit Breakers

i). 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 Amtrak's material control system shall be subject to review and approval.

ii). 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.

iii). 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.

iv). 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.

v). 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.

vi). 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.

vii). All circuit breakers shall be selectively coordinated as to ensure that the protective device nearest the fault trips before upstream devices.

viii). 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.

ix). Each circuit breaker pole shall be equipped with adequate means of arc extinction to prevent flashover.

x). Circuit breakers shall not be intended for use as on/off switches. All circuits requiring on/off switches shall be so equipped.

f). Fuses

i). 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 written approval. Fuses may be considered in applications as follows:

(1) To protect solid-state equipment from catastrophic damage.

(2) Where current or voltage levels prohibit circuit breakers.

ii). 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.

iii). Fuses shall be readily accessible. All fuses mounted in exterior equipment boxes shall be accessible without going under the vehicle.

iv). Fuse holders shall contain fuse retention devices at both ends.

v). 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.

vi). The use of current limit-type fuses is prohibited.

g). Bus Bars

i). 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 and bolted connection points shall be silver or tin plated.

ii). 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.

iii). Bus bars shall be properly brazed together at joints unless bolted connections are found to be 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.

iv). 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.

h). Capacitors and Resistors

i). Dry tantalum capacitors shall be used in place of aluminum electrolytes, except for high values which are not commercially practical or available, in which case long life grade aluminum electrolytic or dry polypropylene film capacitors shall be used.

ii). Dry tantalum capacitors shall be in hermetically sealed metal cases, except for surface mounted types when hermetically sealed metal cases are not available.

iii). 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.

iv). 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.

v). 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.

vi). Use of trim potentiometers or adjustable resistors shall not be permitted without Amtrak approval. Generally, the need for adjustments shall be avoided by use of the appropriate circuitry, and stable precision components.

vii). Transformers and Inductors

viii). Transformers and inductors shall be rated at 20% over the maximum specified current level.

i). Switch, Circuit Breaker and Fuse Panels i). 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.

ii). 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.

iii). 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 device controls and its circuit designation. The dead front panel shall conform to NFPA No. 70, Article 408. A wiring gutter shall be provided along the top, sides, and bottom, for the routing of high voltage leads to their designated circuit breakers.

iv). 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.

v). Power distribution to circuit breakers and switches shall be from a bus bar or bus circuit. Distributing power

vi). by successive or "daisy-chained" connections between device terminals will not be permitted.

vii). Battery Backup Circuits

(1) Any device provided that requires a backup battery must be designed with a five-year battery life unless specifically approved by Amtrak.

(2) A “low battery replacement” indicator or an equivalent fault message in the equipment diagnostics shall be provided to enable timely battery replacement prior to a loss of backup functionality.

19.39 Semiconductor Standards

a). General

i). 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.

ii). 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.

b). Rating

i). Discrete semi-conductors shall have the following minimum voltage breakdown rating, dependent on the use:

(1) 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.

(2) 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. Diodes with less than 1,000 V PIV rating may be used if adequate circuit transient protection is also provided.

(3) All discrete semiconductors operated from 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 limit the circuit voltage to the values specified by the semiconductor manufacturer.

ii). Semiconductors shall be placed in a clean and ventilated environment which shall favor easy replacement.

iii). All semiconductor junction temperatures shall be limited to 150ºC (or to the maximum rated temperature for the device, whichever is less) or less at maximum ambient temperature and at maximum rated output power.

iv). All semiconductors shall be operated at less than 50% of the maximum continuous current rating or maximum continuous power rating, whichever is more restrictive.

v). 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.

vi). 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.

vii). All gallium arsenide and similar optical semi-conductors shall be rated for operation over the temperature range of –40°C to +85ºC.

viii). All semiconductors shall be rated "industrial or automotive grade" for reliable operation over the temperature range of -40ºC to +85ºC, except for discrete power semiconductors (>=1 Watt) which shall be rated for temperature range of -55ºC to +125ºC. Exceptions shall not be taken without proper identification and written authorization from Amtrak prior to first article tests.

ix). 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 Amtrak prior to the first article inspection.

c). Availability and JEDEC Registration

i). To the highest extent practicable, thyristors, transistors and diodes shall be JEDEC registered and numbered.

ii). 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.

iii). Environmental Stress Screening All printed circuit boards or assembled card racks shall undergo Environmental Stress Screening (ESS) in accordance with Section 5.10 of IEEE Std 16-2020. ESS alternatives based upon EN 61163-1 guidance will be considered as approved by Amtrak. All ESS records must be maintained for review by Amtrak inspectors.

19.40 Printed Circuit Board Standards

a). General

i). Printed circuit boards shall be designed to IEEE Std 16-2020, Section 4.10 except as noted otherwise below.

ii). Printed circuit boards incorporating vital functions shall be designed to IPC-2220 Design Standards Series, Printed Boards, Class 3.

iii). Printed circuit boards incorporating components whose power dissipation is in excess of 2 watts, or boards mounted adjacent to such components shall utilize circuit board material per NEMA Standard LI 1, Type FR-5.

iv). Printed circuit boards shall have a minimum thickness of 0.0625 in base material. All conductor material shall be copper and shall be firmly attached to the board and shall be resistant to blistering and peeling when heated with a soldering iron.

v). All printed circuit boards shall be designed for ease of testing per ANSI/IPC-D-275, "Testability Design Check List."

vi). Traces shall be made as wide as practical, with the minimum width being based on a 10ºC temperature rise.

vii). 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.

viii). 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.

ix). 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.

x). All printed circuit boards shall be of the "plug-in" type, with positive support against vibration, except where otherwise approved otherwise.

xi). No more than one PC board shall be stacked on each PC card.

xii). 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.

b). Marking

i). All circuit boards shall be labeled with a part number, serial number, and descriptive nomenclature.

ii). 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.

iii). 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.

iv). 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.

c). Component Mounting

i). 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.

d). IC and Device Sockets

i). IC and device sockets are prohibited except for components that must be removed for reprogramming or initial calibration procedures or devices that are available only for mounting in sockets. All socket applications shall be subject to approval by Amtrak. All other components shall be soldered in place.

ii). Where approved, IC and device sockets shall comply with MIL-DTL-83502E and MIL-DTL-83734H, as is applicable for the device, and shall be made of the following materials:

iii). The bodies shall be molded from diallyl phthalate, PTFE Teflon, or approved equal.

iv). The contacts shall be fabricated from beryllium copper and shall be plated with a minimum of 0.000030-inch (0.000762-mm) of gold over a minimum of 0.000050-inch (0.00127-mm) of low-stress nickel in the area of contact with IC pins.

e). Conformal Coating

i). Both sides of the assembled printed circuit boards shall be coated with a clear insulating and protective coating compliant with IEEE Std 16-2020.

ii). All IC sockets, connectors and test points shall be masked when the coating is applied.

f). Keying

i). 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, PTC, 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.

g). Circuit Board Connectors

i). 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 Amtrak prior to commencing design.

ii). Connectors which comply with MIL-DTL-55302G or DIN 41612 (EN 60603) Level 1 or 2, and which have plated contacts as described below, are considered to comply with the requirements of this Chapter.

iii). 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.

iv). Card edge connectors are prohibited.

v). All connectors within one panel assembly shall be keyed to prevent damage or malfunction due to incorrect insertion.

h). Testing

i). Sufficient clearance shall be provided between components to allow testing, removal and replacement without difficulty due to lack of space.

ii). 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.

iii). 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.

i). Plated-Through Holes

i). In addition to the general guidelines of the Institute of Printed Circuits (IPC), the following requirements shall be met:

(1) 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.

(2) 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.

j). Enclosures

i). 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.

ii). The rack and enclosure shall provide environmental and EMI shielding necessary to meet the requirements of this Specification.

iii). 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.

iv). 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.

k). Extenders

i). 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. The interfaces between extender and enclosure and PC board shall be positive and secure and shall prevent malfunction and loss of securement during testing. Mechanical locking means shall be considered for large PC boards.

19.41 Auxiliary AC Motors

a). 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.

19.42 Recyclable Materials

a). 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.

19.43 CDRLs

CDRL	CDRL Description	Due
CDRL 19-01	Material description and test lab results	During IDR
CDRL 19-02	Joining and fastening data	During IDR
CDRL 19-03	Dissimilar metals report	During IDR
CDRL 19-04	Passivation process details	During IDR
CDRL 19-05	Visual inspection criteria for laminated glazing	During IDR
CDRL 19.06	Paint Process Documentation	During IDR through FDR
CDRL 19-07	Smoke flammability and toxicity matrix	During IDR through FDR
CDRL 19-08	Design and product line for electrical connections	During PDR
CDRL 19-09	Design and product line for conduit fittings and junction boxes	During PDR

* End of Chapter 18 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

20. Test Requirements

Revision 1

Table of Contents

20.1 Overview

a). This Chapter addresses the requirements for the testing of the design and production of the Trainset and its component cars (or units). It is based upon the traditional descriptions of testing an individual passenger car.

b). The trainset may have varying components and features depending upon Amtrak option.

- i). Based upon this, the Contractor shall review each part of this Chapter and prepare a matrix of its adaptation for the specific applicability for testing to the trainset being constructed.
- ii). This trainset testing matrix shall be presented to Amtrak for approval. **[CDRL 20-01]**
- **iii).** The overall testing program shall be mutually agreed upon by the Contractor and Amtrak.

c). In the following text, the words trainset and car may need to be used interchangeably to meet the intention of the specific test.

d). References to first car or pilot train shall refer to the first delivered equipment of a particular type.

e). As part of the production of the trainset and its component 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 and trainset.

f). The Contractor is also responsible to fulfill all requirements called for by the Federal Railroad Administration (FRA) for testing new passenger equipment, and for operation at 110 mph per the applicable requirements of 49 CFR Parts 238 and 213.345 for Tier I equipment, for submission by Amtrak to the FRA.

g). The tests and any required adjustments to be performed are grouped into four classifications:

- i). Material Certification,
- ii). Proof of Design,
- iii). Production and
- iv). Acceptance.

h). Whenever test requirements overlap, the more comprehensive shall govern.

i). The Contractor shall perform all tests under Amtrak observation, and the FRA may also observe such tests.

j). All contractual tests shall be conducted in accordance with Amtrak approved test procedures.

k). Testing activity scheduled and/or conducted before test procedure approval will be at the Contractor's risk.

l). 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.

m). 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 Amtrak for review and approval.

n). 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.

o). 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 Federal requirements, and to ensure that no unintended or undesirable consequences are encountered during production or operation of the cars.

p). 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.

q). 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.

   i). 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.

r). 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 Amtrak'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.

20.2 General Requirements

a). The Contractor is required to perform all tests as specified herein.

b). The Contractor and its subcontractors may, at their option, perform additional testing as they deem necessary as part of the quality assurance program.

c). Unless indicated otherwise, all costs associated with any of the tests performed are to be borne by the Contractor.

d). 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.

e). 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.

f). Notwithstanding the preceding provision, Amtrak shall not charge the Contractor a fee for the use of Amtrak-owned facilities, tracks or utilities located on the Northeast Corridor, or for the use of Amtrak personnel, the first time a particular inspection or test is performed on a particular car.

g). Amtrak shall have the right to charge Contractor for, and Contractor shall pay, all such expenses in connection with any re-inspection or retesting of a particular car required as a result of a car not having successfully passed the applicable test.

h). Acceptance of the Fleet or any car thereof by Amtrak shall not occur until after all tests, and retests if applicable, are successfully completed in accordance with the requirements stated in the Contract.

i). The Contractor shall give at least ten days' notice to Amtrak prior to the start of any test referred to herein.

j). In the case of pre-revenue service tests per 49 CFR Part 238.111 (b) (2), 45 calendar days' notice shall be given to Amtrak in order to assure timely notification of the FRA.

k). If the Contract, or any subcontracts, Applicable Laws of any public authority having jurisdiction over Amtrak operations, require the Locomotives or other Equipment or Supplies to be inspected, tested or approved, Contractor shall give the COTR thirty (30) days (sixty (60) days for international travel) notice of its readiness and of the date arranged for any such testing so Amtrak may observe such inspection, testing or approval.

l). The Contractor shall perform and bear all costs of performing such inspections, tests and approvals unless otherwise provided in the Contract.

m). If after Contractor begins delivery of the Trainsets or other Equipment or Supplies, Amtrak determines that any such item requires additional inspection, testing, or approval (in addition to inspections and tests provided under the Contract), Contractor shall, upon written authorization from Amtrak, order such additional inspection, testing or approval and Contractor shall give notice as provided hereunder.

n). These additional inspections or tests shall be conducted at the initial expense of Amtrak, and Amtrak shall grant a non-compensable extension of time equal to any delay caused by such tests.

o). Notwithstanding the preceding sentence, if such additional test or inspection reveals a defect or failure of the cars or Supplies to comply with the requirements of the Contract; or with any Applicable Laws, ordinances, rules, regulations or orders or if the original test or any retest or additional testing is improperly conducted by a Contractor Party, Contractor shall bear all costs of correction and retesting thereof, and no extension of the Contract Time shall be granted.

p). Required certificates of inspection, testing or approval shall be secured by Contractor and promptly delivered to Amtrak.

q). Neither the observations nor representations of Amtrak in its administration of the Contract, nor Amtrak's inspections, tests or approvals shall relieve Contractor from its obligations to perform the Work in accordance with the Contract.

r). Except as otherwise provided herein or agreed to by the Parties; tests shall be performed at plants of Contractor or its Subcontractors.

s). Contractor shall have a valid Amtrak Temporary Permit to Enter prior to performing any work on the Railroad or Amtrak's premises.

t). For onsite track testing, Amtrak shall identify suitable track meeting the length, alignment and other characteristics identified by the Contractor to permit performance of the required qualification track tests .

u). Except as provided herein, Amtrak may, at its sole discretion, 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. Amtrak has the discretion to reject any test reports from similar or identical equipment that the Contractor may propose in lieu of actual testing, for any reason at all, including but not limited to differences in the equipment, differences in the operating environment, insufficient time or mileage in service, or anything else whatsoever.

20.3 Test Plans, Procedures and Reports

a). The Contractor shall prepare and provide to Amtrak as specified the following test documentation. See Chapter 22 for additional details regarding submittal of documents to Amtrak.

i). Master Test Plan

(1) No later than 180 days after NTP, the Contractor shall submit to Amtrak for review and acceptance a Master Test Plan **[CDRL 20-02]** covering all tests listed in or otherwise required by this Technical Specification.

(2) The Master Test Plan shall be updated monthly and presented as an attachment to the program meeting minutes.

(3) The Master Test Plan shall include a testing matrix identifying, all tests as required to be performed by the Contractor and suppliers, including but not limited to:

(a) Material certification tests;

(b) Proof-of-design tests, including all required carshell, truck and suspension and ride quality tests;

(c) Production tests; and

(d) Acceptance tests.

(4) 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.

(5) The plan shall be updated periodically, showing the status of each test procedure, test and associated report summarized in a spreadsheet format.

ii). Test Procedures

(1) 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. **[CDRL 20-03]**

(2) Tests procedures shall be submitted for approval in advance of the anticipated test dates as follows:

Figure 20-1: Test Procedure Submittal Due Dates

Test Type	**Procedure Due Date**
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

(3) All required testing shall be conducted in accordance with Amtrak-approved master test plan and approved test procedures.

(4) 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	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. 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. Each test performed shall be signed and dated by the technician performing the test.
9.0 Data Sheets	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.

(5) Each car and system shall be tested in exact accordance with Amtrak-approved revision of the test procedure.

(6) All test and inspection instruments shall be properly calibrated.

(7) Should a system or component fail a test, the component or system shall be repaired or replaced, and the test repeated from the beginning.

(a) The test shall not be restarted at the point at which the failure occurred.

(b) Amtrak may, at its sole discretion, determine portions of the failed test which need not be repeated. Unless Amtrak gives written approval to re-test only the portion impacted by the failure of a component.

(8) Each test shall be a separately controlled document and identified by its own number, title and revision.

(9) All revisions shall be submitted to Amtrak for approval.

(10) A history of test revisions and changes shall be maintained and recorded within the test document.

(11) 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).

(12) All special tools and/or equipment to be used must be specified within the test document.

(13) A data collection form shall be used with each procedure and shall be fully identified.

(14) Each individual test shall be accompanied by a separate sheet where the test results are documented.

(15) 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.

(16) Areas shall be provided for recording actual values produced during the test where needed.

(17) In addition, acceptance criteria and associated tolerances shall also be shown in parenthesis near the space available for recording the actual value.

(18) The test number, revision and page number shall be shown on the header of each page or all test procedures.

(19) 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 Amtrak representative.

iii). Testing Notification

(1) In the case of pre-revenue service tests per 49 CFR Part 238.111(b)(2), the Contractor shall provide no less than 45 calendar days' notice to Amtrak in order to assure timely notification of the FRA.

(2) For other tests, each detailed test procedure shall be submitted to Amtrak for review far enough in advance of the planned test date to allow Amtrak at least 60 days for Qualification and Proof of Design tests and 45 days for production tests 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 Amtrak, to have approval a minimum of ten (10) working days prior to any testing covered by the procedure.

(3) Amtrak shall witness all tests.

(a) Under no circumstances will Amtrak accept the results of a test performed without approved procedures.

(b) Amtrak requires the Contractor to do internal pre-testing to validate performance prior to the Amtrak-witnessed testing and may require it for tests requiring Amtrak personnel to travel to a Contractor site. In the event the witnessed tests fails, the unwitnessed test results may not be used as a substitute.

iv). Test Documentation

(1) The Contractor shall be responsible to provide Amtrak with written test reports for all tests performed on the cars and their components, including supplier test reports.

(2) Upon the completion of each test, the Contractor shall submit a written report of each test, including copies of all test data, to Amtrak for approval. **[CDRL 20-04]**

(3) 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.

(4) The test report shall include a record of the testing dates, tracing numbers for any calibrated instruments used during testing and an overall conclusion of the test findings.

(5) A test shall not be considered as completed until Amtrak (and the FRA, as required) has approved its final written test report.

(6) Should the test procedure or reports be inadequate and not meet the requirements of the Technical Specification of the FRA, Amtrak reserves the right to require revisions including those requiring more testing tasks or data to satisfy itself that the test program or report is adequate and does meet FRA and Specification requirements.

(7) The approval of Amtrak does not in any way relieve the Contractor of responsibility for the adequacy of the test program within the scope of this technical specification.

(8) 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 Amtrak in a single volume and a single pdf document with links to each test that is easily searchable. **[CDRL 20-05]**

(9) All material certification and proof-of-design test procedures and reports shall be supplied by the Contractor in a separate binder and submitted to Amtrak for review and approval prior to acceptance of the first car of each type and a single pdf document with links to each test that is easily searchable. **[CDRL 20-06]**

(10) The master test plan shall be included in this binder and a single pdf document with links to each test that is easily searchable.

(11) 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 Amtrak prior to acceptance of the first car of each type and a single pdf document with links to each test that is easily searchable.

(12) For production tests, which are performed on all cars or all components, a separate volume shall be submitted to Amtrak containing all approved tests applicable to individual cars and a single pdf document with links to each test that is easily searchable.

(13) 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 and a single pdf document with links to each test that is easily searchable.

(14) 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 and a single pdf document with links to each test that is easily searchable.

(15) This test log shall be maintained by the Contractor during the equipment assembly.

(16) The test log shall have a place for a technician signature and date and will be signed when each test procedure has been completed.

(17) The test log shall be submitted to Amtrak for review before each car shall be released for shipment to the delivery site.

(18) All Contractor and Amtrak in process inspection sheets and test data records for that car shall be contained in this test log.

20.4 Material Certification Tests

a). 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:

i). All exterior glazing shall be certified to conform to 49 CFR Part 223 requirements.

ii). All interior materials shall be certified to meet smoke, flame and toxicity requirements.

iii). All subfloor panels shall be certified to meet strength and impact resistance requirements.

iv). All materials used in production of the carshell shall be certified to meet material strength, composition and performance characteristics.

v). All components used in the manufacture of truck, suspension and coupler assemblies shall be certified to meet all applicable strength, composition and performance requirements.

vi). All insulation materials shall be certified to meet applicable insulation performance standards.

vii). All materials used in food preparation areas of the Food service car, potable water systems and trash storage shall be certified to meet all applicable Public Health Service sanitation requirements.

viii). All interior and exterior emergency signage materials shall be certified to meet FRA emergency exit signage requirements.

ix). All emergency power sources shall be certified to meet FRA emergency exit pathway.

x). All emergency equipment shall be certified to conform to all applicable FRA regulations and other requirements as necessary.

xi). 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.

xii). All electrical devices producing magnetic fields shall not pose a hazard to any person with a pacemaker or other cardiac device within any area of the carbody interior, including passenger and maintenance areas. They shall be certified to meet the requirements of IEC 60601-2-23 Medical Electrical Equipment, Particular Requirements for the Basic Safety and Essential Performance of Magnetic Resonance Equipment for Medical Diagnosis.

20.5 Proof of Design Tests

a). General

i). 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:

(1) the performance requirements of the carshell structure, systems and components have been met

(2) the system and all component parts function as intended and within all specified parameters

(3) no unintended or unanticipated functions, problems or non-conformances are discovered during production or operation of the cars.

ii). 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.

iii). 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.

iv). 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.

v). 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.

b). Carbody

i). Weight and Balance

(1) Each completed car shall be weighed on a certified scale at AW0 condition ready to run [i.e. water, food service equipment, supplies, bedding, etc.] to determine compliance with the maximum weight and weight distribution requirement of the specification.

ii). Clearance

(1) Each completed car type shall be measured at AW0 and AW2 load to verify compliance with the clearance diagram. This shall include all exterior fittings, hardware, safety appliances, pilot/ snow plow (including FRA top-of-rail clearance requirements) etc. Width measurements shall be taken from the centerline of calibrated track, not the carbody.

iii). Car Curving

(1) The first Trainset containing each car type shall be tested to verify compliance (including having sufficient clearance between truck and carbody/equipment) to successfully negotiate the specified minimum curving radius in both directions of curving.

(2) This must take into account suspension motion (including worst case broken or collapsed springs), wheel wear, and the actions of maximum buff and draft with all connections made between cars within the trainset.

(3) Each possible combination of vehicle end configurations including locomotives and car types shall be tested, with adaptors if necessary.

(4) The test shall also include a trainset coupled to specified locomotive(s) at both ends.

iv). Structural

(1) General

(a) 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.

(b) The test plans shall be coordinated with the final design of the carbody shell compliant with 49 CFR Part 238 requirements and shall test structural element strength and/or crash energy management performance, as based upon the design.

(c) Specific details of the structural test plan shall be submitted to Amtrak for approval.

(d) The first representative carbody of each car type shall be tested by the Contractor to confirm that the FEA is sufficiently accurate to ensure that the carbody structure complies with this Specification.

(e) If there are no major structural differences between the carbody types and the test results are comparable with the FEA, the Contractor may choose to present data showing the similarities and differences between different carshell types to propose that the testing of certain carshell types can validate the performance of multiple types. In those cases, the worst case carshell must be the one subject to testing. Selection of carshells for testing is subject to approval by Amtrak and to review and objections from the FRA

(f) The tests shall be performed at an Amtrak approved facility.

(g) 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.

(h) The tests shall not begin until the carbody stress and any energy absorption analyses have been submitted and approved by Amtrak.

(i) 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.

(j) 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.

(k) The test shell shall have no paint, primer, sound damping coating, or insulation.

(l) The weight of underfloor and above floor compartment-mounted equipment and heavy roof-mounted equipment shall be simulated by equivalent weights at their respective locations.

(m) All structural tests shall be conducted on the same carshell or carshells.

(n) The carshell shall be weighed and the weight recorded prior to installation of any test equipment.

(o) For the tests, the car shall be supported on the trucks or equivalent supports to allow longitudinal movement.

(p) All gauges and instruments shall be in current calibration and remain so for the duration of the test.

(q) The methods of calibration and time periods for recalibration shall be in accordance with the test laboratory's national standard or ISO standards.

(r) The laboratory shall have on file a current certification of calibration traceable to the laboratory's national standard or ISO standards.

(s) The Contractor may conduct preliminary tests per the approved test procedures, but all critical dimensions and flatness shall be verified after the Contractor tests and before the official test begins. All data from preliminary tests shall be recorded per the approved test procedures and available to Amtrak upon request.

(t) The test of record is to be witnessed by Amtrak.

(u) A copy of all recorded data shall be given to Amtrak at the conclusion of each test.

(v) A data acquisition system shall be provided to permanently record all gauge outputs at each load step. The data acquisition system and complete sensor set up shall be qualified by a hand held, high precision fixed shunt resistor across sensors chosen by the Amtrak test representative.

(w) 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 Amtrak or its representative for review. Loads shall be reported in pounds for each individual application and totaled.

(x) The Contractor shall obtain approval of Amtrak or its representative after every load step before proceeding with the next step.

(y) All vertical and compression loads shall be complete removed, residual stresses measured, and sensors (including vertical load sensors) zeroed at the end of each individual test.

(z) The Contractor shall not break down the test fixtures until Amtrak or its representative has reviewed and accepted all data for the applicable test.

(aa) The Contractor shall prepare a color photographic record of the test.

(bb) This record shall include photographs of the car in the test fixture configuration for each test, installation of sensor configuration for each test, repairs or modifications, deviations from the drawings, and any areas found to be non-compliant.

(cc) The entire procedure shall be video recorded by the Contractor. The camera shall rove to view and record key areas.

(dd) All video taken during this test shall become the property of Amtrak. Video camera locations must be approved by Amtrak.

(ee) Amtrak reserves the right to test a second car of each type during the construction period.

(ff) Should such a test be ordered, it shall be at the expense of Amtrak 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 Amtrak's costs, and the cost of modifications necessary for the car and all other cars to be made compliant with the Specification.

(gg) The Contractor (at its expense) shall also perform a complete set of structural tests to qualify the modified car.

(2) Test procedures

(a) A procedure shall be prepared for each test.

(b) 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.

(c) Annotated copies of catalogue cuts may be used to provide parts of the description.

(d) An explanation of the accuracy of the instrumentation shall be provided.

(e) Photographs (where available), drawings and sketches shall be included to clarify the text.

(f) 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 Amtrak or its representative.

(g) 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.

(h) The test procedure shall include a copy of the current calibration certification for each instrument and gauge to be used for the test.

(i) 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.

(j) Tables shall be included to give the maximum allowable reading for each gauge and loading condition.

(k) Other tables shall be included to provide the requirements for all other test criteria.

(l) Each test procedure shall contain a table of predicted strain (or stress) its magnitude of the allowable, and deflection at selected gauge locations.

(m) 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:

$$\% \text{ difference} - \frac{\text{Actual - Predicted}}{\text{Actual}} \times 100$$

(3) Strain gauges

(a) For structural strength testing, a minimum of 200 strain gauges (as typical for an 85 ft long car) shall be applied to the car structure for each of the compression, vertical load and diagonal jacking tests.

(b) 75% of the strain gauges shall be 3 gauge combinations, such as rosette gauges, unless the Contractor can provide a proven history of reaching 20% correlation accuracy with uni-directional gauges.

(c) Some gauges may be used for more than one test if their location on the structure is appropriate for other tests as accepted by Amtrak, but readings from at least 200 strain gauges in locations of interest shall be obtained for each test.

(d) The location of the strain gauges shall be based on the Contractor's experience, the stress analysis and Amtrak's recommendations.

(e) There shall be no less than three locations where there are a sufficient number of gauges to encircle the carbody, providing cross sections through the vehicle for evaluation.

(f) One location shall be outboard of the bolster, one shall be at the quarter-point between the truck centers and one shall be at the center of the car.

(g) 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.

(h) For structural post tests (if used), there shall be a minimum of 100 strain gauges applied to the post and car structure in the vicinity of the post.

(i) 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.

(j) 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.

(i) These drawings shall dimension the location and orientation of each gauge, showing their distances from edges, connections and bends.

(ii) Their locations on the upper or lower, inner or outer surface shall be noted on these drawings.

(k) The gauges shall be calibrated and applied in accordance with the manufacturer's instructions for the material being measured and be compensated for temperature.

(4) Deflection gauges

(a) For structural strength testing, vertical deflection of the carbody shall be measured along both side sills at each load step during all tests.

(b) At least 11 gauges per side shall be used.

(c) Gauges shall be located at the end sills, at the bolsters, and at the mid-point between the bolsters.

(d) The remaining gauges shall be evenly spaced between the five locations.

(e) 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.

(f) 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.

(g) For the diagonal jacking and lifting tests, an additional deflection gauge shall be applied at the jack or crane that is lowered or raised to measure the vertical movement at the lifting locations.

(h) 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.

(i) 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.

(j) 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.

    (i) These gauges shall be mounted to measure the deflection of the post in the direction of the applied force.

(k) Deflection gauges shall be mounted on rigid stands separate from the carbody and its fixtures.

(l) The contact surface on the car shall have a smooth, polished, low-friction surface plate mounted perpendicular to the axis of the deflection gauge.

(m) 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.

(n) The gauges shall be readjusted and the test repeated from the beginning.

(o) The deflection gauges shall have electrical outputs compatible with the data logging apparatus used with the strain gauges.

(p) All deflections shall be recorded simultaneously with the strain gauge recordings.

(q) In addition to the above electronic recordings, dial indicators (mechanical) of sufficient stroke shall be employed.

    (i) Two shall measure the vertical deflection at the center of both side sills during all tests.

(r) 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.

(i) An indicator shall be located next to the lowering jack during the diagonal jacking test.

(ii) A dial indicator shall be mounted at the center of the post during each post tested.

(iii) These dial indicators shall be read and manually recorded at each load step.

(s) 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.

(5) Load cells

(a) 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.

(b) 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.

(6) Load Application

(a) Unless otherwise agreed to by Amtrak, all loads for all tests shall be applied using hydraulic actuators to ensure quick testing schedules of the multiple carshell variants.

(7) Vertical load test

(a) Test description

(i) For structural strength testing, 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, equivalent to the AW3 passenger load, shall be applied to the car in 4 equal steps, resulting in a total of five vertical load increments. The test load 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.

(ii) During the vertical load structural testing, both sets of doors on the vehicle shall be installed and their performance validated during max load. Alternatively, six additional deflection gauges can be used to validate the FEA's predicted worst case door opening deflections and the door may be test separately using these worst case deflections.

(b) Test criteria

(i) The car shall be considered compliant with vertical load testing if all of the following conditions are met:

1. Stresses are in accordance with the requirements of APTA Standard PR-CS-S-034-99.

2. 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.

3. 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.

4. 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.

5. Recorded residual vertical deflection between bolsters following removal of the maximum vertical test loading does not exceed 0.01 in.

6. Recorded residual car transverse width and/or opening diagonal dimensions following removal of the maximum vertical test load do not exceed 0.01 in.

7. 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.

8. 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.

9. Door operation is normal, including normally expected cycle times.

10. 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 Amtrak to determine if the failure is the result of weld quality or stress.

11. Vertical deflection readings validate the required camber values

(8) End Sill Compression Load Test

(a) Test description

(i) For structural strength testing, a compression test load as defined in APTA Standard PR-CS-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.

(ii) 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.

(iii) 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. The ram's connection to the structure shall allow vertical rotation for any deflection of the structure throughout the test.

(b) Test criteria

(i) The car shall be compliant with end sill compression testing if all of the following conditions are met:

1. Stresses are in accordance with the requirements of APTA Standard PR-CS-S-034-99.

2. The vertical deflection of each side of the test structure is within ± 10% of the value determined by the analysis.

3. The force measured at the reaction load cell is within 1.0% of the force applied at the ram.

4. 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.

5. 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.

6. There are no permanent deformations, fractures, cracks or separations in the car structure. Broken welds are to be jointly inspected by the Contractor and Amtrak to determine if the failure is the result of weld quality or stress.

(9) Compression load test at the draft stop

(a) Test description

(i) For structural strength testing, 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.

(ii) 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 AW0 loaded car. This loading shall be distributed in proportion to the distribution of weight in the finished car. The ram's connection to the structure shall allow vertical rotation for any deflection of the structure throughout the test.

(iii) 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.

(b) Test criteria

(i) The car shall be compliant with compression testing if all of the following conditions are met:

1. Stresses are in accordance with the requirements of APTA Standard PR-CS-S-034-99.

2. The vertical deflection of each side of the test structure is within ± 10% of the value determined by the analysis.

3. The force measured at the reaction load cell is within 1.0% of the force applied at the ram.

4. 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.

5. 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.

6. 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.

7. Recorded residual vertical deflection between bolsters following removal of the maximum vertical test load does not exceed 0.01 in.

8. The residual horizontal deflection between ends following removal of the maximum load does not

exceed 0.04 in.

9. 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.

10. There are no permanent deformations, fractures, cracks, or separations in the car structure. Broken welds are to be jointly inspected by the Contractor and Amtrak to determine if the failure is the result of weld quality or stress.

(10) Diagonal Jacking Test

(a) Test description

(i) For structural strength testing, the carshell shall be loaded to its AW0 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.

(ii) The amount of torsional deflection or twist shall be measured.

(b) Test criteria

(i) The car shall be compliant with diagonal jacking testing if all of the following conditions are met:

1. Maximum stresses calculated from strain readings in any structural element do not exceed 80% of the yield strength.

2. 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.

3. Indicated residual strains at strain gauges following return to original level do not exceed the maximum

error resulting from the accuracy of the instrumentation.

4. There are no permanent deformations, fractures, cracks or separations in the car structure.

5. Broken welds are to be jointly inspected by the Contractor and Amtrak to determine if the failure is the result of weld quality or stress.

(11) Diagonal lifting test

(a) Test description

(i) For structural strength testing, the carshell shall be loaded to its AW0 weight, with trucks, or equivalent weight, hanging from the body bolsters. The carshell shall be supported symmetrically at the four most outboard jacking pads of the car. One of the corners shall be lowered in five equal increments until it is free of the support. The selection of the corner to be lowered should be based on its relation to the center of gravity of the carshell so that the diagonally opposite corner remains in contact with the support and carries some car weight. All gauges shall be recorded at each increment of crane position. The procedure shall be reversed until the load is returned to its original level.

(ii) The amount of torsional deflection or twist shall be measured.

(b) Test criteria

(i) The car shall be compliant with diagonal lift testing if all of the following conditions are met:

1. Maximum stresses calculated from strain readings in any structural element do not exceed 80% of the yield strength.

2. 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.

3. Indicated residual strains at strain gauges following return to original level do not exceed the maximum error resulting from the accuracy of the instrumentation.

4. There are no permanent deformations, fractures,

cracks or separations in the car structure.

5. Broken welds are to be jointly inspected by the Contractor and Amtrak to determine if the failure is the result of weld quality or stress.

(12) Collision post (if included) elastic test

(a) Test description

(i) For structural strength testing, the ability of the carbody structure to resist collision post longitudinal loads shall be tested.

(ii) 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 AW0 loaded carbody. This loading shall be distributed in proportion to the distribution of weight in the finished car.

(iii) 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.

(iv) A longitudinal test load as specified in APTA Standard PR-CS-S-034-99 shall be applied to, and centered on, the collision post. This load shall be distributed over an area not to exceed the width of the collision post by 6 in. in height. If the required load allows an ultimate strength limit, a reduced load can be proposed but shall maximize the lad to the greatest extent practicable and shall be approved by Amtrak.

(v) 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.

(b) Test criteria

(i) The car shall be compliant with collision post testing if all of the following conditions are met:

1. 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.

2. 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.

3. 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.

4. 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.

5. There is no permanent deformation, fractures, cracks or separations in the car structure.

6. Broken welds are to be jointly inspected by the Contractor and Amtrak to determine if the failure is the result of weld quality or stress.

(13) Corner post (if included) longitudinal load test

(a) Test description

(i) For structural strength testing, the ability of the carbody structure to resist primary side corner post longitudinal compressive loads to all cars shall be tested.

(ii) 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 AW0 loaded carbody. This loading shall be distributed in proportion to the distribution of weight in the finished car.

(iii) 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.

(iv) Longitudinal test loads shall be applied to, and centered on, the corner post as specified in APTA Standard PR-CS-S-034-99. The magnitudes of the loads shall be limited to values that approach the yield strength of the past as predicted by the approved FEA but shall maximize the load to the greatest extent practicable and shall be approved by Amtrak. 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.

(v) 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.

(b) Test criteria

(i) The car shall be compliant with corner post longitudinal testing if all of the following conditions are met:

1. 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.

2. 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.

3. 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.

4. 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.

5. There is no permanent deformation, fractures, cracks or separations in the car structure. Broken welds shall be jointly inspected by the Contractor and Amtrak to determine if the failure is the result of weld quality or stress.

(14) Corner post transverse load test

(a) Test description

(i) For structural strength testing, the ability of the carbody structure to resist corner post transverse loads shall be tested.

(ii) 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 AW0 loaded carbody. This loading shall be distributed in proportion to the distribution of weight in the finished car.

(iii) 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.

(iv) Longitudinal test loads as specified in APTA Standard PR-CS-S-034-99 shall be applied to and centered on the corner post. 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.

(v) 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.

(b) Test criteria

(i) The car shall be compliant with corner post transverse testing if all of the following conditions are met:

1. 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.

2. 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.

3. 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.

4. 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.

5. 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 Amtrak to determine if the failure is the result of weld quality or stress.

(15) Collision post (if included) elastic-plastic test

(a) Test description

(i) Collision posts at the vehicle ends coupled with locomotives shall be tested per the following requirements.

(ii) For structural strength testing, 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 shall be tested.

(iii) This test shall also verify the structural energy absorption requirement outlined in APTA Standard PR-CS-S-034-99, if used in the design.

(iv) The test specimen shall be a full-scale structural model of the 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.

(v) 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. 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.

(vi) 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.

(vii) 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.

(viii) 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.

(ix) 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.

(x) 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.

(b) Test criteria

(i) The collision post shall be compliant with collision post elastic-plastic testing if all of the following conditions are met:

1. 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.

2. The connections between the collision post and all other structural members are not completely broken.

3. If required by the design, the collision post and supporting structure have absorbed energy as per APTA Standard PR-CS-S-034-99.

v). Floor Panel Fire Resistance

(1) Amtrak approved sample of materials representing structural flooring and floor panels shall be tested to verify the ability to withstand the requirements of ASTM E119, when exposed for 30 minutes at up to 1400°F on the material underside.

vi). Safety Appliances

(1) Must demonstrate compliance with FRA and APTA requirements.

vii). Emergency Window Egress and Access

(1) Tests shall be conducted to measure the force required to remove each type of emergency window from the carbody. This shall be done both from inside and outside the car. The test shall include a check that car interior furnishings do not interfere with window removal.

viii). Paint Adhesion

(1) A paint adhesion verification test shall be performed using a standard cross cut adhesion test. This test consists of scribing a grid of four horizontal and four vertical 1-inch long lines through the coating with a sharp steel blade. Pressure sensitive tape, Scotch brand No. 335-2, is then pressed firmly over the scribed area and is then pulled away at 90 degree angle to the sample sheet. The coating shall pass the test if no coating is removed from the substrate material. Several test specimens shall be created by preparing the base metal in the same fashion as the carbody, selecting them to represent different conditions on the car. Specimens shall be painted at the same time as the carbody, with the same painting orientation as on the car (side, overhead, etc.).

ix). Gap Filler

(1) If being supplied as part of this procurement, the powered side door high level station platform gap filler shall undergo proof-of-design testing to evaluate and verify that the filler meets all specification requirements for:

(a) Compliance with all applicable ADA requirements;

(b) Functional and operational performance under all design loads, track conditions as specified, and safety factors without deformation or deflection;

(c) Rate of travel for extension and retraction;

(d) Proper operation of all safety provisions and functional interlocks and isolation devices within the unit and with the door system, brakes and indicators;

(e) Maintainability and reliability requirements; and

(f) Manual retraction with power failure

(2) These tests shall include an endurance test in which the filler shall be subjected to no less than 500,000 repeated cycles of deployment and storage.

c). Trucks

i). Wheel Load Equalization

(1) The truck shall be tested in accordance with APTA Standard PR-M-S-014-06, for Class G passenger equipment

(2) To verify the equalization provided by the truck design, one truck on the first car at AW0 load shall have one wheel jacked up (lifted) 2.5 in. and then increasing to 3 in. while taking load readings every 0.5 inches in both the increasing and decreasing direction and suitable instrumentation provided to measure the load carried on the other wheels. The process shall be repeated with one wheel being dropped (lowered). The load changes shall be in accordance with the requirements of APTA Standard PR-M-S-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.

ii). Truck Frame and Bolster Static Load Test

(1) The truck frame and bolster shall be tested to verify that the maximum allowable stresses established by the Contractor and approved by Amtrak 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 Amtrak.

(2) 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 Amtrak, Amtrak having the power of decision in disagreement. The locations of maximum stress points are to be determined by analysis. The critical stress readings of the two applications shall be averaged for comparison with the estimated stresses.

(3) The loads shall be as listed in Chapter 7. The vertical, lateral, longitudinal, and braking loads shall be applied simultaneously. At no point shall the average stress exceed the allowable stress. If it does, Amtrak 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 Amtrak.

iii). Truck Frame and Bolster Overload Test

(1) 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 listed in Chapter 7.

(2) 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 Amtrak, Amtrak having the power of decision in case of disagreement. The location of maximum stress is to be determined by analysis.

(3) 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 Amtrak, Amtrak 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. Amtrak 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 Amtrak.

iv). Truck Frame and Bolster Fatigue Load Test

(1) To demonstrate that the truck has adequate fatigue strength under dynamic loading, the truck frame and bolster shall be fatigue tested according to the provisions of APTA Recommended Practice PR-M-RP-009-98. Rev.2. For cast and fabricated truck frame and bolster designs the base fatigue test (Phase 1) shall be 6 Million cycles. The number of quasi-static lateral load reversals (curves), braking/traction direction reversals and applied twist loads shall correspond to the expected operation and service environment.

(2) 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 loads shall be as listed in Chapter 7. 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 Amtrak, Amtrak having the power of decision in the event of disagreement.

(3) The frequency of the load cycling shall be as proposed by the Contractor for approval by Amtrak. 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.

(4) 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 Amtrak and the Contractor after which an appropriate correction shall be established and the test repeated.

(5) At the conclusion of the fatigue test, a magnetic particle or dye penetrate inspection shall be made for cracks in the presence of Amtrak. 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 Amtrak.

(6) After completion of the base fatigue test, an extended fatigue test shall be performed. The purpose of the extended fatigue test is to quantify the additional fatigue margin in the truck design.

(7) The extended fatigue test shall be 2 Million cycles with loads increased by 20% (Phase 2), then 2 Million cycles with loads increased by 40% (Phase 3) or until failure occurs.

(8) At the conclusion of the extended fatigue test, a magnetic particle or dye penetrate inspection shall be made for new cracks and propagation of pre-existing cracks. Note that new cracks, propagation of pre-existing cracks and structural failures do not by default constitute a failure for the extended fatigue test but rather data gathered during the extended fatigue test shall be used as part of the Fatigue Assessment Validation Report.

v). Truck Primary Suspension Tests

(1) A load deflection test 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.

(2) For elastomeric primary suspension elements, the following tests are also required following the guidance in EN 13913: low temperature (stiffness), fatigue resistance, static creep, stiffness under sinusoidal motion and damping.

(3) Hydraulic shock absorber (damper) accelerated life cycle endurance tests shall be performed following the guidance in EN 13802, selection of additional operational environment, physical characteristic and functional requirement tests to be proposed by the Contractor and approved by Amtrak.

(4) If defects are found, the design shall be corrected and shall be retested at the expense of the Contractor, and all trucks modified to be in accordance with the corrected design.

vi). Truck Secondary Suspension Tests

(1) A load deflection test shall be performed to demonstrate that the spring rates of the secondary suspension system in all axes are within the design limits. This test shall demonstrate that the secondary suspension system behaves as predicted and will not result in excessive deflection.

(2) Hydraulic shock absorber (damper) accelerated life cycle endurance tests shall be performed following the guidance in EN 13802, selection of additional operational environment, physical characteristic and functional requirement tests to be proposed by the Contractor and approved by Amtrak.

(3) If defects are found, the design shall be corrected and shall be retested at the expense of the Contractor, and all trucks modified to be in accordance with the corrected design.

vii). Shunting

(1) A shunting test shall be performed to verify the rail to rail resistance over the vehicle complies with the requirements in Section 5.8 using a suitable track signal voltage. Any auxiliary equipment shall be tested for proper operation per the manufacturer's specifications. Any auxiliary equipment activation and deactivation sequences shall be tested through 1000 cycles or the manufacturer's recommendation, whichever is greater, without defect.

d). Couplers

i). 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 if used), range of motion, vertical loading, draft and buff loads and operations. This shall apply to all coupler types and/or drawbars used on the Trainsets.

e). Brakes

i). General

(1) 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.

ii). Brake pad/shoe force tests

(1) 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 parking brake and a non-parking brake 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 parking brake.

(2) Load cell brake disk caliper and tread brake shoe force measurements shall be taken on each car type to determine brake efficiency. Measurements shall be taken at minimum, full service and emergency brake pipe conditions, operating from 110 psig brake pipe setting and 140 psig main reservoir value. Force shall be measured also with the parking brake applied.

iii). Brake component fatigue tests

(1) 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 Amtrak.

iv). Friction brake system endurance tests

(1) 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 Amtrak.

v). Brake capacity tests

(1) 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 Amtrak defined train schedule service for speeds up to 110 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 Amtrak. This procedure is an amendment to the qualification of brake shoe and disc brake materials as specified in Amtrak Specification 973 and Amtrak Specification 80-276. All other attributes of friction brake material performance shall be in accordance with Amtrak Specification 973 and 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. For tread brake and brake shoe dynamic testing, a test wheel shall be provided by Amtrak. The test shall be coordinated according to the planned operating pattern.

vi). Handbrake tests

(1) Handbrake performance shall be verified for compliance to the specification as well as APTA PR-M-S-006-98 using new brake shoes/pads.

(2) 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.

(3) The “handbrake-applied” indicator light shall also be tested.

f). Door System

i). General

(1) The side and end door systems shall be subjected to extensive testing to confirm that the systems and components meet all requirements for:

(a) System integrity

(b) Safety

(c) Functionality and operation

(d) Weather sealing

(e) Opening and closing times and speeds

(f) Trainline controls, indicators and interlocks

(g) Compliance with regulations, recommendations and standards

(h) Reliability

(i) Maintainability

(j) Sustained and compliant performance under all specified operational and environmental conditions

(2) All door system components shall be tested through rigorous multiple-cycle operation that simulates the actual installation, hardware and climatic conditions as specified.

ii). Passenger Room Door Endurance Tests

(1) The passenger room entrance door shall undergo endurance testing to verify the door installation is not subject to premature wear. This shall include:

(2) Simulated door installation: door, track, module structure supporting track, door frame with adjoining partition, door latch assembly, detent, etc.

(3) 24,000 Open-close cycles with every tenth slammed

(4) Every 100 cycles, latch/ unlatch the door

(5) Measurement of change from initial setting at every 1500 cycles

(6) Measurement of force required to open/ close door every 1500 cycles

(7) Mutually agreed upon pass/ fail criteria shall be determined for allowable wear in advance of starting the test.

iii). Side door system reliability test

(1) A set of side door panels and operators, fully equipped with all required equipment as designed (including gap filler devices), 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 any 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 Amtrak, 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.

(2) 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 15,000 continuous trouble-free cycles each, split evenly between high level and low level opening/closing of the door and including gap filler cycling. 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 15,000 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.

iv). Side door safety test

(1) Once installed in a completed car, the side door system, including all side doors, shall be functionally tested to verify that the door system and gap filler design conforms to all applicable safety requirements, including:

(a) Trainline and local control, door summary circuit and zero-speed operation

(b) Obstruction detection and recycle operation

(c) Interlocks, isolation and manual locking

(d) Interior, exterior and trainline door status indicators

(e) 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

(f) Structural integrity of the door panel and glazing

(g) Signage and emergency operation

(2) Under no circumstances shall a door be allowed to create an unsafe condition.

v). End door reliability test

(1) An end door 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 500,000 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 Amtrak, 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 500,000 cycles.

(2) Once the first car has been completely assembled, and the entire end door system has been installed and the functionality has been verified, the end doors shall be operated for 15,000 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 for all 15,000 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.

(3) 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, and the push button.

(4) A set of end door push buttons shall be subjected to a 100,000-cycle test that simulates the use of the buttons to command an end door to open. The buttons 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.

vi). Side Door Wheelchair Lift

(1) The powered wheelchair lift shall undergo proof-of-design testing to evaluate and verify that the lift meets all specification requirements for:

(2) Compliance with all applicable ADA requirements;

(3) Functional and operational performance under all design loads, track conditions as specified, and safety factors without deformation or deflection;

(4) Rate of travel upward and downward for the lift platform under loaded and unloaded conditions; rate for one full cycle shall not exceed 105 seconds in powered operation and 305 seconds in manual operation;

(5) Full range of vertical movement for the lift to adequately reach the range of station platforms as specified;

(6) Proper operation of all safety provisions and functional interlocks and isolation devices within the unit and with the door system, brakes, car diagnostic system and indicators;

(7) Function of lift after loss of power while in mid-travel, then with restoration of power;

(8) Proper and secure storage of the lift within the car;

(9) Maintainability and reliability requirements; and

(10) Manual operation of lift at rated load.

(11) 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.

g). Interior

i). Luggage Racks/Towers

(1) A complete overhead luggage rack, mounted on simulated carbody structure, shall be tested to verify it meets the 250 lb. load requirement. A complete overhead luggage rack, 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. Similarly, a luggage tower module shall be mounted on simulated carbody structure and tested to verify that it meets the design load requirements as well as the 8/4/4g crashworthiness requirements. Additionally, luggage tower modules shall be tested to verify proper operation of all auxiliary functions in secondary storage configurations (i.e. bike storage, ski storage, etc). All variations of luggage towers including towers utilized in the baggage area shall be tested.

ii). Seats

(1) One sample seat of each seat type identical to a production version shall be tested in a simulated carbody structure by the manufacturer for all criteria specified in APTA Standard PR-CS-S-016-99 and submitted to Amtrak with a detailed test report. This test result must

be approved by Amtrak before additional seats can be ordered and assembled into the pilot cars for pre-delivery testing.

iii). Seat Cushion Tests

(1) Seat cushions of each seat type selected twice at random by Amtrak during cushion production shall be tested to verify compliance with Chapter requirements.

(2) Seat cushions including those in sleeping accommodations and booth seats (both foam and upholstery) shall be tested to verify compliance with requirements.

iv). Side and End Wall Liner Tests

(1) A 20lb load distributed over a 0.5 in x 0.5 in surface area applied anywhere on the surface of interior panels shall not cause the panel to deflect more than 1/8 inch. A 50lb load distributed over a 6 in x 6 in surface area applied anywhere on the surface of interior panels shall not cause the panel to damage or crack. Upon removal of the loads, the panel shall return to the original position without signs of damage or permanent deflection.

v). Doors and Hardware

(1) All interior doors and hatches, including food service units, shall be functionally checked to verify:

(2) doors hang vertically; verify correct relationship between carbody plane and door plane

(3) proper open travel

(4) proper fully closed position

(5) smooth movement

(6) smooth latching/ unlatching

(7) smooth locking & unlocking from external side of door

(8) correct latch and/ or lock engagement/ release

(9) non-interference, freedom from sticking or excessive looseness (rattles)

(10) proper switch activation for all door opening/closing lights, i.e., restroom, locker, closet, etc.

(11) proper engagement of the ceiling hatch safety catches

(12) proper function of RFID door lock

(13) proper function of emergency egress capabilities

vi). Elevator Lift

(1) The elevator lift shall undergo proof-of-design testing to evaluate and verify that the lift meets all specification requirements for:

(2) Compliance with all applicable ADA requirements;

(3) Functional and operational performance under all design loads, track conditions as specified, and safety factors without deformation or deflection;

(4) Rate of travel upward and downward for the lift platform under loaded and unloaded conditions; rate for one full cycle shall not exceed 105 seconds in powered operation and 305 seconds in manual operation;

(5) Full range of vertical movement for the lift to adequately reach the range of station platforms as specified;

(6) Proper operation of all safety provisions and functional interlocks and isolation devices within the unit and with the communication system, lighting system, car diagnostic system and other indicators;

(7) Function of lift after loss of power while in mid-travel, then with restoration of power;

(8) Proper and secure storage of the lift within the car;

(9) Maintainability and reliability requirements; and

(10) Manual operation of lift at rated load.

(11) 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.

h). HVAC

i). Heating and Air-Conditioning Tests

(1) 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 Amtrak.

(2) The actual HVAC control system, with actual temperature sensors, shall control all system operations during the test, unless indicated otherwise for specific tests.

(3) 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.

(4) 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.

(5) Note: If more than one type of HVAC unit and/ or controls is provided, then each type shall be fully tested for the following:

(a) Temperature Control Performance

(i) Verify:

1. function after cold-soak of controls

2. integration with HVAC unit

3. demonstration in all possible modes of operation, for all car types identified in the temperature control specification; not merely cars ordered at this time.

4. ramp up and ramp down of all temperature inputs

5. demonstration of all logic functions, input and output, including:

a. control and power circuits

b. operation of all safety circuits

c. all modes of operation, including fault conditions

d. indicators/ display(s), including each condition possible

e. fault displays, including each condition possible

f. Portable Test Unit (PTU), including all modes of operation

(b) HVAC Unit and Controls Performance

(i) Verify:

1. operation of capacity controls

2. operation of pressure controls

3. performance of expansion valves and measurement of superheat

4. performance of duct heater safety circuits and thermostat(s)

(ii) Refrigerant charge test

1. 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 Amtrak. The criteria shall include the following, at a minimum:

a. Level of superheat at the evaporator outlet;

b. Level of superheat at the compressor suction valve;

c. Compressor suction and discharge pressures;

d. Level of liquid refrigerant sub-cooling at condenser outlet;

e. No air bubbles in liquid line sight glass;

f. Compressor(s) working at full load/capacity.

(c) HVAC Unit Performance

(i) Verify:

1. Design Cooling Capacity Test – Measured airflow with dry evaporator coil and with wet evaporator coil, Determination of cooling capacity at rated conditions, including power requirements

2. Modulation Capability Test

3. Maximum Operating Conditions (MOC) Functional Test

4. Extreme Operating Conditions Functional Test - capacity at 130° F ambient

5. Humidity Control Test

a. humidity control at mild load, high humidity conditions

6. Insulation Efficiency and Liquid Carryover Test

7. Low Temperature Operation – Minimum Cool / Low Ambient Test

8. Heating Capacity Test

9. Abnormal Heating Test with Restricted Airflow

10. Abnormal Heating Test with No Airflow

11. Test of High Limit Temperature Thermostat/Switches

12. Blower Motor / Heater Circuit / Cooling Circuit Interlock Test

    a. Blower Motor, heater interlock with airflow switch test

    b. Blower Motor, cooling circuit interlock with airflow switch test

13. Water Tightness Test

14. Exterior Noise Test

(d) Temperature Control Integration/Operation with HVAC Unit

(i) The temperature control components and software shall be connected with an HVAC unit and either fully functional PTU or necessary temperature and pressure sensing controls to effectively perform full functional testing of all software controls. Controller shall simulate actual operational controls and provide controls and verify correct feedback of HVAC unit response. 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. Demonstration of all HVAC operating modes including the pump-down operation, bump start routine, and staggered compressor starting, when appropriate, shall be included.

(ii) Functional testing shall also include verification of all software control functions, status reporting, and fault recording including lockout conditions and reset.

(iii) 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.

1. All subjects identified above in “temperature control integration/operation” shall be verified on the integrated system of the temperature controls and HVAC unit.

ii). HVAC System Vehicle Level Pre-Test Requirements

(1) 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.

(2) The pre-tests shall be satisfactorily completed before continuing to further climate room testing.

iii). Air balance test

(1) 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.

(2) Each car type shall be tested and the results recorded to verify specification requirements are met for air distribution and balance, including:

(a) Fresh air flow rate

(b) Return air flow rate

(c) Exhaust air flow rate

(d) Car pressurization: car interior, restrooms (negative), electric locker

(e) Pressure differential of restrooms relative to adjacent car interior

(f) Uniformity of supply air flow

(g) Interior car noise levels after balancing with blowers on

(3) 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 and diffuser/baffle settings permanently fixed to be used as base settings for the remaining cars of that type.

iv). Temperature control tests

(1) 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, bump start routine, staggered compressor starting, when appropriate, shall be included.

(2) 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.

v). Heating and air-conditioning system tests

(1) General

(a) 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.

(2) Data requirements

(a) The Contractor shall record sufficient data at intervals of no more than 30 seconds for each air conditioning and heating test to show that the equipment operates satisfactorily and meets design requirements.

(b) The recorded data shall include the following:

(i) Temperatures (°FDB):

1. Return air at both HVAC units;

2. Mixed air at both HVAC units;

3. Fresh air at all air intakes (for both HVAC units);

4. Distributed air throughout the car;

5. Condenser air inlet at both units;

6. Liquid at the filter-drier outlet on both units;

7. Suction at evaporator on both units;

8. Suction at compressor(s) on both units;
9. All temperature sensors and thermostats;
10. Exterior temperature at 24 in. above the rail at both ends of the car;
11. Exterior temperature at 24 in. above the roof at both ends of the vehicle;
12. Interior temperature at 14 seats at 6 in. and 48 in. above the floor;
13. Interior temperature at 4 aisle positions at 6 in. above the floor and 12 in. below the ceiling;
14. Toilet room 6 in. and 48 in. above the floor and 12 in. below the ceiling;
15. Heater guard temperature at all heater locations;
16. Overheat heater compartment at all overheat protection devices;
17. Wet bulb temperatures at a minimum of two ambient locations next to the fresh air intakes.

(ii) Pressures:

1. Compressor(s) discharge on both units;
2. Compressor(s) suction on both units;
3. Liquid leaving condenser/sub-cooler outlet on both units;
4. Suction at evaporator at each evaporator circuit on both units;
5. Evaporator air pressure drop on both units;
6. Condenser air pressure drop on both units;
7. Vehicle pressurization (inches of water gauge).

(iii) Electrical Data:

1. Input Voltage;
2. Blower motor current, power, and speed on both units;
3. Compressor(s) motor current, and power on both

units;

4. Condenser fan motor current, power, speed on both units.

5. Fresh air damper motor current, power, and position on both units,

6. Supply air diversion damper motor current, power, and position an all dampers.

(iv) Relative Humidity Data:

1. Relative Humidity (RH) sensors at 3 aisle positions at 12 in. below the ceiling.

(c) 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.

(d) The data acquisition system shall have the capability to add channels, if required.

vi). Control scan test

(1) 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 the toilet room, stay within ± 3ºF 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, bump start routine, staggered compressor startup and cooling lockout shall also be demonstrated during this test. Heating and cooling shall be sufficiently capable of maintaining desired interior temperature near the lockout temperatures for the compressors or condenser fans with maximum solar loads.

vii). Vehicle heat transfer test

(1) 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 the specified value.

(2) 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.

viii). Cooling system tests

(1) General

(a) The air conditioning tests shall demonstrate the performance 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 ± 3ºF, during all tests.

(2) Pull down and steady state operation at design conditions test

(a) 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.

(b) 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.

(c) The time required for the system to reduce the interior air temperature to normal ASHRAE conditions 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 the toilet room, stay within ± 3ºF 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.

(d) 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 30 second 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.

(3) Door cycling test (cooling)

(a) 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 shall recover within 2°F of the required interior car temperature within 3 minutes maximum after each door closing.

(4) High ambient temperature test

(a) 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 be recorded at one minute intervals during the entire test.

(b) 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.

(5) High pressure cut-out test

(a) 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 be recorded at one minute intervals during the entire test.

(6) Condensate carry over test

(a) 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%.

(b) 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.

(c) 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.

(7) Low ambient temperature test

(a) 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.

(8) Low ambient temperature test with high internal load

(a) Upon completion of the low ambient temperature test, the interior loads shall be increased to the maximum design passenger load and full solar load and the ambient air temperature shall be lowered to 3 degrees F above cooling system lockout. Operate the system continuously for a period of 4 hours. During the entire test, the system shall operate continuously without damage to the equipment, 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 must conform to the comfort requirements of Chapter 10.

ix). Heating system tests

(1) General

(a) 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 ± 3ºF, during all tests. All heating tests shall demonstrate compliance to acceptable touch-safe temperatures on any heaters (125 degrees F).

(2) Layover verification test

(a) 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. 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.

(b) 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.

(c) No areas of the vehicle may drop below 40°F throughout the test and random measurements may be taken during the test to verify compliance, with particular attention to water piping or sensitive equipment.

(3) Steady state heating at design conditions test

(a) Following the layover verification test, the nominal voltage supply is reapplied, and the car is placed in its normal mode, with all car doors closed. Fresh air dampers shall operate per control logic.

(b) The time required for the system to raise the interior air temperature to normal ASHRAE conditions 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 the toilet room, stay within ± 3ºF 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.

(4) Steady state heating (minimum voltage)

(a) 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 normal ASHRAE conditions. 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 of 125°F during the entire test.

(5) Door cycling test (heating)

(a) 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 shall recover within 2°F of the required interior car temperature within three minutes maximum after each door closing.

(6) Steady state heating tests

(a) 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 of 125°F during the entire test.

(b) 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.

(i) An additional test shall be performed at the maximum voltage to determine the evaluate the temperatures of heaters and heater guards.

(c) 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 normal ASHRAE conditions. 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 of 125°F during the entire test.

(7) Overhead heater safety tests

(a) 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.

(b) 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 are 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 are no smoke or significant odors detected.

(8) Freeze protection tests

(a) The operation of the freeze protection system (including any door threshold, door pocket, water tank, waste system 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.

(b) 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.

(c) Continue this operation for one hour. The door thresholds must remain free of ice, any door pocket drains must drain freely, and doors must open and close smoothly for the entire test period.

(d) 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.

(e) 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.

(f) A final manual test shall be conducted of the Ogontz water valve freeze protection. Following testing above and with the chamber at -30°F and water tanks full, remove all power from the vehicle and verify that the Ogontz valves operate at their intended temperature range and provide dumping of all water on the vehicle. Verify that the water piping, valves, and components are not damaged by visual inspection, and following test by bringing the car and chamber back up to room temperature and resupplying the water system to check for leaks and functionality.

i). Lighting

i). The function and intensity of all lighting systems and their respective controls shall be tested in the first car to verify compliance with the requirements. All systems shall be designed to function in accordance with APTA PR-E-S-010-98.

ii). Lighting fixture performance

(1) Light level of each fixture shall be measured and compared to the design requirements.

iii). Independent power sources (for emergency lights)

(1) Performance shall be verified in all modes of operation. Charge and discharge time shall be measured.

iv). Marker light certification

(1) The marker lights and fixture shall be tested to verify compliance with FRA 49 CFR Part 221.

v). Lighting intensity-interior

(1) Test shall verify light levels are in accordance with Chapter 13 including APTA PR-E-RP-012-99, APTA SS-PS-004-99, APTA PR-PS-S-002-98, all lighting modes as specified in Chapter 13 and table 13-1, and for all configurations and locations of HPPL signage and LLEPM.

(2) Test shall verify adaptive white light control per Chapter 13.13.c.

vi). Emergency lighting intensity and duration

(1) The test shall verify light levels and duration of each car type are in accordance with APTA Standard PR-E-S-013-99, 49 CFR Part 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.

vii). Accent RGB Lighting

(1) Test shall verify train level control, car level control, and zone control operation.

(2) Remote update testing shall verify updating preset color combinations or sequences shall be loaded from an external source to be run automatically without physically loading onto each trainset or each car per Section 13.7.

viii). Lighting intensity-exterior

(1) Test shall verify headlight and auxiliary light levels comply with 49 CFR Part 229.125, 229.133, and the requirements of Chapter 13.

ix). Head Light Intensity

(1) The high beam lights shall allow sufficient light to view a 50th percentile man 800 feet away and a 50th percentile man wearing a reflective vest at 1200 feet away. The low beam lights shall strike the tracks at approximately 150 feet in front of the leading end.

j). Communication/OTIS

i). General

(1) The communication system shall be tested on the first car of each type to verify that it functions in accordance with the requirements of Chapter 12. 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 Unit (CDU) 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 system database

can be updated, the CDU and wireless LAN systems shall be fully functionally tested.

ii). PA/IC/OTIS system performance

(1) The performance of the public address and passenger intercom system shall be tested to verify that all aspects of the system perform as intended:

(a) System selector switch function and indication

(b) PA announcements to the car interior only

(c) PA announcements to the car interior and to other cars in the train

(d) PA announcements received from other cars in the train (coupled to legacy equipment and within trainset)

(e) PA interface with the OCU and the passenger information system

(f) Intercom function between IC stations within the car and between the car and other cars in the train (coupled to legacy equipment and within trainset)

(g) Communication along analog COMM/MU lines and communication on the DTL

(h) Emergency two-way intercommunications (intercom)

(i) Speaker volume, including interior and exterior speakers, and in both Normal and Night modes

(j) Signal to noise ratio

(k) Fault log tests and communication with the CDU

iii). OTIS system performance

(1) The performance of the automatic announcements, sign, and train map portions of the 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.

(2) Proper readability of the interior signs at 45 feet and exterior signs at 115 feet in direct sunlight and complete darkness shall be demonstrated.

(3) The function used to advance the sign reading to the next message shall be demonstrated, using the actual input message to the system. Changes to data files within the OCU shall be demonstrated including editing of files and replacing in-kind.

(4) Simulated power drops and restarts shall be tested to ensure the system returns to proper operation without abnormal behavior.

(5) OTIS shall be tested per the manufacturer's recommendations to ensure system can be properly set-up, adjusted, reprogrammed, and edited to verify normal operation, minor changes to route or display options, or uploading of entirely new route and visual packages.

iv). EMI/EMC

(1) The test plan shall meet the requirements of APTA Standard PR-E-S-010-98, plus any additional requirements of the specification. All modes of operation shall be tested.

v). Wayside equipment tests

(1) Each wayside and Control Center component of the communications system installed under this Contract, including the radio system, CDU, 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. GPS accuracy shall be tested. 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 CDU and the wireless local area network shall be fully tested. Testing shall be conducted to ensure that car faults can be downloaded remotely and that the system database can be updated.

(2) 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 Amtrak to fully verify all functions. All equipment which is installed under the Contract on Amtrak wayside or Amtrak 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.

vi). Wireless LAN

(1) The wireless LAN system shall be shown to demonstrate communication between trainset and wayside equipment, to properly connect to representative user devices, and to properly function through intermittent connectivity or power.

k). Electrical

i). General

(1) All electrical circuit breakers, protection systems, switches, and relays shall be cycled under full load to demonstrate proper functionality.

Electrical protection systems, where included, shall be tested to the degree possible to adhere to the manufacturers specifications.

ii). Electrical load/phase balance/power factor

(1) 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.

iii). Trainline tests

(1) Trainline tests shall be conducted at both ends of the first cars of each type. All receptacles for the HEP, inter-car, MU and COMM trainline circuits shall be tested for proper functionality using a trainline test unit. Proper functioning of the PA/IC/OTIS shall be conducted to verify communication into and out of the trainset functions properly.

(2) The first trainset shall be coupled to a locomotive or other car on the Contractor's test track, and all trainline functions, including coupling and uncoupling and diagnostic messages, shall be tested to verify correct operation.

(3) End of Train functionality for trainlines and 480VAC HEP shall be tested per Sections 15.3.c and 15.5.e.

iv). Network tests

(1) The Contractor shall submit the results of a Network Interface Card (NIC) test of each end device implementing Ethernet communication in order to verify compliance to IEEE standards. The Contractor shall submit the results to Amtrak for review.

(2) The Contractor shall perform a complete network integration test of all train networks, including all subsystems and all on-board networks in order to pre-qualify the proposed network architecture prior to implementation on the car and trainset. This test shall consist of a simulated trainset with all train switches. The subsystem controllers and end devices shall be the actual units in one car, with at least one of every type of controller represented in the test. Other cars and devices may use simulated traffic generators. The tests shall verify that the protocols, datasets, and messages used on all networks correspond to the Network Interface Control Document, and that the specific signal, message, and dataset documentation are provided for each network. At the time of the integration tests, the Contractor shall also demonstrate the fault tolerance of all networks by simulating all possible faults. Amtrak shall have the option of witnessing the tests. The test procedures and results shall be submitted to Amtrak for review and approval.

(3) Network testing performed by the Contractor shall demonstrate that all networks have capacity 50% above the expected worst case in service load.

v). Battery and battery charger tests

(1) 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. Proper functioning of the load shed and load drop systems at the specified voltages shall be conducted. The ability to check the battery fluid levels and refilling shall be demonstrated.

(2) Utilizing a heat gun or approved simulated heat source, proper functioning of the over temperature protection of the batteries shall be demonstrated.

vi). Battery capacity

(1) Battery on each car type shall be tested to demonstrate specification compliance.

vii). Battery/battery charger performance

(1) 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 instrumentation shall monitor battery voltage and car 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. Proper load shed and load drop at the specified voltages shall be demonstrated. The test shall also verify proper operation of the equipment during:

(a) Loss of input phase (component supplier Proof of Design test)

(b) Reversed phase rotation (component supplier Proof of Design test)

(c) Reversed battery connections (component supplier Proof of Design test)

(d) Fault coordination between battery charger system, battery and main DC circuit breakers (train level Proof of Design test)

viii). Battery tilt and shock

(1) Verify each battery type complies with the 45 degree tilt and 8/4/4g acceleration requirements of 49 CFR Part 238.115.

ix). Emergency 480VAC Backup Operation (OPTION)

(1) Test locomotive loss of 480VAC HEP failure and automatic changeover to emergency 480VAC backup operation.

(2) Test emergency 480VAC backup operation and recovery of locomotive 480VAC HEP

(3) Test emergency 480VAC backup operation reserve time of at least eight (8) hours per Section 15.5.f.

l). Food Service

i). The following food service equipment tests shall be performed as required to verify the design:

ii). Structural performance

(1) Verify crashworthiness structural requirements for retaining carts, chillers, and appliances are met. Tables and booth seating shall meet APTA PR-CS-S-016-99.

iii). Refrigeration system performance

(1) A complete car set of Food service refrigeration equipment for each food service car type shall be assembled and connected to operate. Particular concern is that the system might slowly lose capacity over time, with buildup of ice on the evaporators, etc. Room in which the test is conducted shall have a relative humidity of at least 60% at the 70° condition. The following shall be verified:

(a) Pull down capacity at rated conditions with nominal condenser inlet air temperature of 70°F and 110°F

(b) Hot-soak pull down: cases soaked > 95°F rated high ambient

(c) Operation at light load

(d) Operation of condenser environmental controls

(e) Ability to maintain cases to required values, including minimal temperature gradient within case

(f) Ability of thermometer on units to accurately track air temperature

(g) Operation of protective devices, such as pressure switches.

(2) Instrumentation and measurement shall include:

(a) Inlet and outlet air temperature of each galley cart

(b) Inlet and outlet air temperature of evaporator of each freezer and/ or refrigerator box.

(c) For large units, such as stand-up freezer, several locations within the unit are required.

(d) Evaporator surface temperature inlet and & outlet of each coil

(e) Expansion valve bulb temperature of each valve

(f) Chiller conditioned air inlet and outlet air temperature each unit

(g) Condenser air inlet and outlet temperature each unit, also including chillers

(h) Suction and discharge pressures each unit, also including chillers

(i) Compressor current each unit, also including chillers

(j) Activation of chiller thermostat

(k) Activation of chiller defrost cycle

(l) Activation of each box thermostat and solenoid valve

(m) Activation of each freezer defrost function

(n) Activation of environment controls

(3) All food service equipment shall be installed and shall be operated in a test simulating revenue service to verify the proper operation of the appliances, cases, power distribution system (including proper operation of the battery and inverter for backup power for refrigerated equipment), HVAC, lighting, and the water and waste systems.

iv). Food Service Appliances

(1) Correct operation of all modes of all appliances and any interfaces shall be demonstrated. The effects of interruption of HEP and its restoration shall be demonstrated to verify compliance. Any wireless functions shall also be included. Tests shall also verify EMI/EMC requirements are met.

v). Point of Sale System

(1) Correct operation of all modes of the complete point of sale system and any interfaces shall be demonstrated. The effects of interruption of HEP and its restoration shall be demonstrated to verify compliance. Any wireless functions shall also be included. Tests shall also verify EMI/EMC requirements are met.

vi). Cart Lift and Dumbwaiters

(1) The cart lift and dumbwaiter shall undergo proof-of-design testing to evaluate and verify that they both meet all specification requirements for:

(2) Functional and operational performance under all design loads, track conditions as specified, and safety factors without deformation or deflection;

(3) Rate of travel upward and downward for the cart lift under loaded and unloaded conditions; rate for one full cycle shall not exceed 90 seconds in powered operation and 305 seconds in manual operation;

(4) Rate of travel upward and downward for the dumbwaiter under loaded and unloaded conditions; rate for one full cycle shall not exceed 60 seconds in powered operation and 240 seconds in manual operation.

(5) Proper operation of all safety provisions and functional interlocks and isolation devices within the unit and with the communication system, car diagnostic system and other indicators;

(6) Function of car lift and dumbwaiter after loss of power while in mid-travel, then with restoration of power;

(7) Maintainability and reliability requirements; and

(8) Manual operation of lift at rated load.

(9) These tests shall include an endurance test in which the car lift and dumbwaiter shall be subjected to no less than 2,500 repeated cycles of deployment and storage.

m). Water and Waste

i). 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.

ii). The proper operation of the following shall be verified:

(1) Performance of all system components and controls

(2) System pressures, temperatures and flow rates

(3) Safety controls

(4) Backflow prevention devices

(5) Tank level indications

(6) Vacuum/pressure levels attained and maintained

(7) Valve sealing

(8) Protection mechanisms

(9) Flush valve life cycle

(10) Water fill and capacity

(11) Freedom from backflow

(12) Showers

n). Diagnostics and Test Equipment

i). The Contractor shall demonstrate fully functionality of the diagnostic and test equipment. The Central Diagnostic Unit shall display, record, and upload any failure throughout the trainset.

ii). The Contractor shall develop acceptance and qualification tests for all systems identified as diagnostics and test equipment, including but not limited to the central diagnostics unit, the portable test units, the car temperature monitoring, and any bench testers. The tests shall verify all features and components are in compliance with the requirements of this Technical Specification.

(1) Verification that all faults that are configured for all sub-systems to be displayed on the CDU are displayed properly.

(2) Verification that all faults that are configured to be reported to the CDU are so reported.

(3) Verification that fault logs of all systems in the trainset are accessible from the maintenance screen of the CDU in any of the cars in the trainset.

(4) Verification that the software version numbers on all non-communications subsystems in the trainset can be accessed from the CDU of any car.

(5) Verification that all software changes made as a result of the CDU Factory Qualification Test have been implemented on all systems connected to the CDU.

(6) Any faults from each and every system shall be simulated and demonstrated to display properly.

(7) Simulate fault data upload and alarming.

(8) Access to system level fault information and current status parameters through the CDU terminal, the PTUs, and the online portal.

(9) Proper operation of the data recording functionality.

(10) Verification that all PTUs and bench test equipment properly connect, function, and diagnose system-level equipment.

o). Emergency Equipment

i). The performance of the Fire and Smoke Detection System and any Fire Suppression systems shall be verified for specification compliance on each relevant car type. Each type of sensor, alarm, indicator, control and annunciator, as well as all inputs and outputs, shall be demonstrated. All functions and modes of operation shall be demonstrated. The effects of interruption of HEP and its restoration shall be demonstrated to verify spec. compliance. Operation of the complete system from its battery shall be demonstrated from full charge down to fully discharged condition and then recharge. Time the system is supported on battery and the duration of the recharge shall be recorded with a data recorder.

20.6 Installation, Removal, and Maintainability of Equipment

a). This test shall measure the time it takes as well as demonstrate that it is possible to successfully install and remove without interference large components as well maintain frequently serviced pieces of car equipment. These items shall be demonstrated on a fully assembled car, unless otherwise agreed in writing by Amtrak. Items include:

i). Car Exterior: Removal/Installation

(1) Side Loading Doors, gap fillers and operators – each unique location

(2) End Doors – each unique type and location

(3) Gangways

(4) Undercar and sidewall access door change-out (each type)

(5) Tread brake unit and disc brake unit: worst-case location(s)

(6) Brake valves, including wheel slide dump valves

(7) On-board mobility device lifts

(8) Digital Displays

(9) All other equipment located on the exterior of the Car unless otherwise agreed to by Amtrak.

ii). Equipment Room: Removal/ installation

(1) HVAC unit: - each unique site

(2) Refrigeration condenser tray (if used)

(3) Waste System including complete waste tank assembly

(4) Water heater (each type)

(5) All other equipment located in the equipment room unless otherwise agreed to by Amtrak

iii). Coach/Premium Coach Cars – Interior: Removal/Installation

(1) Seats (all configurations of each type, i.e., single seats, double seats, left-hand, right-hand, coach, premium coach, etc.)

(2) Interior Doors – each unique type and location

(3) Elevator

(4) Restroom with associated assemblies – each type and each unique location

(5) Lighting

(6) Digital Displays (all locations)

(7) Water fill station

(8) All other equipment located in the interior of the coach and premium coach cars unless otherwise agreed to by Amtrak.

iv). Food Service Cars – Interior: Removal/Installation

(1) All Food Service appliances (each car type)

(2) Cart Lifts

(3) Dumbwaiters

(4) Booth Seats – each unique location i.e., coach café and diner

(5) Lounge Seats

(6) All other equipment located in the interior of the Food Service cars unless otherwise agreed to by Amtrak.

v). Sleeper and Utility Cars – Interior: Removal/Installation

(1) Sleeper and restroom modules (each type)

(2) Room entrance doors including any en-suite doors – all accommodation types and all unique locations.

(3) Sleeper seats and convertible beds – each unique accommodation type

(4) Upper Berths – each unique accommodation type

(5) Elevators

(6) Lighting

(7) Digital Displays (all locations)

(8) All other equipment located in the interior of the sleeper and utility cars unless otherwise agreed to by Amtrak.

vi). Food Service Preparation Areas – Removal/Installation

(1) Dishwashers (all locations)

(2) Freezers (all types and locations)

(3) Refrigerators (all types and locations)

(4) Chillers (all types and locations)

(5) Each appliance: all oven types, turbochefs, coffee makers, griddles, steam tables, warming drawers, microwaves, etc.

(6) Gaylord exhaust fan & motor (for cleaning)

(7) Trash compactor (option)

(8) Point of Sale system

(9) All other equipment located in a food service preparation area unless otherwise agreed to by Amtrak.

vii). Car Exterior – Servicing:

(1) Change brake shoes and brake pads, all locations, without the use of a pit

(2) All other equipment that requires servicing in the exterior of the car unless otherwise approved by Amtrak.

viii). Equipment Room – Servicing:

(1) Clean HVAC unit evaporator drains, each drain on each unit

(2) Clean HVAC unit condenser coil, each unit

(3) Clean refrigeration unit condenser, if supplied

(4) All other equipment that requires servicing in the exterior of the car unless otherwise approved by Amtrak.

ix). Interior - Servicing

(1) HVAC air filters

(2) Air duct cleaning

(3) Removal of diffusers and grilles

(4) Seat cushion removal/ installation - each type

(5) Booth seat cushion removal/ installation - each type

(6) Curtain/Shade removal/ installation- each type

(7) Toilet shroud - each type

(8) Toilet bowl assembly - each type

(9) Waste lines - to clear blockage in line - all unique locations

(10) Drains - to clear blockage in line- each type – all unique locations

(11) Trash receptacle container - each type

(12) Sleeper Modules – each type

(13) Restrooms – each type

(14) Shower valve – each type

(15) Elevators

(16) Lifts and Dumbwaiters

(17) All other equipment that requires servicing in the exterior of the car unless otherwise approved by Amtrak.

b). Tests shall also demonstrate that all 49 CFR 238 calendar day inspections and Class I brake inspections shall be capable of being performed without the use of a pit or elevated track.

20.7 Pilot Car and Pilot Train Testing

a). Roll Angle (Lean) Tests

i). The first pilot car, in both the AW0 and AW3 load conditions, shall be placed upon a superelevated track up to a maximum of 7 inches in one inch increments. The test shall be performed in both lean directions to determine compliance with:

ii). Clearance requirements by verifying the Contractor's clearance diagram despite any body roll and lateral shifting of the car body.

iii). Static lean (maximum cant deficiency and maximum cant excess) limits for wheel unloading and carbody roll angle.

iv). Tests shall measure body roll and wheel unloading to verify compliance with 49 CFR Part 213.57 and 213.329. The Contractor shall provide a test report providing all data required by 49CFR Part 213.329 and shall fully support

Amtrak's submission to the FRA with additional information as requested by the FRA. This test must be simulated on all cars and performed on each representative car type.

b). Pilot Cars

i). General

(1) Pilot car testing refers to the test of the first car 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.

(2) All tests listed in this Chapter are in addition to the testing required for Production units, road brake tests, and post-delivery testing of pilot cars with other equipment, called out in other sections of this Chapter.

(3) All pilot cars shall be weighed and verified for proper weight distribution by wheel and maximum total weight.

ii). Pilot train testing

(1) After the pilot cars have undergone and passed all applicable proof-of-design and production testing requirements, the cars shall be combined to form the pilot trainset for car-to-car operational, compatibility and coupler tests.

(2) All pilot train testing shall be performed at a dedicated facility that has the capability of testing trainset operations of up to 110mph for uninterrupted 8-10 hours per day.

(3) All trainline functions shall be tested and verified, including:

(a) Door control, door system status and door summary circuits

(b) End of train identification

(c) Locomotive control

(d) PA, IC, and OTIS communications

(e) DTL and Wi-Fi data transfer, including wireless and cellular connectivity at all seating or standing locations within the car without interference

(f) HEP, power distribution, and power balancing

(g) Air brake application and release in ECP mode

(4) The pilot trainset 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:

(a) Carbody clearance

(b) Truck swing

(c) Coupler swing

(d) MU, COMM, DTL, ECP, and HEP cables

(e) Brake pipe and main reservoir air hoses

(f) Gangways and buffer plates

(5) 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 trainset, 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.

(6) The trainset 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 trainset under all operating conditions. Trainset test cars shall be selected so that all variations of car end configuration can be covered.

iii). Pilot train compatibility testing

(1) After the pilot trainset has undergone and passed the above, existing bi-level cars will be coupled to one end of the equipment and an Amtrak ALC-42 locomotive will be coupled to the other end of the equipment.

(2) All trainline functions shall be tested and verified, including:

(a) Door control, door system status and door summary circuits

(b) End of train identification

(c) Locomotive control

(d) PA, IC, and OTIS communications

(e) DTL and Wi-Fi data transfer

(f) HEP, power distribution, and power balancing

(g) Air brake application and release in Emulation

(3) 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:

(a) Carbody clearance

(b) Truck swing

(c) Coupler swing

(d) MU, COMM, DTL, ECP, and HEP cables

(e) Brake pipe and main reservoir air hoses

(f) Gangways, buffer plates and gangway curtains

(4) 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 cars and locomotives 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. It shall be possible to couple and connect cars and wiring throughout the range of worst case angular relationships based on track curvature. 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.

(5) For any ECP system used, testing shall be performed in both Normal and Emulation modes per APTA PR-M-S-020-17 and PR-M-S-021-17.

iv). Vehicle/Track System Qualification

(1) General

(a) The Pilot Trainset shall be tested in accordance with the applicable requirements of 49 CFR Part 213.345 for vehicle testing at speeds up to 110 mph on the track and cant deficiency of a qualified test facility to be selected by the Contractor. After the completion of vehicle testing at the selected test facility, the official qualification testing shall be performed on Amtrak's Northeast Corridor (NEC). Testing shall begin at a speed of no less than 80 mph and test speeds will be incrementally increased as described below. Test results shall be made available on the Pilot Trainset immediately after the completion of each test trip and will be reviewed by Amtrak before the decision is made to proceed to the next higher speed increment. The maximum test speed shall be per 49 CFR 213.345 using the Pilot Trainset 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.

(b) As track class, signal, propulsion and other required infrastructure becomes available on the route intended for service to support speeds above 90 mph, the equipment shall be tested in accordance with 49 CFR Part 213.345. Should the infrastructure to achieve speeds above 90 mph (test speed to be 5 mph_ greater) become available at the time of delivery of the vehicle order, the Contractor will be responsible for the conduct of these tests. On all train routes identified by Amtrak where trainset operation is planned for a speed greater than 90 mph, the Contractor will be responsible to conduct Pilot Trainset tests using a trainset over the identified route segments to enable trainset operation at the maximum allowable timetable track speed. As information, the following are Amtrak route segments as of 2023 which operate at speeds greater than 90 mph:

(i) Boston, MA - Washington, DC

(ii) Philadelphia, PA – Harrisburg, PA

(iii) New York, NY - Amsterdam, NY

(iv) New Haven, CT - Springfield, MA

(v) Porter, IN - Kalamazoo, MI

(2) Test instrumentation

(a) Test instrumentation shall be provided by the Contractor to record all data necessary to demonstrate compliance with the acceleration limits identified in 49 CFR Part 213.345. Each of the instrumented cars on the Pilot Trainset shall be provided with one truck equipped with two Instrumented Wheelset (IWS) axles. The truck with the worst performance per the trainset simulation shall be equipped with the IWS-equipped truck. Tests shall be conducted in both directions of movement. Friction brakes on the IWS-equipped truck shall be cutout for the duration of testing. The location of the IWS truck is dependent on the worst performing position identified by the MCAT analysis. The consist configuration under test shall be equal to the worst performance in the trainset simulation.

(b) 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. All 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.

(c) A GPS location system shall be used during testing to accurately report the location of the IWS trucks. This shall be done 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 by separate test instrumentation. The speed signal data and the cab speedometer display shall agree to within 1 percent across the entire speed range.

(3) Data collection and reporting

(a) 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. Real time operational safety must be provided. Results will be reviewed on the test train for acceptability by Amtrak 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.

(b) The reporting software shall be capable of generating the following for each data package:

(c) A time and date stamp.

(d) A graphical depiction of train location and speed by railroad milepost.

(e) 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.

(f) 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.

(g) Exception reports shall be provided for all events flagged as exceptions. These reports shall include the values recorded plus a close-up time history view of the data signal associated with each exception.

(h) Data packages shall be available within 5 minutes or less 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 Amtrak in both paper and electronic media which shall include all software required to format, process and graphically view the test data.

(4) Failure to Satisfy Requirements

(a) Should the car fail to satisfy the vehicle/track interaction requirements, a program for correcting the deficiencies shall be submitted to Amtrak for approval. The Contractor shall submit to Amtrak, within 60 calendar days, a program containing mathematical analysis of the problem and a course of action for its correction. If Amtrak 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.

(5) Test reports

(a) The Contractor shall prepare the required final test reports for submission to the FRA by Amtrak. 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. Amtrak 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 110 mph, or if additional dynamic behavior which may present a safety issue is observed.

v). Noise and vibration tests

(1) The interior and exterior noise levels and vibration levels of the pilot trainset 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 110 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.

(2) 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 train Engineer's ear. Measurements with an audio dosimeter shall be conducted in accordance with manufacturer's procedures as to microphone placement and orientation.

(3) Vibration tests shall be made with all car subsystems operating, with the car stationary.

vi). Friction brake performance tests

(1) 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 Amtrak will be required for final approval of the friction brake system.

vii). Ride quality tests

(1) To verify conformance to the ride quality requirements, one of the first pilot trainsets 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 cares 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 Amtrak 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 Amtrak's revenue service environment may, at the sole discretion of Amtrak, 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 7.

(2) Instrumentation capable of measuring and charting (for permanent record) the magnitude and frequency of the vertical and lateral shocks expected, up to 5g and 0.5 to 80 Hertz, shall be provided and operated by the Contractor, who shall reduce the raw data for presentation to

Amtrak. 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.

(3) In the event that the dynamic behavior of the cars is non-compliant in any respect with the requirements, the Contractor shall submit to Amtrak, within 60 calendar days, a program containing mathematical analysis of the problem and a course of action for its correction. If Amtrak 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.

viii). Wheel Spin/Slide Control System Performance

(1) In order to provide a test of the operation of the wheel slide protection system under actual operating conditions, facilities shall be provided for a test of this system during the friction brake performance brake tests. Instrumentation shall be maintained on this train at all times ready to record the following quantities simultaneously:

(a) Individual axle speeds (all cars in the consist)

(b) B.C.P. (after each wheel slide dump valve and car command level)

(c) Time intervals

(d) Tractive effort / braking effort command level

(e) longitudinal acceleration of train

(2) Recording shall be by means of multiple-channel recording digital chart recorders. Personnel assigned to observe the test shall be prepared to run this instrumentation at any time that adverse adhesion conditions may occur. This test shall be continued until recordings have been obtained showing three stops and starts during which slides and slips were successfully corrected. In the event that sufficiently adverse rail conditions to obtain such recordings do not occur during the test, the Contractor shall induce slips and slides with artificial rail wetting equipment (soap or other material to induce slippery conditions that represent leaves on the rails with a 6% - 8% adhesion level) to demonstrate the performance of this system. The slip/slide test can be run in conjunction with the track test.

(3) The test consist size shall be determined based on consist configurations selected by Amtrak and shall include the following sections:

(a) Braking Performance (Friction only and blended for propulsion equipped cars)

(i) baseline (dry): full service braking at 15, 30, 60, 75 and 110 mph

(ii) reduced adhesion: full service braking at 15, 30, 60, 75 and 110 mph using the lubricant

(iii) very low adhesion: 30 and 75 mph, with dry rail for 650 feet, 65 feet heavily lubricated rail, followed by dry rail

(b) Propulsion Performance

(i) Baseline (dry): Full Acceleration from zero to 30, 60 mph

(ii) Reduced Adhesion: Full Acceleration from zero to 30, 60 mph

(iii) Very Low Adhesion: from zero - 65 feet heavily lubricated rail, followed by dry rail for 650 feet followed by heavy lubricated rail for 65 feet followed by dry rail. Acceleration till the train reaches steady state acceleration

(4) For all adhesion levels above 5% the system shall regulate brake cylinder pressure, dynamic braking and tractive effort to achieve a minimum slide control efficiency of 80% under continuous full service braking and continuous tractive effort. "Worst-case" conditions shall be simulated by use of a compressed air powered spray device, with a solution of dish-washing soap and water or water-soluble cutting oil and water, as agreed between the Contractor and the Railroad, sprayed in front of the wheels on the leading axle to lower wheel-to-rail adhesion. Slide protection shall be verified by full service brake applications from initial speeds of 15, 30, 40, 60, and 70 mph. Test shall be performed both with and without dynamic braking. A similar set of tests shall be performed under full acceleration.

20.8 Production Tests

a). General

i). As a minimum, the tests listed in this Chapter shall be performed on each car (including all pilot trainsets) prior to the issuance of a release for shipment document by Amtrak. 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 Amtrak to a minimum.

ii). Prior to performing each production test for witness by Amtrak, the Contractor shall successfully perform the test internally. Amtrak may request the results of the internal test prior to attending the witness test.

iii). After completion of each car, the Contractor shall demonstrate that each car subsystem is operational.

iv). 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.

v). 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 Amtrak inspectors, have been suitably resolved to Amtrak's satisfaction.

vi). 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.

vii). All air, water, waste system and HVAC pipe work, hoses and fittings shall be properly cleaned, purged checked for leaks with all systems in operation and any faults rectified.

viii). 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 Amtrak. 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 Chapter 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 Amtrak 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.

ix). The Contractor shall conduct an acceptance test for each car of the trainset provided. The test shall verify that each device in the assembly is adjusted correctly and operates properly, both mechanically and electrically. All wiring shall be verified and, as appropriate, tested for insulation resistance and dielectric strength. All cars shall be weighed to verify overall weight and distribution. Leak tests and pressure tests shall be conducted. All modes of operation shall be verified, with every switch and control, staging and input and output exercised, and motor currents measured. At a minimum, acceptance tests shall be conducted on the following systems:

(1) Powered body end doors, operators and controls

(2) Temperature controls

(3) HVAC system and controls

(4) Air circulation fans & controls

(5) Lighting components

(6) Independent Power Sources (for emergency lights)

(7) Public Address/Intercom System (PA/IC)

(8) Onboard Train Information System (OTIS)

(9) Passenger Emergency Intercom (PEI)

(10) Reservation Display System

(11) Video Surveillance System

(12) Electronic Door Lock System

(13) Car and Train Networks

(14) Electronic display signs

(15) Electrical panels and electronic equipment

(16) Battery and Battery Charger

(17) Brake Equipment

(18) Wheelslide control system

(19) Food Service Appliances

(20) Water Heaters

(21) Waste System

(22) Fire and Smoke Detection System

(23) Elevators, Lifts and Dumbwaiters

(24) Sleeping Module Amenities

b). Carbody

i). Watertightness tests

(1) General

(a) Each car shall be tested for watertightness in both the completed shell and assembled car stages prior to pre-shipment.

(b) The entire carbody and all weather sealing around the doors, windows, and any exterior screens shall be tested during water tightness test similar to AMAA 501.1. A fan or turbine shall be set up that will provide 110 mph air speed longitudinally along the car body. 8" per hour of simulated rain water shall be applied to the area and the fan shall run for no less than 15 min showing no signs of leakage. This shall be repeated again but this time the fan shall be set up so that it will provide 50 mph of air speed at a perpendicular direction with respect to the car body with simulated 8" of rain per hour. This test is to be completed for all side doors and windows and shall closely mimic the test conditions spelled out in AMAA 501.1.

(c) 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.

(d) The entire carbody shall be watertightness tested in two stages during production:

(i) Stage 1: Bare carshell with windows and doors installed

(ii) Stage 2: Complete assembled car: all doors with gaskets including but not limited to side loading doors, junction boxes, access panels and maintenance doors shall be verified to be free from water ingress as part of stage 2.

(2) Water spray - bare car shell (watertightness test)

(a) 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 Amtrak approval.

(3) Water spray - completed car

(a) 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.

(b) All weather sealing around the doors, windows, and any exterior screens shall be tested during water tightness test similar to AMAA 501.1. A fan or turbine shall be set up that will provide 110 mph air speed longitudinally along the car body. 8" per hour of simulated rain water shall be applied to the area and the fan shall run for no less than 15 min showing no signs of leakage. This shall be repeated again but this time the fan shall be set up so that it will provide 50 mph of air speed at a perpendicular direction with respect to the car body with simulated 8” of rain per hour. This test is to be completed for all side doors and windows and shall closely mimic the test conditions spelled out in AMAA 501.1. Door weather sealing shall meet the latest version of EN 14752.

ii). Onboard wheelchair lift

(1) Verify all functions, interlocks, safety features and timing

(2) Demonstrate lifting range

(3) Demonstrate manual operation of lift and timing

iii). Elevators

(1) Verify all functions, interlocks, safety features and timing

(2) Demonstrate emergency egress of elevators and timing

(3) Demonstrate manual operation of elevator and timing

iv). AEI tag

(1) A tag reader shall be used to verify that each AEI tag on each car operates correctly and contains the correct data.

c). Truck Tests

i). All trucks

(1) Trucks (including the frame, bolster and any primary structural members) shall have their fabrication techniques qualified by means of a complete radiographic inspection of the entire structure. If determined by the Contractor and agreed to by Amtrak 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 or destructive sectioning methods approved by Amtrak. Castings shall be radiographed in accordance with requirements. Radiographs shall be made in accordance with ASTM Standards E94, E446 or E186 as may be applicable. 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 Section 6.12.2 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.

(2) After qualification of the fabrication and casting techniques as per the above method, 4% of each production lot, randomly chosen by Amtrak, shall be inspected using radiographic, ultrasonic, and magnetic particle inspection methods as proposed by the Contractor and approved by Amtrak.

ii). Truck weight

(1) 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.

iii). Carbody leveling and floor height

(1) Each completed car shall be leveled and measured to verify correct truck setup adjustments, that the car is level, has the correct floor and gangway buffer plate heights and gangway curtain heights. Measurements shall be taken with the car on calibrated track.

iv). Truck attachment, leveling and coupler height tests

(1) All mechanical, electrical, pneumatic and hydraulic connections between the trucks and the carbody shall be checked. The AW0 car floor height/car level and the end car coupler height shall also be verified.

(2) 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.

d). Couplers

i). Coupler height and operation of each car shall be verified, including clearance and operation of the uncoupling apparatus. All couplers and drawbars shall be gauged according to applicable FRA, APTA, and manufacturer standards.

e). Brakes

i). Single car brake and pneumatic system operation

(1) The brake system and auxiliary air system of each car shall be tested for leaks. The AAR S-471 Brake Pipe Restriction Test shall be conducted on the Brake Pipe. A functional test that exercises each function of all brake system valves, trainline, and components shall be conducted in accordance with the OEM recommendations. 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 PR-M-S-005-98 shall be met.

(2) For any ECP system used, testing shall be performed in both Normal and Emulation modes per APTA PR-M-S-020-17 and PR-M-S-021-17.

(3) 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, cut-out functionality tests, and handbrake test.

ii). Hand brake operation

(1) 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.

iii). Wheelslide control system operation

(1) 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 exercise the brakes. Speed signal interfaces for the door system shall also be tested. Dynamic testing shall also be performed to ensure the wheelslide control system is operating as intended. The contractor is responsible for providing the dynamic test procedures for review and approval by Amtrak prior to dynamic testing.

iv). Air Compressor

(1) The air supply system shall be tested to verify successful operation of the compressor(s) and distribution of air within the trainset at measured design volumes. Compressors shall be stop-start cycled 100 times without failure.

f). Door System Tests

i). General

(2) 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. All power operated doors shall be operated a minimum of 1000 consecutive, separate successful cycles in each of the applicable control methods. Initiation of the cycling through the trainline external from the car and initiation from a local control stand or push button shall be tested separately. 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. Tests shall include, but not be limited to verification of:

(a) All doors:

(i) door hangs vertically; verify correct relationship between carbody plane and door plane

(ii) seal is attached properly

(iii) proper open travel

(iv) proper fully closed position

(v) seal is aligned properly with door and seals the door all the way around the periphery, with no gaps

(vi) the door moves freely on the door track or hinges

(vii) the door hinges do not have excessive sloppiness at any hinge

(viii) door does not drag on floor or other surface

(ix) proper engagement of hold-open device

(x) door latch engages smoothly at each site and with correct depth of engagement

(xi) lock operates smoothly and without undue effort

(b) Additionally for all passenger and crew doors:

(i) proper location of threshold on the trap/ floor

(ii) proper attachment of threshold to the trap/ floor

(iii) proper engagement of bottom of door with the threshold (vertically and laterally)

(iv) that the mechanical lock is adjusted properly so it can lock the door leaf closed

(v) that the secondary door latch or dog operates properly

(vi) dogs shall remain distinctly open when in that position (not close on their own, even resulting from train motion.

(vii) that the drain for the door threshold is clear

(i) doors equipped with a door closer close reliably by themselves and engage the latch each time the door closes.

ii). Door safety systems

(1) All doors shall be individually tested to confirm correct operation, including all indicators, audible signals and interlocks, from the cab of a locomotive, 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.

g). Interior

i). Interior doors and hardware

(1) 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.

(2) Proper engagement of the ceiling hatch safety catches shall be checked.

(a) Safety catches shall be self-engaging when closing panels.

ii). Seats

(1) Operation of each movable function of each seat and table on each car shall be tested to verify:

(2) Recline, footrest, tray table, workstations, and any deployable ADA tables shall be level when in the fully extended position and shall deploy and retract smoothly without binding.

h). HVAC

i). Air Distribution

(1) Each car shall be measured, and the results recorded to verify correct air distribution, including:

(a) fresh air flow rate

(b) return air flow rate

(c) exhaust air flow rate

(d) car pressurization

(e) uniformity of supply air flow

ii). Temperature Control

(1) Proper thermostatic operation of the air conditioning and heating equipment shall be verified on each car for compliance with the specified values. This shall include, but not be limited to:

(a) integration with HVAC unit- every input/ output verified

(b) demonstration in all possible modes of operation (day/ night, layover, as well as partial and full cool, partial & full heat, etc.)

(c) ramp up and ramp down of all temperature inputs: fresh air, return air and car air

(d) demonstration of all logic functions, input and output, including:

(e) control and power circuits

(f) operation of all safety circuits

(g) fault conditions- representative examples

(h) indicators/ display(s)- representative examples

(i) fault displays - representative examples

(j) Portable Test Unit (PTU), including all modes of operation

(2) The test shall include operation of the controls using car temperature sensors/ thermostats as follows:

(a) use override to warm car to 80° F minimum (est. value). Then, under thermostatic control, verify car cools to setpoint.

(b) use cool override to chill car to 60° F maximum (est. value). Then, under thermostatic control, verify the car heats to setpoint.

(c) verify car temperature gradient meets specified requirements

(d) Verify proper operation of sleeper room control panel for validation of temperature ranges

iii). Heater circuit tests

(1) Each heater circuit shall be high potential tested in accordance with IEEE Standard number 16.

iv). Heating tests

(1) General

(a) The heating system, including 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.

(2) Duct heater operation

(a) Duct heat of each car shall be verified for function, uniform temperature distribution and correct current draw.

(3) Duct heater shunt trip operation

(a) 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.

(4) Floor heat operation

(a) Floor heat of each car shall be verified for function, uniform temperature distribution and correct current draw.

v). Air conditioning unit tests

(1) 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. Unit shall be tested for proper sealing against weather. Unit shall pass subcontractor qualification test for shock and vibration.

(2) All cars shall have proper air balancing performed, and smoke testing shall be used to verify ducting is free from leaks. Amtrak may re-evaluate this requirement once repeatability is demonstrated.

vi). Air conditioning system tests

(1) General

(a) 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.

(2) Air conditioning system operation

(a) 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:

(i) Blower fan

(ii) Condenser fan(s)

(iii) Compressor

(iv) Exhaust fan(s)

vii). Freeze Protection

(1) Proper operation of all freeze protection equipment shall be verified on each car, verifying that each heater heats and that the current draw is proper. Heaters employing a local thermostat shall have cycling by the thermostat verified.

i). Lighting

i). Lighting operation

(1) 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.

ii). Marker lights

(1) Proper operation of marker lights shall be verified.

j). Communication/OTIS

i). General

(1) The performance, installation, and integration of all components which combine to meet the requirements of Chapter 14 shall be tested to verify proper installation and operation.

ii). PA/IC system performance

(1) The performance of the public address and passenger intercom system shall be tested to verify that all aspects of the system perform as intended:

(a) Control terminal function and indication

(b) PA announcements to each identified zone, including verification of the functionality and control of each speaker (interior and exterior)

(c) PA announcements received from other cars in the train (coupled to legacy equipment and within trainset)

(d) Intercom function between IC stations within the car and between the car and other cars in the train

(e) Communication along analog COMM/MU lines (where equipped) and communication on the Ethernet Train Backbone

(f) Passenger Emergency Intercom functionality

(g) Speaker volume, including interior and exterior speakers, and in both Normal and quiet modes

(h) Attendant Call control and indication

(i) Inductive Audio Loop

(j) Bluetooth LE Broadcast

iii). OTIS system performance

(1) The performance of the automatic announcements, sign, and train map portions of the system shall be verified for specification compliance on each car type. All modes of operation shall be demonstrated, as well as interaction with the PA/IC system, Attendant Call, and diagnostic systems.

(2) Performance and indication of each interior and exterior Display Sign, including that each display sign can appropriately indicate messages specific to each individual sign location.

(3) Simulated power drops and restarts shall be tested to ensure the system returns to proper operation without abnormal behavior.

(4) System shall be loaded with the Amtrak route and display profiles and demonstrated to properly function per the manufacturer's recommended test plan.

iv). Passenger Compartment Control Unit

(1) Each Passenger Compartment Control Unit shall be tested to verify proper operation.

v). Reservation Display System

(1) Proper control and indication of each reservation display system screen, and proper communication between the reservation display system controllers and the diagnostic system.

vi). Electronic Door Lock System

(1) Operation and control of all door locks, including keyed overrides, performance on battery backup, and each method of wireless communication.

vii). Data Communication System and Global Positioning System

(1) The Data Communication System functionality including on-board cellular and Wi-Fi connections, shall be shown to demonstrate communication between the car and representative wayside equipment, to properly connect to representative user devices, and to properly function through intermittent connectivity or power.

(2) The Global Positioning System (GPS) capabilities of the communications system shall be verified.

viii). Video Surveillance System

(1) The proper aiming and operation of each video surveillance camera shall be verified. The aiming of each surveillance camera shall be compared against the approved coverage design, and a screenshot shall be included in the vehicle history book.

(2) The NVR shall be tested for proper operation, including proper recording of all cameras and interface with onboard signals and networks for the purpose of metadata recording.

k). Electrical

i). Electrical apparatus tests

(1) 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 Amtrak. Tests shall be in accordance with IEEE Standard number 16 for control apparatus as appropriate.

ii). Battery tests

(1) Battery and battery charger operation

(a) 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)

(2) Battery capacity

(a) Verify battery meets 5 hour name-plate rating.

(3) Battery/battery charger performance

(a) The performance of the battery charger connected to the battery and a simulated car load, shall be tested to verify correct operation. The test shall also verify proper operation of the equipment during:

(i) Sustained low input voltage (component supplier Production test)

(ii) Overload or shorted battery charger output (component supplier Production test)

(iii) Battery ground fault (vehicle level Production test)

(iv) Temperature sensor fault (vehicle level Production test)

(v) System overload (component supplier Production test)

(vi) Ability to support large step loads on car, such as door operators cycling (vehicle level Production test)

(b) Each battery shall be given a capacity test at the point of manufacture in accordance with APTA Standard PR-E-RP-007-98 (component supplier Production test).

iii). Car wiring tests

(1) Continuity

(a) On each car, all wiring shall undergo a continuity test in which wire labeling, continuity of conductor and proper connection point are verified.

(2) Power distribution

(a) 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.

(3) Electrical insulation testing

(a) 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.

(4) Network testing

(a) Every Ethernet cable installed on each car shall be certified to ISO/IEC 11801-1 – Class F after installation, demonstrating channel suitability for IEEE 802.3an-2006 10GBASE-T. The results shall be recorded and submitted as a part of the vehicle history book.

iv). Insulation testing

(1) All wiring on each car shall undergo a Megger and high potential test, in accordance with APTA Standard PR-E-S-001-98.

(2) Insulation resistance tests shall be conducted before high potential tests are conducted.

(3) 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.)

v). Trainline tests

(1) General

(a) 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 the trainset. 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 on all door control panels, PA controls, etc. All spare trainline circuits shall also be tested.

(2) 480V HEP trainline

(a) The 480V trainline wiring shall be tested at each end of the trainset to verify continuity of each power and control conductor and grounding of control contacts.

(3) 27-Point communication trainline

(a) Through the use of a test fixture, the 27-point communication trainline shall be tested at each end of the trainset 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.

(4) 27-Point MU trainline

(a) Through the use of a test fixture, the 27-point MU trainline shall be tested at each end of the trainset 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.

(5) Digital Trainline / Ethernet Train Backbone

(a) Through the use of a test fixture, the digital trainline and all switches shall be tested at each end of the trainset to verify continuity of each cabling run and check for unintended cross-connections and shorts. Transmit/receive functions of equipment which is controlled by the trainline shall be demonstrated.

vi). Convenience outlets

(1) All 120VAC receptacles shall be tested for proper polarity, grounding and the trip action of any associated GFCI devices on each car. All USB ports shall be tested for proper operation. Operation of DC receptacles shall likewise be verified.

vii). Auxiliary circuits and equipment tests

(1) All auxiliary circuits and equipment shall be tested for proper operation, and adjusted or corrected as required.

l). Food Service

i). Doors and hardware

(1) All food service doors, hatches and quarter-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.

ii). Food service appliance operation

(1) Each appliance shall receive a functional test to verify operation. Coffee makers shall operate through a complete brew cycle.

iii). Other Devices

(1) The unit shall be tested to verify proper operation of all controls, limit switches, timing and safety functions.

iv). Refrigeration/chiller

(1) Refrigeration equipment shall undergo testing to verify:

(a) Freedom from refrigerant leaks (evacuation and "sniff test" if split system)

(b) 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

(c) No-load pull down time for each refrigerated space

(d) Correct thermostat settings for each refrigerated space

(e) Correct tracking of chiller thermometer with chilled space

(f) Correct operation of environmental controls for the condenser (if split system): damper, room exhaust fan, etc.

v). Point of Sale System

(1) Correct operation of all functions

m). Water and Waste

i). Water and waste piping

(1) All car water and waste 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, showers, and drinking water spigots shall be tested for correct temperature adjustment range, water flow rate and freedom from splashing. All sinks, showers, and drinking water alcove shall be tested for proper operation.

ii). Water fill and capacity

(1) Starting with the water tank empty, the water tank shall be filled while measuring the fill time and water pressure of the fill line statically. After the tank has been filled, it shall be drained while measuring the time, using the tank manual drain valve and the volume of water leaving the tank measure to verify the effective water tank capacity, The use of Amtrak SMP #47601 “Water Tank Flush” shall be demonstrated.

iii). Water raising and distribution operation

(1) The water raising system of each car shall be tested, including the correct operation pressure of each regulator in the distribution system.

(2) Freedom from backflow shall be demonstrated to verify that when the water tanks are filled and then air slowly bled off from the main reservoir, no water back-flows from the water tanks into the water-raising system.

(3) Demonstration of the Ozone water treatment system by use of analysis of water samples before and after treatment via the appropriate NSF/ANSI water treatment method..

iv). Water fill stations

(1) Correct operation shall be verified, including chilled water temperature and timing, and operation of the controls.

v). Water heater operation

(1) 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. Polyphase water heaters shall have the correct current value of each phase verified.

vi). Toilet operation

(1) Correct operation shall be verified on each toilet of each car though 1000 cycles in a qualification test. 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.

(2) If the option is executed, verification of toilet flushing utilizing the emergency operation mode for all ADA accessible toilets verifying this operation for a minimum of 8 hours.

vii). Waste System

(1) Waste system performance shall be verified by the following:

(a) Performance: flush times, vacuum attained and maintained, etc.

(b) Controls

(c) Safety controls

(d) effective capacity of the waste tank

viii). Gray Water System

(1) Verification of circulation of grey water from sinks, showers, and drinking stations to the toilet system for flush water.

n). Diagnostics and Test Equipment

i). The Contractor shall demonstrate fully functionality of the diagnostic and test equipment. The Central Diagnostic Unit shall display, record, and upload any failure throughout the trainset.

ii). The Contractor shall develop acceptance and qualification tests for all systems identified as diagnostics and test equipment, including but not limited to the central diagnostics unit, the portable test units, the car temperature monitoring, and any bench testers. The tests shall verify all features and components are in compliance with the requirements of this Technical Specification.

(1) Verification that all faults that are configured for all sub-systems to be displayed on the CDU are displayed properly.

(2) Verification that all faults that are configured to be reported to the CDU are so reported.

(3) Verification that fault logs of all systems in the trainset are accessible from the maintenance screen of the CDU in any of the cars in the trainset.

(4) Verification that the software version numbers on all non-communications subsystems in the trainset can be accessed from the CDU of any car.

(5) Verification that all software changes made as a result of the CDU Factory Qualification Test have been implemented on all systems connected to the CDU.

(6) Any faults from each and every system shall be simulated and demonstrated to display properly.

(7) Simulate fault data upload and alarming.

(8) Access to system level fault information and current status parameters through the CDU terminal, the PTUs, and the online portal.

(9) Proper operation of the data recording functionality.

(10) Verification that all PTUs and bench test equipment properly connect, function, and diagnose system-level equipment. Fire and Smoke Detection

(11) Tested per manufacturers specifications

o). Completed Car

i). Weighing

(1) 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 wheels. A weighing device which provides a permanent printed record of the weight shall be used, and the weight tickets shall be submitted to Amtrak and copies thereof included in the vehicle history book.

(2) 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.

(3) Any total car weight deviation in excess of the maximum allowable weight specified in Chapter 1, or any car with a weight distribution not in compliance with the provisions of Chapter 1 must be documented on a nonconformance report and explained to the satisfaction of Amtrak prior to shipment. Amtrak may require that the Contractor reduce the weight of any cars exceeding the overall weight or weight distribution limits.

ii). Clearance tests

(1) 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.

20.9 Acceptance Tests

a). Car Acceptance Tests

i). The tests specified in this Chapter are to be performed by the Contractor on Amtrak railroad, or as otherwise designated by Amtrak. 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 Amtrak.

ii). After receipt of each trainset at Amtrak site and before it is operated, it shall be carefully inspected jointly by Amtrak 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.

b). Functional Tests

i). 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 Amtrak 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.

c). Road Brake Test/Stop Distance and Coast-Down

i). The test shall be conducted on a consist to be determined by Amtrak based on configurations selected, ready to run, both with no passenger load, to simulate actual operational performance. Other trainset configurations may be proposed. Selected car brakes shall be disabled so as to provide a total of 80% braking capacity on the passenger cars. The test shall be conducted on flat, tangent track, with the brake application made at the same site for each test run. If necessary, to conduct the test on a slight grade, the entire braking distance shall occur at constant grade; calculations shall be made to correct the stop distance for the effect of the grade. The test shall be conducted in both directions: locomotive leading and trailing. Train brake pads/ shoes shall be worn in before conducting the test.

ii). The full set of tests shall be conducted in the following conditions:

(1) Full Service, Blended Braking

(2) Full Service, Friction Braking Only

(3) Emergency, Friction only

(4) Speeds of 110, 90, 75, 60, 45, 30 and 20 mph

iii). Two stops shall be made from each speed, with sequence controlled to minimize wheel heating. Wheel and disk temperatures shall be measured to verify adequate brake system thermal capacity and to ensure the stop distance is not influenced by beginning the test with hot brake components. Thermal imaging equipment shall not be used for this.

iv). If time and track availability permit, a coast-down test shall also be conducted to determine non-braking frictional losses of the train. The test shall be conducted from the rated speed of the train, with the train allowed to coast down to a near stop.

v). Instrumentation shall include:

(1) Means to determine distance

(2) Train Speed

(3) Brake cylinder pressure of each truck on the locomotive/Multiple Unit

(4) Blended brake current on locomotive/Multiple Unit

(5) Brake cylinder pressure of each truck

(6) Longitudinal acceleration of train

(7) Switch to detect movement out of release position of automatic brake valve from the locomotive

(8) Brake pipe pressure on both ends of the train

vi). At the completion of this test, the brakes shall be reactivated, except those on the instrumented wheelsets.

20.10 Post-Delivery Testing of Pilot Train with Other Equipment

a). After the Pilot Trainset has been delivered to Amtrak's facility and have undergone and passed all applicable acceptance inspections and tests, it shall be combined with other rail equipment as designated by Amtrak to verify operational, compatibility and coupler tests with other car and locomotive types that may constitute part of Amtrak's existing rail service. The specific types of rail equipment with which the Pilot Trainset shall be tested for compatibility includes:

i). P32, P40, P42, ACS-64, SC-44, ALC-42 and ALC-42E Charger locomotives, as owned by Amtrak.

b). All trainline functions shall be tested and verified, including:

i). End of train identification

ii). Locomotive control

iii). HEP, power distribution, and power balancing

iv). Air brake application and release in ECP and Emulation

v). EMI/EMC requirements

c). The pilot 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:

i). Carbody clearance

ii). Truck swing

iii). Coupler swing

iv). MU, COMM, DTL/ETB, ECP, and HEP cables v). Brake pipe and main reservoir air hoses

vi). Gangways, buffer plates and gangway curtains

vii). ECP brake intercar cables

d). All equipment shall be tested to be fully functional on Amtrak-supplied wayside HEP power.

20.11 Reliability and Post-Delivery Tests

a). The complete operational car fleet shall be monitored by the Contractor to demonstrate conformance with the reliability requirements.

b). 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.

c). 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. **[CDRL 20-07]**

i). If a satisfactory completion cannot be obtained before the end of the specified warranty period, the Contractor and Amtrak shall resolve any outstanding issues in accordance with the Contract terms and conditions.

20.12 CDRLs

CDRL	**Description**	**Due**
CDRL 20-01	Trainset testing matrix	NTP + 90 days
CDRL 20-02	Master Test Plan	First submittal NTP + 180 days
CDRL 20-03	Test Procedures	Per Figure 20-1
CDRL 20-04	Test Results (Reports)	Within 5 days of test completion
CDRL 20-05	Contractor shall provide a single volume incorporating all required engineering tests	30 days after successful

	associated with the pilot program, all copies of all test procedures, reports and approvals	completion of testing
CDRL 20-06	All material certification and proof-of-design test procedures and reports in a single, binder for of each car type.	Prior to shipment of each car type
CDRL 20-07	Reliability and Post-Delivery Test Report	30 days after successful completion of testing

* End of Chapter 20 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

21. Tools, Consumables and Spare Parts

Revision 1

Table of Contents

21.1 Overview

a). 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 trainsets to be delivered to Amtrak.

b). Most of this Chapter shall be covered in the Technical Support, Spares and Supplies Agreement (TSSSA) SOW; however, in the event that the TSSSA is not executed or upon termination of the TSSSA, the following sections shall be the responsibility of the Contractor.

c). The detailed information identified in the following sections will be provided to Amtrak in a timely fashion during design review or prior to the first trainset delivery, but the physical delivery of materials where applicable shall only occur in the absence of or at the conclusion of the TSSSA.

d). Amtrak shall retain all specialized tools, consumables, spare parts and any subsystem mock-ups as detailed in this Chapter.

e). All information required in this Chapter shall also be included in the appropriate operating and maintenance documentation as identified in Chapter 23, including:

  i). Operating Manual

  ii). Running Maintenance Manual

  iii). Heavy Maintenance Manual

  iv). Illustrated Parts Catalogue

  v). Troubleshooting Guide

21.2 Specialized Tools

a). The Contractor shall provide to Amtrak a complete set of all specialized tools, gauges, meters, diagnostic equipment (including laptop computers), etc. for each of the ten (10) Amtrak shops that will be maintaining the long distance fleet that will be necessary to operate, maintain, inspect, test, troubleshoot and repair all car type configurations or subsystems of the trainset throughout their forty (40) year design life.

b). These tools and equipment shall be delivered to Amtrak at all long-distance maintenance locations and shall be delivered to Amtrak prior to the Conditional Acceptance of the first trainset, but no sooner than thirty (30) days prior to the submission of the first trainset for Conditional Acceptance.

c). All specialized tools shall be included in the base warranty as specified.

d). See Chapter 24 for additional details regarding portable test equipment.

e). Any diagnostic equipment will include spare copies of all software and source code licensed to Amtrak.

i). The license shall allow Amtrak to modify and duplicate this code without limit.

f). Throughout the vehicle design process, the Contractor shall work to minimize the number of special tools required for the maintenance of the vehicles.

g). As part of the design review process, the Contractor shall submit a list of specialized tools and drawings if applicable and diagnostic equipment that will be provided to Amtrak.

i). 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.

ii). This list shall include all specialized tools and diagnostic equipment required to operate, maintain and repair the trainsets throughout their design life, and shall include:

(1) Specialized tools for inspecting, repairing, removing, installing, maintaining or measuring components and systems on the cars;

(2) Diagnostic equipment to troubleshoot problems, determine component or system status or condition, or interpret diagnostic information;

(3) 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

(4) All cables, connectors, software, power supplies, carrying cases and peripherals as required for use with the portable computers or Portable Test Unit (PTU).

(5) All diagnostic download and programming software shall be provided in the Microsoft Windows professional level operating system format identified by Amtrak with no use restrictions, so that Amtrak can install the software on additional computers as needed.

h). The Contractor shall provide drawings, schematics, specifications, part numbers and prices for all special tools and maintenance equipment to enable Amtrak to purchase additional quantities.

i). Drawings shall be provided for any component or special not produced by a supplier not owned in whole or part by the Contractor.

i). Drawings shall provide sufficient information to facilitate the manufacture of the required components or special tools should the manufacturer cease to support the component or special tool.

j). During the production of the pilot vehicles, the Contractor shall demonstrate the usage and validate the successful operation of each proposed special tools.

i). During this validation, Amtrak shall identify any of the proposed special tools that are determined to be unsuited or incapable of performing their intended function.

ii). The Contractor shall redesign such tools until they can successfully serve their intended purpose.

k). The Contractor shall supply complete sets of each type of bench type shop test equipment to each of the ten (10) facilities that will be maintaining the long-distance fleet.

l). Training on the use of the Special Tools shall be included in the delivered Training Program (See Chapter 23).

21.3 Consumables

a). The Contractor shall provide a list of all service consumables needed to support the trainset throughout its service design life.

i). 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.

ii). This list shall be provided as a component of the final design review. **[CDRL 21-01]**

b). This list should include items such as but not limited to:

i). Brake pads and shoes

ii). Filters - Heating, Ventilation and Air Conditioning (HVAC), air, water

iii). Lamps/Light Emitting Diodes (LEDs), marker lamps, indicators lamps

iv). Fuses, Diodes and Resistors

v). Air hoses

vi). All rubber / polymer components

vii). Shock absorbers

viii). Air brake and other pneumatic component overhaul kits

ix). Truck and draft gear elastomers

c). This list shall include the following information as it relates to these parts:

i). Contractor part number

ii). Part description

iii). Original Manufacturer name

iv). Original Manufacturer part number

v). Quantity required by car type

vi). Frequency of replacement

21.4 Spare Parts

a). As a part of final design review, the Contractor shall provide to Amtrak a list of strategic spare parts that Amtrak should acquire and maintain to support the fleet of equipment after the end of the warranty period. **[CDRL 21-02]**

b). This list shall include, but is not limited to the following:

i). Parts that are critical to the safe operation of the equipment;

ii). Parts with a moderate to high failure rate, based on the Contractor's reliability analysis (see Chapter 4);

iii). Parts located on the vehicle exterior or undercar and therefore subject to damage from debris strikes or accidents;

iv). Parts installed in a high-wear environment; and

v). Parts that require troubleshooting and repair off of the car, such as electronic components or LRU assemblies.

c). This list shall include the following information as it relates to these parts:

i). Contractor part number

ii). Part description

iii). Original Manufacturer name

iv). Original Manufacturer part number

v). Quantity required by car type

vi). Shelf life/maximum storage period

vii). Recommended quantity to have on hand

d). The Contractor shall be responsible to provide replacement parts for those failing under the terms of the warranty.

i). Amtrak shall not be responsible for supplying replacement parts to the Contractor for the purposes of fulfilling warranty provisions.

ii). Amtrak shall not be responsible for supplying cores or subcomponents to the Contractor for the purposes of fulfilling warranty provisions.

21.5 CDRLs

CDRL	Description	Due
CDRL 21-01	List of all service consumables needed to support the trainset throughout its service design life	FDR
CDRL 21-02	List of strategic spare parts recommended to support the fleet of equipment after the end of the warranty period	FDR

* End of Chapter 21 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

22. Shipping Preparation

Revision 1

Table of Contents

22.1 Overview

a). This Chapter describes the requirements for preparing completed cars and trainsets for shipment from the Contractor's final assembly facility to the Contractor's field site, where vehicle acceptance will take place by Amtrak.

b). All vehicles must receive approval for shipment from Amtrak before they can be shipped to the field site.

c). The Contractor is responsible for all costs and arrangements associated with the shipment of the completed vehicles to the Contractor's field site.

d). The car clearance for all cars in the trainset shall be verified with all involved railroads for the delivery routing.

22.2 Requirements for Shipping Vehicles

a). All completed vehicles shall be prepared for shipping as follows:

i). All hoses and inter-car cables shall be connected between vehicles.

ii). A Single Car Air Test shall be successfully conducted within 30 days of shipment.

iii). Brake control valve selector plate shall be set to graduated release if being moved in passenger service and a transport control valve shall be installed if required for normal Brake Pipe brake control without HEP electrical power being supplied to the trainset (see Chapter 9).

iv). Automated 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 6).

v). New air filters shall be installed in Heating, Ventilation and Air Conditioning (HVAC) system (see Chapter 10).

vi). All required inspections must be complete, including inspections and approvals from the FRA, the FDA and Amtrak.

vii). As part of the shipping process, the following documents must be completed and signed, and be installed in the document holders in each car and in the cab of the locomotive as applicable

(1) Amtrak MAP 100, Equipment Condition Report

(2) Amtrak MAP 1173, Class 1 Brake/Calendar Day Test

(3) Amtrak MAP 10C, Passenger Car Daily Inspection

viii). The Water and Waste systems, and Food service area equipment shall be drained, blown out with compressed air and winterized (see Chapter 17). All water fill ports shall be tagged as out of service.

ix). All doors and windows shall be closed, but means shall be provided to access the parking brake controls during shipment from the exterior of the trainset.

x). Shipping labels and warning signs shall be applied as needed (such as do not hump, do not couple to shelf couplers, instructions for operation of parking brake, etc.)

xi). Loose jumper cables shall be included for shipment (see Chapter 15).

xii). The Contractor shall perform other shipping-related tasks as required by Amtrak.

xiii). The Contractor shall comply with the requirements of the Association of American Railroads (AAR) Specification M-1006 and Recommended Practices RP-2001 and RP-2002 regarding railroad shipping information and shall be considered the Point of Contact for additional information.

b). The following shall be set up at the discretion of Amtrak in accordance with the requirements for each shipment of cars:

i). If HEP and main reservoir trainlines are being used for shipment, 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.

ii). 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. Battery power may be needed for wheel slide protection during shipment.

iii). Gangways shall be removed if necessary. If removed, body end door shall be sealed and gangways shall be properly prepared for shipment by the Contractor to the Contactor's field site, where they will be reinstalled by the Contractor prior to Amtrak acceptance of the car.

* End of Chapter 22 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

23. Training and Documentation

Revision 1

Table of Contents

23.1 Overview

a). 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 trainset.

b). 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.

c). 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 Amtrak and any designated maintenance and/or operations providers have access to all necessary resources to properly and successfully operate, maintain, repair and administer the equipment as required by Amtrak, the Contractor, the FRA and others. **[CDRL 23-01]**

23.2 General Requirements

a). General

i). 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 Amtrak. Sharp, clear drawings shall be used throughout the documents for illustration. Photographs may be used only where explicitly approved by Amtrak. 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.

ii). All correspondence, drawings, data, manuals or other written communications pertaining to this Contract shall be in the English language.

iii). 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.

iv). All publications must be reviewed in detail by the Contractor to ensure completeness and accuracy of information and quality prior to any submittal to Amtrak for approval. Chapter numbers shall be consistent for all documents.

v). 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 Amtrak. Each updated information submittal shall be accompanied by a file containing a revised list of effected pages for the manual set being changed.

vi). 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 operator's manual, 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 Amtrak to control ECSBs, such as using note tools on the existing electronic PDF versions and/or the development of master lists of outstanding ECSBs.

vii). The Contractor shall be responsible to provide instructional full system mock-ups in the design of at least three full training cars (one sleeper, one diner and one premium coach) that are fully functional and can be used for training and troubleshooting for repair personnel and onboard crews, independent of any spares required for trainset maintenance. The systems shall be kept up to date with all applicable software and hardware during the warranty time frame. The training cars should be provided at a central location for training purposes determined by Amtrak. Applicable systems shall include at a minimum:

(1) Air brake

(2) Waste/water/toilet

(3) HVAC

(4) Door Systems and controllers

(5) Wheelchair lifts and controllers

(6) Trucks

(7) Diagnostic system CDU

(8) Accessibility systems including elevators

(9) Roomette and Sleeping modules

(10) Food Service equipment including appliances, carts and dumbwaiters

(11) Seats and other seating accommodations

(12) Lighting

(13) Communication System

(14) Digital Technology Systems

b). Contractor Responsibility

i). The Contractor shall provide documents such as drawings, Solid works models, photographs and a family of operating and service manuals which shall provide Amtrak with the information necessary to properly operate and provide all maintenance functions for the trainset vehicles. These include drawings and manuals to safely and properly conduct:

(1) Operation

(2) Service and inspection

(3) Troubleshooting

(4) Running maintenance

(5) Heavy repair/overhaul (vehicle and system/component level)

(6) Part identification (to the lowest repairable level)

(7) Wreck repairs

(8) Modification of equipment (documenting as-built configuration)

c). Rights To Technical Data

i). The Contractor and all of its subcontractors shall grant to Amtrak in connection with this Contract the right to use, duplicate or disclose, in whole or in part and without charge, all technical data required by Amtrak to install, operate, understand, maintain, modify, replace, test, repair or overhaul the cars and their equipment. Amtrak shall not disclose proprietary information and data being supplied under this Contract except for the limited purpose of obtaining individual part repairs or specialized testing or repair services outside the ability of its shops, and then only on a confidential basis. Technical data means information of a scientific or engineering nature, regardless of form or characteristics, to be furnished by the Contractor pursuant to this Contract. Examples are research and engineering data, engineering drawings and associated lists, as-built drawings (regardless of restrictions contained therein), specifications, standards, process sheets, manuals, technical reports, catalog item identifications or related information. This shall not include financial information or information of a contract administrative nature. The Contractor shall not patent or copyright any original materials or information created by this procurement which will be submitted to either the Engineer or Amtrak, as per Federal procurement regulations.

23.3 As-Built Drawings

a). General

i). The Contractor shall provide Amtrak with a full set of sub-component, component, system, arrangement and installation drawings, schematics and specifications for all parts and assemblies as provided on each type of car, from both the Contractor and all of its suppliers. These drawings shall be in a Amtrak-approved 3-D CAD format utilizing the latest major version of Solid Works (SLDDRW for Mechanical and DWG for Electrical) which includes a SMART searchable index and all material characteristics. 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. A drawing template shall be approved by Amtrak prior to submittal of any drawing. The Contractor's title block must include wording that explicitly grants Amtrak full rights to use the drawing contents.

ii). 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, and the next higher 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 or to maintain the cars. Circuit board level detail, installation and connection drawings shall be supplied. Also included shall be general arrangement drawings for each car type, color schedules and clearance drawings. Electrical schematic drawings shall indicate all wire numbers, references to other drawings of any and all manufacturers to which connections are made, nominal voltages, currents and frequencies, significant resistance values, and the rating of all loads. Devices shall be labeled in agreement with the identification appearing on the actual device, and their locations on the cars shall be shown. Pneumatic schematic drawings shall be prepared in a similar fashion.

iii). 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.

iv). Updates to any drawings need to be provided to Amtrak once every quarter (3 months) unless otherwise directed by Amtrak.

b). Drawing Availability

i). Preliminary as-built drawings needed to perform maintenance, repairs, testing or measurements shall be supplied 180 days prior to the delivery of the first completed trainset. **[CDRL 23-02]**

ii). A complete set of as-built drawings shall be delivered within 30 days after the delivery of the first trainset. **[CDRL 23-03]** iii). A complete bill of material for each car type, in standard 8.5 in. by 11 in. size, and electronically, covering all major components and hardware, shall also be provided within 30 days after the completion of the last trainset of the base order.

iv). The Contractor shall make available, for the life of the equipment, and without charge, hard copy drawings or electronic files that are required by Amtrak to conduct equipment modifications, conduct overhauls or make extraordinary repairs, such as those arising from accidents, etc. The contractor shall upload all drawings to the Enterprise Product Data Management (EPDM) system, Product Lifecycle Management (PLM) system and/or the latest document control system utilized by Amtrak at the acceptance of the first trainset.

v). All electronic and hard copies of drawings shall be marked with a statement of "Printed Documents are Uncontrolled" to ensure personnel check the latest electronic version for updates to any drawing. The contractor shall also provide a complete set of electronic drawings in Portable Document Format (PDF) within 30 days after the delivery of the first trainset. PDFs shall maintain an electronic parent/child relationship to the associated Solid works drawing.

c). Drawing Originals

i). The Contractor shall submit to Amtrak for review and approval, within 30 days after completion of first car of each base type, and then again after completion of all modifications, the as-built drawings and 3-D CAD models of all assemblies, sub-assemblies and arrangements in accordance with this chapter. If the Contractor decides not to maintain the drawing originals, they shall be supplied to Amtrak at no cost. Likewise, if the Contractor terminates operations, all drawings pertaining to this project, CAD files or any other Amtrak approved media shall be provided to Amtrak free of charge.

d). Electronic Delivery

i). Within 30 days of the delivery of the last car of the base order, the Contractor shall provide an electronic file 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 and car history books. **[CDRL 23-04]** The car number(s) shall be included in the filing system for car-specific data such as the history books.

e). Photographs of Car Assembly

i). For each car type, the Contractor shall take not less than 50 different digital color photographs, large format, showing the progression of vehicle construction. **[CDRL 23-05]** Special emphasis shall be made to illustrate hidden areas which are later concealed, such as carbody structure, floor pans, ceiling structure, ducting, and electrical lockers. The views shall be approved by Amtrak.

f). Photographs of Completed Cars

i). For each car type, the Contractor shall take not less than 50 different digital color photographs, large format, showing the interior and exterior of the fully completed and painted vehicle. **[CDRL 23-06]** They shall include at least four different exterior views of each car type, including full broadside, 3/4 side, top and rear views, the overall interior, detail views of the passenger area interior surfaces, all lockers, rest room details, galley, vestibules, open and closed side and body end doors, and the water and waste servicing areas. Included shall be high quality exterior views of each car type against a non-distracting background (broadside and 3/4 side view), suitable for publicity purposes. The views shall be approved by Amtrak.

g). Digital Format

i). All photographs shall be taken in digital format (jpeg), at high resolution (2400 x 3000 pixels). All photographic files will be submitted to Amtrak within 30 days following completion and acceptance of the first car of each base type.

23.4 Conformed Specification

a). Within 30 days after completion of each car type, the Contractor shall update and revise this Specification to provide an as-built specification and contract document. **[CDRL 23-07]** The revised document shall require Amtrak review and approval. One reproducible electronic copy in Adobe PDF format of the approved version shall be provided.

b). 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.

23.5 Manuals

a). General

i). The Contractor shall provide a complete family of operating and maintenance manuals. The following manuals are required:

(1) Operator's Manual

(2) Service and Inspection Manual

(3) Troubleshooting Guide

(4) Running Maintenance Manual

(5) Heavy Maintenance Manual

(6) Integrated Schematic Manual

(7) Illustrated Parts Catalog

ii). The manuals shall include full descriptions of all systems and components requiring maintenance or servicing. Description of systems shall be included in the nomenclature of all digital files. The manuals to be supplied shall contain information required for effectively understanding operation of all car types 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.

iii). 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.

iv). All manuals shall have, at a minimum, the following information on the front cover:

(1) Contractor name

(2) Amtrak name

(3) Type of equipment

(4) Car numbers

(5) Date and level of revision

v). Contractor manuals shall be provided electronically in an editable Adobe PDF format or other Amtrak approved language. The front of each volume of any manual type shall include a listing of the Chapter numbers and title for the complete manual.

b). Manual Review and Availability

i). The Contractor shall develop a master plan and schedule for the development and completion of the manuals. **[CDRL 23-08]** This manual development plan shall be submitted to Amtrak 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.

ii). A full set of first draft manuals, including those provided to the Contractor by suppliers, shall be submitted for Amtrak review no less than 90 days prior to the completion of the first car. **[CDRL 23-09]** If the manuals require revision, as determined by Amtrak, 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 Amtrak has approved the first draft of the manuals. The Contractor shall provide 10 full sets of manuals, in electronic format, to Amtrak prior to Amtrak acceptance of the first trainset.

c). Manual Updates

i). 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 Amtrak. Upon the completion of the warranty period, the Contractor will issue 10 sets of finalized manuals to Amtrak, 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 23-10]**

ii). 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.

d). Work Management System

i). The manuals will be used electronically in Amtrak's Work Management System (WMS) or successor maintenance tracking database. The Contractor shall work with Amtrak to ensure that this is implemented successfully. **[CDRL 23-11]**

e). Operator's Manual

i). 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 each car type, including definitions giving nomenclature, function, location and operation of all indicators, controls, components and subsystems utilized in the operation of the equipment. This shall include preparing the equipment for operation, securing the equipment from operation and operation of each car type individually and as an integrated trainset. Normal and rescue locomotive coupling/ uncoupling procedures to both ends of the trainset shall be provided, along with coupling to equipment with completely dead batteries, and deadhead movement of equipment in freight train service.

ii). Emergency procedures and safety precautions of a specific nature applicable to the equipment shall be included. This shall include ADA and wheelchair passenger evacuation methods. 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.

iii). 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

iv). 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:

(1) Index

(2) Safety instructions

(3) Instructions for communications during fault isolation

(4) Authorized fault isolation procedures

(5) Authorized on-the-road repairs

(6) Equipment location diagrams

v). 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 equipment in all possible configurations. Illustrations shall include layouts of the equipment, showing major components and controls referenced in the text and their locations on each type of car. This shall include all electrical, pneumatic, water and waste system cutouts and bypasses.

vi). 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.

f). Service and Cleaning Manual & Maintenance and Inspection Manual

i). The Service and Cleaning (S&C) manual as well as the Maintenance and Inspection Manual (M&I) 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, the FRA and FDA. All daily inspection items shall be in the S&C manual. Periodic inspections including those occurring every 92 days, every 184 days and annually (every 368 days) shall be in the M&I manual. **[CDRL 23-12]** Inspections and servicing activities occurring on an interval that is not used by Amtrak may be included in the tasks shown for the next more frequent interval. The weight of each car type, and instructions for water system flushing and draining/winterization of the equipment shall be included in both manuals.

ii). The inspection tasks described in these manuals shall include, but are not limited to the following:

(1) Item or system requiring inspection

(2) Frequency or period of inspection

(3) Inspection procedure, including location and description of system being inspected

(4) Pass/fail criteria for inspection

(5) Special tools, conditions or other requirements for inspection to be performed

(6) Source of inspection requirement (Contractor, Amtrak, FRA, FDA, etc.)

(7) Reference for inspection requirement (CFR, maintenance manual, etc.)

iii). For both manuals a summary table in order of frequency shall be provided for quick reference that lists the item or system, frequency, source and reference for all required inspections. A digital copy of all manuals shall be provided and updated for the duration of the warranty period.

iv). The M&I manual will also provide complete instructions for all pertinent maintenance activities for the routine operation of the cars that are required every 92 days, or more frequently, including:

(1) Fresh water filling

(2) Waste tank draining

(3) Removal of trash and recyclables

(4) Installation and replacement of consumables

(5) Inspection and replacement of filter elements

(6) Cleaning and lubrication

(7) Replacement of brake shoes and pads

(8) Elevator and various other vertical lift maintenance

v). Th 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 Amtrak name, car numbers, car types, the Contractor name, issuance date and revision level.

g). Troubleshooting Guide

i). This manual shall 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:

(1) Carbody

(2) Trucks

(3) Coupler and Draft Gear

(4) Brakes

(5) Door System

(6) Interior

(7) HVAC

(8) Lighting

(9) Communications

(10) Electrical System

(11) Food Service

(12) Water and Waste

(13) Digital Technology

(14) Emergency Equipment

(15) Diagnostics System CDU

(16) Software and Microprocessors

(17) Cyber Security

(18) Accessibility Systems including Elevators and onboard lifts

ii). 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.

iii). Each chapter of the troubleshooting procedures shall contain the following sections:

(1) Introduction, including general information, safety precautions, and definition of warnings, cautions, and notes with specific details

(2) Operational and functional system descriptions

(3) Troubleshooting

(4) Use of diagnostic test equipment

(5) Corrective maintenance procedures

iv). 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:

(1) Identification of the system covered

(2) A concise explanation of the troubleshooting format and how to use the procedure

(3) Test equipment and tools required

(4) Safety precautions that must be taken

(5) A reference to the supporting block diagrams

(6) Preliminary tasks that must be performed prior to initiating troubleshooting

v). 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 shall include a listing of every type of diagnostic software used on the equipment, including instructions for their use including cable connections. The manual format shall utilize diagrams and illustrations as required to enhance understanding. All procedures shall be proved out in the field on the first car and shall be revised as necessary.

h). Running Maintenance Manual

i). 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 equipment out of service. The manual is to be divided into three volumes as listed below.

ii). 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.

iii). 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:

iv). 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.

v). 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.

vi). 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.

vii). Instructions shall be provided for the removal, addition, or rearrangement of car types within a trainset. The weight and instructions for the lifting and jacking of each car type shall be provided.

i). Heavy Maintenance Manual

i). Heavy maintenance is defined as the maintenance that may be performed on the shop track or one of the heavy maintenance tracks if the equipment is taken out of service. Heavy maintenance tasks will generally require more than one 8 hour shift to complete. The Heavy Maintenance Manual shall contain a detailed description and analysis of all mechanical, electrical and electronic assemblies/subassemblies so that Contractor overhaul facilities can effectively and safely service, inspect, adjust, troubleshoot, repair, overhaul and test these assemblies. The 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 Amtrak.

ii). 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 removal" may only 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 removal" may still be used. Installation instructions must be provided for procedures that are complex and require additional step-by-step detail or are significantly different from that of removal procedures.

iii). 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.

iv). The manual shall include descriptions of how each assembly/subassembly operates within the car system. Each shall include:

(1) Block diagrams

(2) Signal flow diagrams

(3) Simplified schematics

(4) Functional wiring and piping diagrams

(5) Completely detailed overhaul procedures

v). 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 Amtrak all such specialized test equipment and their drawings.

vi). Rewinding procedures in full detail for all rotating and wire-wound apparatus, except as agreed to otherwise by Amtrak.

vii). 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.

viii). For overhauls, the maintenance action required to restore an item to a completely serviceable and operational condition. Overhaul is not normally performed in the car and does not necessarily return an item to like-new condition.

ix). 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. The rebuild operation allows returning to zero those age measurements including, but not limited to, hours and miles, considered in classifying Amtrak's equipment and components.

x). Complete instructions for use, drawings and parts information for all special tools that are required to be provided to Amtrak by the Contractor.

xi). 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, HVAC module, etc.

xii). Maintenance, calibration and adjustment, repair and overhaul of all diagnostic test equipment.

j). Integrated Schematic and Wiring Manual

i). The integrated schematic manuals shall include all electrical, hydraulic, pneumatic, mechanical, refrigerant, water 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 unless otherwise approved by Amtrak. The manual shall provide schematic and wiring diagrams including (but not limited to) the following:

(1) Electrical power distribution

(2) Trainline assignments and connections to car-borne equipment

(3) Door control system

(4) Lighting system (interior and exterior, in normal, standby and emergency modes)

(5) Communications system, including PA, intercom and passenger information system

(6) HVAC system, including refrigeration units in the food service car (electrical, refrigerant and air flow schematics)

(7) Brake system (electrical, mechanical and pneumatic)

(8) Main reservoir air distribution system

(9) Fresh water distribution and waste retention systems (electrical, pneumatic and water routing)

(10) Onboard mobility device lift (electrical and hydraulic, if used)

(11) Food service equipment, including all appliances (electrical, water distribution)

(12) Elevators, Cart Lifts and Dumbwaiters (electrical and, hydraulic, if used).

ii). 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.

iii). 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.

k). Illustrated Parts Catalog (IPC)

i). 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). **[CDRL 23-13]** 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 must include the accepted generic modified noun-name description, the original supplier, the original supplier's part number and name, the Contractor's part number, and space reserved for the Amtrak 10 digit internal catalog number. Providing the original supplier and its own part number for all components is of great importance to Amtrak. Complete piece-part breakdowns of all subcontractor assemblies shall be provided, regardless if the Contractor only purchased completed assemblies. 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 exploded view illustrations to fully indexed parts. Amtrak shall have the right to make direct purchase from the sources listed by the Contractor. If provided to the Contractor, Amtrak part numbers shall be included in the IPC. An appendix giving the original supplier's contact information responsible for parts ordering shall be included.

ii). Identical parts within the equipment, regardless of where used in the car types, 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. Common bulk materials such as weather strip or hose used in several locations, but which is cut to specific application length for an individual application may use one common part number, but the specific location application must identify the length in the text description. All assemblies shall be listed alphabetically by name with reference to corresponding figure number.

(1) The IPC shall include two cross-reference lists that sort all listed parts as follows:

(2) Sorted alphanumerically by part number

(3) Sorted alphabetically by part name

iii). 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.

iv). Illustrations shall be exploded view and located on the same page or facing page of the text they support. A sequence of illustrations must be used in order to clarify or simplify a complex assembly. All illustrations shall be properly scaled in order to show each individual part being called out. 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 maintenance manual, the reference index in both manuals must identify the same parts.

l). Manual Quantities to be Provided

Name	**Quantity**
Operator's Manual	250
Service and Inspection Manual	50
Running Maintenance Manual	15 sets
Troubleshooting Manual	15 sets
Heavy Maintenance Manual	15 sets
Illustrated Parts Catalog (IPC)	15 sets
Integrated Schematic Manual	15 sets
Manual quantities are subject to change.	

i). The Contractor shall also supply 15 sets of every type of software used on the equipment, from the Contractor and its suppliers, in an agreed-upon format. This shall include diagnostic tester software, any passenger information and Wi-Fi system software, and databus software. All such software shall be licensed in Amtrak's name and include master passwords to allow future changing of system parameters by Amtrak when necessary.

m). Inspection, Testing and Maintenance Plan

i). The Contractor shall be responsible for the creation and maintenance of the Inspection, Testing and Maintenance Plan annually in accordance with 49_CFR_238.107. The Plan shall include all detailed inspection, testing and maintenance requirements for each car. The list of activities shall be considered an all-encompassing and complete list of every inspection, testing and maintenance requirement throughout the life of the equipment. This requirement shall be provided to Amtrak for submittal to the FRA on an annual basis.

ii). This plan shall include a detailed description of the following:

(1) Inspection procedure, intervals and criteria;

(2) Test procedures and intervals;

(3) Scheduled preventive maintenance intervals;

(4) Maintenance procedures; and

(5) Special testing equipment or measuring devices required to perform inspections and tests.

23.6 Car History Books

a). General

i). The Contractor shall produce a car history book for each completed car. **[CDRL 23-14]** The car history books shall be a specific record of production, testing, inspection and relevant documentation for each individual vehicle and the associated trainset, if applicable.

ii). The car history book shall contain original documents unless specified otherwise.

iii). All documents for a car shall be marked with all carshell serial numbers, the production sequence numbers or the road numbers for the completed car.

iv). The Contractor shall provide one electronic set and one paper set of originals of the car history book for each car. The electronic set shall be color scanned at high resolution. The printed car history books shall be provided in three-ring binders. Documents shall be copied double-sided where practical.

v). At a minimum, each car history book shall contain the following:

(1) Table of contents

(2) Production control cross-reference sheets, listing:

(a) Carshell serial numbers

(b) Shop order/production sequence numbers

(c) Final car reporting marks and road numbers

(3) Production schedule for each car showing start and end dates for each major stage of manufacturing

(4) List of all production drawings by number and revision status (release date, current revision, and outstanding engineering change requests at time of production)

(5) List of all parts by supplier and part number (bill of material)

(6) List of all serialized components

(7) Truck records (separate set of records for each truck)

(a) Inspection records and component serial numbers

(b) Truck assembly sequence

(c) Truck assembly weight certificate

(d) Wheel/axle pressing graphs

(e) Truck to carbody attachment record

(8) Log of all non-conformances including status

(9) Component test certificates

(10) Test records:

(a) Master test plan

(b) Test procedures

(i) Production tests

(ii) Acceptance tests

(11) Record of measurements and results

(12) Critical dimensional inspection report

(a) Carshell dimensional inspection (prior to production)

(b) Carbody leveling, balancing and centering record

(c) Carbody overall dimension measurement, including compliance with clearance diagram

(d) Coupler height measurement

(e) Scale certificate for each completed car (dry weight)

(13) Records of all required inspections

(14) USPHS Certification forms (originals are to be installed in the appropriate certificate holder in the food service car)

(15) FRA documentation

(a) Record of compliance with FRA regulations

(16) Completed pre-shipment checklist

(17) Shipping approval form

(18) Amtrak acceptance form

(19) Transfer of title of the car from Contractor to Amtrak (with original blue-ink signature of Contractor's representative).

vi). The car 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 DVD. Procedures, electronic signatures and controls shall be established to ensure the validity of information in this document at all times.

vii). Each car history book shall be fully completed and presented to Amtrak prior to the car being released from the Contractor's facility.

23.7 Training

a). General

i). The Contractor shall organize and present formal instruction programs for personnel who will operate, maintain, repair and troubleshoot the equipment. In addition, the Contractor shall provide instruction and training materials for Amtrak personnel who shall train others in the future. Training shall take place at four locations designated by Amtrak.

ii). All training shall meet the requirements of the FRA contained in 49 CFR Part 243 regarding the training and qualification of safety-related Amtrak employees. This shall include all train operating staff (Engineers and Conductors), customer service personnel (On-Board Service and Lead Service Attendants), Mechanical Department maintenance personnel, Digital Technology personnel and the Amtrak Police Department.

iii). The regulation requires that the training plan:

(1) categorize all 'safety-related railroad employees' (SRREs);

(2) identify all training (subject to FRA regulation) that each category receives; and

(3) provides outlines for each training course, that includes learning objectives, instructional method(s), and assessment approach.

iv). All training shall also be compliant with Section 5 of Railway Passenger Handling Safety Rules from Transport Canada O-0-16.

b). Method of Presentation

i). At the choice of the Contractor, the direct training of the Amtrak employees identified above shall be performed either:

(1) by the Contractor, using a training plan which it has directly submitted to the FRA for review and approval; or

(2) by the Amtrak Safety and Technical Training Department, which shall be fully based upon a Contractor-developed and supplied training plan.

ii). The Contractor's proposal must therefore identify whether the Contractor will either be submitting a stand-alone training plan to the FRA for their approval, or if the Contractor would be requesting that Amtrak adopt the Contractor-supplied training plan. The training plan in any case must be fully approved by the FRA and ready to be presented to Amtrak personnel prior to the delivery of the first car.

c). Contractor Training Plan to FRA

i). If the Contractor intends to submit a training plan directly to the FRA for its approval, the Contractor must submit a copy of that plan to the Amtrak's Safety and Technical Training Department no less than 90 days prior to training any Amtrak employee. Amtrak will not review, comment, or approve the plan, but will rely on FRA's approval.

d). Amtrak Adopts Contractor Training

i). If the Contractor will be relying on Amtrak to adopt its training into Amtrak's own plan, the Contractor must submit fully completed draft training materials to the Amtrak's Safety and Technical Training department no later than 180 days prior to training any Amtrak employee. Amtrak will review the materials and provide comments within 30 calendar days. The Contractor will be expected to incorporate any comments/changes and return the materials to Amtrak within 30 days. This process will continue until the Amtrak Safety and Technical Training Department determines that the training materials meet the FRA Part 243 requirements.

e). Annual Review

i). Whichever party that performs the training (Contractor or Amtrak) is also required to perform an Annual Review, using operating rule violations, FRA inspections, NTSB incident findings, etc., to determine if the identified training was effective. If knowledge and/or skills gaps are identified in the Annual Review process, the training plan is to be suitably updated or modified, and the changes reported to the FRA.

f). General Training Requirements

i). The following provides the general requirements for the content and level of details of the training materials that shall be prepared and submitted by the Contractor. 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. The manuals shall be used as the major element of the training program. Amtrak shall advise the Contractor as to how many individuals of each discipline are to be trained at each location.

ii). The Contractor shall provide a program to train and educate personnel in all details of the equipment as required to enable Amtrak to satisfactorily operate, service, and maintain the equipment. The program shall include 4,250 Contractor hours of classroom training at designated sites; 750 of which shall be for operations, 500 for Train the Trainer, and the remainder for maintenance. A primary objective of the program shall be to develop within Amtrak 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. Amtrak shall have the right to video record any classroom training sessions. Amtrak will retain ownership of the video recordings, following a final editing as mutually agreed with the Contractor and will have the right to use video recordings for future training sessions. Additional Train the Trainer classes shall be provided which is supplemental to the Contractor hours of classroom training.

iii). The Contractor's program shall include formal and informal instruction, training mock-ups, models, manuals, diagrams and component catalogs. All materials used in the programs, such as models, manuals, mock-ups, video recordings and drawings, shall be of durable construction and shall become the property of Amtrak. 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 Amtrak personnel. However, the Contractor may assume that maintenance personnel have the basic skills pertinent to their crafts.

iv). Field instruction may also be provided in locations approved by Amtrak using actual cars or training mock-ups to provide hands-on instruction in the maintenance and operation of the equipment.

v). Before delivery of the first car, the Contractor shall provide Amtrak with a proposed training plan incorporating the following elements:

(1) 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.

(2) Schedule of instruction at each location.

(3) State of the Contractor's experience in organizing and delivering similar training programs and qualifications of the designated instructors.

(4) List of training materials to be provided by the Contractor to support the training program.

(5) Instruction guides for each course to be taught within each program.

(6) Student workbooks for each course, each workbook including a syllabus, objectives, schedule, outlines, figures, lesson summaries and any other appropriate instructional information.

(7) Train the Trainer classes which is supplemental to the Contractor hours of classroom training.

vi). 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 Amtrak. An editable electronic copy of the training presentation must be provided to Amtrak after the training is approved and delivered by the contractor. Color copies must be used where it is needed to communicate the training concepts in the document / course.

g). User Training

i). The Contractor shall provide a user training program, designed for Amtrak operating, maintenance and training personnel. **[CDRL 23-15]** 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.

ii). Class audience will be:

(1) Operating personnel

(2) Maintenance personnel

(3) Food service personnel

(4) Supervisors and management

(5) Training department personnel

(6) Amtrak representatives

(7) Amtrak Police Department and Emergency Management personnel

(8) Others as required

h). Training Requirements

i). General

(1) The courses listed below shall be accompanied with training manuals, guides, training aids, student and instructor workbooks, and operator and maintenance manuals.

(2) It is the desire of Amtrak that the content and structure of the manuals be used as direct input into the training course materials where applicable.

ii). Course 1: System Operation Instruction Training Course

(1) This course shall include:

(a) General vehicle familiarization;

(b) Location, function, and operation of pertinent controls, gauges, indicators, and switches;

(c) Subsystem operation, inspection, setup, and shutdown procedures;

(d) Trouble symptoms diagnostic and troubleshooting procedures for isolating and correcting minor faults including, at a minimum, techniques for the following:

(i) Release of brakes;

(ii) Door isolation and cut-out;

(iii) Circuit breaker and/or fuse reset or replacement;

(iv) Water and waste system failure recovery;

(v) Head End Power (HEP) failure recovery;

(vi) Elevators and Vertical Lifts;

(vii) 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;

(viii) Towing and rescue, including with completely dead batteries.

(ix) Head End Power (HEP) Backup Power (option)

(e) Emergency Procedures including, at a minimum, techniques to respond to fire on board or emergency evacuation.

(2) 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 car. Subsequent classes shall be scheduled as approved by Amtrak. This class shall include at least 40 hours of training.

iii). Course 2: Repair and Maintenance Training Course

(1) 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.

(2) Course 2 shall provide the training needed for the following:

(a) Troubleshooting in-service failures as described in course 1

(b) Performing running maintenance including:

(i) General servicing

(ii) Lubricating

(iii) Inspecting

(iv) Adjusting

(3) The training shall include maintenance instructions on the use of the integrated wiring diagrams.

(4) 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 Amtrak. This class shall include a minimum of 80 hours.

iv). Course 3: Workshop Training

(1) The workshop training course shall provide the training for in-shop repair and trouble diagnosis of each LRU to the level of the lowest replaceable component.

(a) The training shall contain detailed explanation of flow charts, schematic drawing and detailed analyses related to each LRU, so that Amtrak maintenance personnel will be able to effectively service, inspect, maintain, adjust, troubleshoot, repair, replace and overhauled the LRU.

(b) The flow charts, schematic drawings and detailed analyses shall be included in the training manuals.

(2) The training shall include maintenance instructions on the use of the integrated wiring diagrams and shall include reference to the manuals.

(3) The major sections of the workshop training course will address, at a minimum the following subsystems and products, as defined above:

(a) Carbody

(b) Trucks

(c) Coupler and Draft Gear

(d) Brakes

(e) Door System

(f) Interior

(g) Elevators

(h) Onboard Mobility Device Lifts

(i) HVAC

(j) Lighting

(k) Communications

(l) Electrical System

(m) Food Service

(n) Cart Lifts and Dumbwaiters

(o) Water and Waste

(p) Emergency Equipment

(q) Digital Technology

(r) Microprocessor-based products

(4) Participation shall include, up to 25 Amtrak Mechanical Maintenance Personnel. 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 Amtrak. Each class shall include a minimum of 120 hours.

v). Course 4: Diagnostic Test Equipment (DTE) and Special Tools Course

(1) 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.

(2) It shall be conducted twice. It shall be conducted upon the delivery of the test equipment and special tools and as agreed upon by Amtrak. It shall be a minimum of 20 hours.

(3) Subjects addressed shall include:

(a) Introduction

(b) General description of the equipment

(c) Description of controls and indicators

(d) Operation of equipment

(e) Operation of safety and emergency equipment

(f) Troubleshooting

(g) Introduction and use of operator and maintenance manuals

(h) Review

vi). Course 5: Material Control Training Course

(1) This course shall provide Amtrak Material Control personnel instruction on the use of the Illustrated Parts Catalog.

(2) Participation shall include, up to 15 Amtrak Material Control Personnel and will be conducted twice. Other classes shall be conducted at dates to be scheduled as approved by Amtrak. Each class shall include a minimum of 16 hours.

vii). Course 6: Amtrak Police and Emergency Management Training Course

(1) This course shall provide Amtrak Police Department and Emergency Management personnel with a detailed understanding of the new equipment as outlined by a Train the Trainer type syllabus.

(2) Emergency equipment and all procedures shall be provided to aid in the training of all internal department personnel as well as outside first response agencies.

viii). Course 7: Specialty Training Courses

(1) The Contractor shall be responsible for arranging specialty training courses utilizing the sub-supplier for training.

(2) Systems such as but not limited to elevators and lifts would be expected to be instructed by the sub-supplier.

i). Training Materials

i). General

(1) Draft copies of the training materials shall be provided for Amtrak review and approval, with sufficient time to allow review and Contractor revision. **[CDRL 23-16]**

(a) Open discussion is encouraged early in the development process between the Suppliers, Contractor and Amtrak.

(2) The Contractor shall provide materials to support each course in the training program, including:

(a) instructor guides,

(b) training aids,

(c) student workbooks

(d) operator manuals

(e) maintenance manuals.

(3) Instructor guides and student workbooks shall be submitted for Amtrak's approval 60 days in advance of the start of the first class for each category of training.

(4) All training materials shall become the property of Amtrak.

(5) Format

(a) 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.

(b) Any Power Point presentations used in training will be supplied along with camera-ready, paper copy.

(c) Master copies of slides and other audiovisual materials shall also be provided to allow for reproduction as necessary.

(d) An editable electronic copy of the training presentation must be provided.

(e) Color copies must be used where it is needed to communicate the training concepts in the document / course.

ii). Instructor Guides

(1) The Contractor shall provide an instructor guide for each training course. **[CDRL 23-17]**

(2) The guides shall include:

(a) course agendas;

(b) course objectives;

(c) procedures for managing training sessions;

(d) resources and facilities required;

(e) guidelines for preparing for training;

(f) detailed lesson plans, including scripted or outlined presentations and discussion guides;

(g) training aids and job aids;

(h) pre-tests and post-tests;

(i) criteria and methodology for measuring performance in the classroom and in the shop/field;

(j) instructions for using any audiovisual support, training mock-ups, and scale models;

(k) detailed instructions for managing any on-the job training.

iii). Training Aids

(1) The Contractor shall provide training aids, such as training mock-ups, scale models, Power Point presentations, video recorded demonstrations, diagnostic testing equipment and any special tools required. **[CDRL 23-18]**

(2) These training aids shall become the property of Amtrak upon the completion of the training program.

(3) Any training mockups shall be separate and distinct from mockups provided during design review unless explicitly approved for training purposes by Amtrak.

(4) If Contractor proposes to provide a full size completed car in lieu of the mockups required in Chapter 3, Contractor must still meet the training aid requirements unless otherwise approved by Amtrak.

iv). Student Workbooks

(1) The Contractor shall provide, for each course, a student workbook **[CDRL 23-19]**, which shall include course agenda, course objectives, schedule of sessions, paper copies of Power Point presentations, lecture outlines, lesson summaries and any other information that will facilitate the learning process.

(a) The Contractor shall provide a copy of any course materials in the workbook.

(b) Color copies must be used where it is needed to communicate the training concepts in the document/course.

(2) The training program shall be conducted prior to the start of the new equipment in revenue service.

(3) The Contractor shall develop a training action plan and schedule and submit it to Amtrak within 90 days of Notice to Proceed (NTP), and shall update it periodically, to be submitted with program meeting minutes. **[CDRL 23-01]**

(4) Contractor shall provide paper and electronic (editable and PDF) copies of all training materials at the completion of the training program and shall become the property of Amtrak for unrestricted use for future training purposes.

23.8 CDRLs

CDRL	Description	Due
CDRL 23-01	Training Action Plan	90 days after NTP with on-going updates
CDRL 23-02	Preliminary As-Built Drawings	180 days prior to the delivery of the 1st trainset
CDRL 23-03	As Built Drawings	30 days after delivery of first trainset
CDRL 23-04	Electronic Documentation Delivery	Within 30 days after the last car of the base order is shipped
CDRL 23-05	Photographs-Car Assembly	30 days after completion and acceptance of first of each car type
CDRL 23-06	Photographs-Completed Car	30 days after completion and acceptance of first of each car type
CDRL 23-07	Conformed Specification	30 days after completion of each car type
CDRL 23-08	Master Manual Plan	90 days before completion of first car
CDRL 23-09	First Draft of Manuals	90 days before completion of first car
CDRL 23-10	Manual Updates	After delivery of the first car, and continuing through the end of the warranty period
CDRL 23-11	WMS Implementation	360 days prior to shipment of first trainset
CDRL 23-12	Service and Cleaning Manual & Maintenance and Inspection Manual	30 days prior to IDR with on-going updates
CDRL 23-13	Illustrated Parts Catalog	30 days prior to shipment of first trainset
CDRL 23-14	Car History Book	30 days prior to shipment of first trainset
CDRL 23-15	User Training Program	360 days prior to shipment of first trainset
CDRL 23-16	Draft copies of Training Material	360 days prior to shipment of first trainset
CDRL 23-17	Instructor Guide	360 days prior to shipment of first trainset
CDRL 23-18	Training Aids	360 days prior to shipment of first trainset
CDRL 23-19	Student Workbooks	360 days prior to shipment of first trainset

* End of Chapter 23 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

24. Diagnostics and Test Equipment

Revision 1

Table of Contents

24.1 Overview

a). This chapter defines the hardware and software requirements and describes the basic structure that shall form the diagnostic and fault reporting system used on each car of the trainset.

b). The system shall supply two levels of diagnostic information.

   i). A simplified system using indicator lights, fault status and system status screens, shall inform the train crew of failures affecting train operation, and a detailed diagnostic level shall be used by maintenance personnel which shall include detailed fault and system status information.

c). Faults and status information shall be available remotely and shall also be downloadable utilizing standard connectors which shall function as a Portable Test Unit (PTU).

d). Fault information from the individual car systems shall be sent to this central database location on each car for storage and display, which shall allow remote status access through an online portal, downloading of the reported faults via wireless or wayside connection, or hardwire downloading via standard connections.

e). The CDU and HMI screens shall also allow train-wide control software and database updates to car level systems and the monitoring of certain system level parameters on a real-time basis.

f). The Contractor shall submit a detailed functional description of the Central Diagnostic System to Amtrak for review and approval. **[CDRL 24-01]**

g). The CDU, HMI and car-level connector for the PTU shall be in Amtrak-approved interior locations, to be finalized during design review.

h). The diagnostic and fault reporting system shall provide sufficient information to enable operations and maintenance personnel to assess the operational readiness and suitability for service of each car and shall provide detailed failure information sufficient to enable maintenance personnel to troubleshoot and isolate failures down to the lowest replaceable unit level and confirm proper operation upon replacement.

i). PTU shall not be required for routine maintenance or routine replacement of components.

j). Tests, resets, or configuration adjustments during any routine maintenance activity shall be able to be accomplished through the Central Diagnostic System HMI displays.

k). As part of the acceptance testing of the test equipment, the Contractor shall fully demonstrate the function of each type of test equipment being supplied, once delivered and setup in the shop facility.

l). All on-board test equipment and the Central Diagnostics Unit and HMI screen shall be tested as part of the car-level First Article Inspection.

- i). This shall include the demonstration of the ability to change password-protected program parameters in all available car systems.

m). Portable test equipment shall be tested on the first trainset following delivery.

n). All diagnostic connection ports for the PTUs throughout all cars, regardless of subsystem, shall make use of standard connections.

o). No proprietary cables, connectors, accessories or wiring shall be required to run or copy diagnostic programs, or to copy or upload new software to any piece of equipment on the cars, including at the Central Diagnostics Unit.

p). The CDU shall serve as the source of network time for all microprocessor systems connected via Ethernet, with time synchronized between CDU systems throughout the train network.

q). All carborne equipment clock time shall use the GPS obtained Coordinated Universal Time (UTC).

- i). It shall be the responsibility of the Contractor to enforce this requirement for all car systems.

r). The Contractor shall make all modifications to test equipment specified herein which are required because of changes and modifications made to the cars or any of its systems or subsystems to meet the requirements of this Contract.

s). The Contractor shall maintain a master database of all software and its current revision level used for each type of diagnostic and test equipment being supplied for the trainset program, including onboard and shop equipment, until the conclusion of car warranty.

t). All shop support equipment shall be covered in Exhibit G, Technical Support, Spares and Supplies Agreement (TSSSA); however, in the event that the TSSSA is not executed or terminated, the Contractor is responsible for providing all shop support equipment to Amtrak as outlined in this Chapter.

24.2 Subsystem Integration

a). Each intelligent subsystem shall include status monitoring, self-diagnostic, fault-detection, recording, and troubleshooting capability including, but not limited to, the following systems:

- i). Air Brake/Wheelslide
- ii). Truck/Ride Quality
- iii). Powered Doors
- iv). HVAC
- v). Lighting Controllers

vi). OTIS/PA/Train Information

vii). Battery/Chargers/Power Systems

viii). Food Service Equipment (appliances, cart lifts, dumb waiters)

ix). Water and Waste (Tankless water heaters, gray water recycling, tank levels, etc.)

x). Automatic Vehicle Location System/GPS

xi). Car Temperature Monitoring

xii). Elevators and on-board mobility lifts

xiii). Room entry door lock and key system

xiv). Smoke Detectors and Fire Suppression

xv). Powered Rotating Seats (option)

xvi). Powered Adjustable Queen Bed (option)

b). On-board testing shall be either internal, using self-contained diagnostic routines, or external, using a portable tester, or may be a combination of both techniques.

i). Systems which are microprocessor-based shall use both techniques, incorporating an internal self-test routine which can be initiated and monitored through the CDU HMI, without use of a portable tester.

c). The built-in diagnostic test routines shall be used for the testing of all power circuit devices.

d). All power circuit devices shall be testable without the need to remove any connections to the device from the circuit.

e). The on-board test routine shall apply high current or high voltage to the device as appropriate to check calibration and perform failure diagnosis.

i). Provisions shall be supplied to accept a clamp-on current sensor for high current-in circuit calibration checks and jacks for high voltage isolated probes for in-circuit calibration checks.

f). The systems shall constantly monitor their own system health and report problems as a fault to the CDU.

g). Faults shall be stored at the CDU for remote access or later retrieval using the PTU.

h). Each stored fault shall contain car status information at the time of the fault, such as, handle position, speed, temperature, etc., in addition to the actual problem or failure.

i). The CDU shall also be designed to include a real-time data recorder capable of recording no less than one weeks' worth of status information from all subsystems listed above.

j). The data recorder shall have both pre-trigger and post trigger recording capabilities and shall be fully configurable from the PTU.

  i). It shall record both analog and digital channels selectable by the PTU.

k). Triggers shall utilize the pre-assigned system faults and it shall also be possible to trigger on configurable equations based on one or more analog or digital channels when a selected threshold has been exceeded, or at a specified time interval.

l). Sampling rates shall be selectable and based on the actual sampling capabilities of the subsystem hardware, with 20 Hz being the minimum.

m). All signals, including all subsystem inputs and outputs as well as calculated values shall be transmitted to the CDU to facilitate real-time data recording.

n). Set-up parameters and data shall be stored in non-volatile memory. Recorded data shall be downloadable to the PTU, which shall convert the data into a chart recorder type display format that can be displayed, printed and saved to removable media.

  i). The system design shall be approved by Amtrak during design review. **[CDRL 24-02]**

24.3 Central Diagnostics Unit

a). The Contractor shall supply a Central Diagnostics Unit (CDU) and HMI touch screen on each car for use by Amtrak personnel.

b). The HMI touch screen shall display train and car status, event and failure information useful to operations, maintenance, and engineering personnel.

c). Faults downloaded by the PTU shall not be automatically deleted from memory, so that they can be downloaded and included into the maintenance database.

d). Using the CDU and HMI screens, it shall be possible to ascertain the current software version of all software configuration items installed on the train, as approved by Amtrak.

e). From the CDU and HMI screens, it shall be possible to upload new control software to all microprocessors on a train basis (except the systems as deemed safety sensitive during design review, which require update via the subsystems local PTU port).

  i). The proposed design shall allow updates to the OTIS content via methods approved by Amtrak.

f). The CDU shall also be capable of providing train-level information over the digital trainlines to the train crew using an HMI touch screen in an approved location.

g). The contractor shall utilize the HMI touch screen devices defined in Chapter 14.

h). The HMI screen shall alert the train crew of major system faults, such as brake problems, HVAC failures, HEP problems, water/waste problems, door problems, and/or other major failures, as approved by Amtrak.

i). It is intended that this data supplied to the train crew be simplified in nature.

i). Fault information shall be given for all major system failures which require that they be reported to the Amtrak Operations Center (CNOC) or that require a change in operating procedure, as approved by Amtrak.

j). The HMI screen shall also provide train wide subsystem status information to operations and maintenance personnel.

k). The Contractor shall submit for Amtrak review and approval a Fault Management Plan. **[CDRL 24-03]**

i). The Fault Management Plan shall include a fault listing, detailed description of each fault, detailed description of the triggering condition for each fault, conditions required to reset the fault, details of any lockout imposed by the subsystem for the fault, and attributes for each fault.

ii). Attributes shall include whether a fault will be recorded by the subsystem and/or CDU, whether a snapshot will be triggered, the criticality of the fault, if the fault will trigger an alarm for the operator or crew, whether the fault is accessible to crew or maintainers, or if the fault should trigger immediate message to the wayside server.

iii). Additional attributes may be defined by Amtrak during design review. Faults shall be able to be added by use of equation base on subsystem signals and faults for multiple systems similar to the fault trigger requirements listed in section 24.2.k.

l). It is the intent to have maintenance personnel review the faults from the CDU to determine if a problem exists on a car and/or train.

i). The Central Diagnostics Unit shall provide the capability to monitor system status, faults and data in real time by maintenance personnel.

ii). The system data to be monitored shall be selectable by use of the PTU or through configuration on the CDU HMI screen. An approved touch screen display shall be provided to view the selected system data in real time.

iii). The CDU shall be designed to be extensible, with the understanding that additions and subtractions of systems on the vehicle will occur throughout the life of the vehicle.

iv). The CDU shall be configurable to add or remove systems using a defined interface._The car builder shall be responsible for developing and providing a CDU system interface document that can be used for future additions or subtractions to the system.

m). The Contractor shall provide a highly available database backed web-based Wayside Server system for installation at an Amtrak datacenter.

n). The CDU shall interface with the wayside and shall be capable of communication to the server enroute.

o). This system shall enable Amtrak personnel to download faults remotely and view live status information on the cars remotely through an online portal.

p). The system shall allow automatic, scheduled, and manual requests for transfer of status, fault, software configuration and real-time data recorder information.

i). It shall be capable of configuring condition-based alerts and alarms of differing severities to various distribution lists, subject to design review.

q). Cars shall be capable of automatically reporting car number and faults at set locations for car tracking and repair.

i). This system shall also allow uploading and updating OTIS content.

ii). The system shall be utilized through an approved multi-carrier cellular and WiFi communication device which shall be configured and integrated in the vehicle which shall be as transparent to connected systems as practical to allow future technology upgrades or changes with minimal impact to ancillary systems.

iii). Wireless data communications shall be encrypted and protected against intrusion.

iv). The design and capabilities of the wayside server system and design of train to wayside interface shall be submitted to Amtrak for review and approval. **[CDRL 24-04]**

r). The Contractor shall provide an analysis of the potential effects of various possible security attacks on network transmissions and the operation and effectiveness of the measures taken to ensure the security and safety of the networks and equipment.

i). The security analysis shall be guided by IEC/ISO 27000 series standards. This document shall be submitted for Amtrak review and approval. **[CDRL 24-05]**

s). Information on the Amtrak server, communication protocols, and cyber security shall be provided.

t). For enroute communication in areas with limited communication capability, faults and diagnostic information shall be stored for transmission when communication capability returns.

24.4 Car Temperature Monitoring

a). Each food service car shall be outfitted with a remote temperature monitoring system.

i). This system shall operate as a semi-independent portion of the CDU or shall be a separate system.

ii). The temperature monitoring system shall have power provided to it by the car when Head End Power (HEP) is present and have an internal rechargeable and replaceable battery back-up power supply capable of powering the unit and transmitter for at least 12 hours without power from the HEP or car batteries.

iii). The design of the Car Temperature Monitoring system shall be submitted to Amtrak for review and approval. **[CDRL 24-06]**

b). The temperature monitoring system shall include global positioning information, a sensor to monitor whether HEP is being provided to the car, a sensor to detect whether the main water supply tank is empty, two temperature inputs, and a carbody based accelerometer.

i). One temperature input shall measure water temperature in a relatively cold location characteristic of where water would be most likely to freeze on the car.

(1) This may be on the outside of a water pipe as long as the area is well insulated outside the sensor and it is measuring the pipe temperature.

ii). The other temperature input shall be the ambient air temperature inside the car.

c). The power sensor shall include a delay feature that only signals that the HEP power is off when longer than three (3) minutes.

d). An exterior temperature sensor or Global Positioning Information shall be used to determine local ambient air temperatures.

e). The temperature monitoring system shall have a communication system to transmit data from the car via cellular and WiFi communication links.

i). It shall send the car number, location, speed, direction, temperatures, HEP on/off status, and water tank status every thirty (30) minutes.

ii). When the outside temperature is below 32 F, it will transmit every fifteen (15) minutes.

f). While a proprietary database and tracking system may be provided by the Contractor for installation on Amtrak infrastructure, the database and tracking system shall be capable of communicating all information over to the same server utilized by the CDU.

g). The interface control document and a means to adjust the destination for the temperature monitoring system messages shall be provided for Amtrak review and approval.

h). The tracking system shall allow alerts to be sent to different distribution lists of personnel developed by Amtrak, such that when a trainset is at a facility and in danger of freezing, an urgent alert may be sent by text and/or email to the relevant Mechanical personnel at just that location.

i). It shall be possible to trigger the alert based on the status of any variable sent, or by how long any of the variables has been in a certain state or below a set threshold.

ii). Amtrak shall have the ability to change the criteria and thresholds for alerts, trainset makeup, and the lists they are sent to, without requiring Contractor or sub-contractor assistance.

24.5 Portable Test Equipment

a). The Contractor shall furnish eight complete sets (including cables, connectors, associated equipment required to interface with the car, instructions, software, chargers, etc.) of all portable test equipment required to perform in-service testing necessary to verify proper operation of all car subsystems prior to the delivery of the first trainset. **[CDRL 24-07]**

i). Eight additional sets of all portable test equipment shall be delivered during production delivery. **[CDRL 24-08]**

b). All parts used in the construction of diagnostic test equipment shall be sufficiently rugged for a railroad shop environment and approved by Amtrak during design reviews.

i). Where necessary, it shall include cases and water-resistant seals and switches.

ii). It shall have prior successful experience in similar railroad or transit car workshops and shall use the latest version of Microsoft Windows operating system at time of delivery or approved equal.

c). Each PTU shall be supplied with a carrying case which includes a communications cable and two extra sets of extended-life rechargeable batteries.

d). The PTUs generally shall be of the highest performance level systems available in the commercial marketplace at the time of the first trainset delivery and shall be approved by Amtrak.

i). All equipment shall be registered by the Purchaser in Amtrak's name, as directed by Amtrak.

e). The Contractor shall provide drawings of the test equipment.

i). Each piece of test equipment, excluding the PTU itself, shall be accompanied with the complete diagrams, schematics and maintenance, parts information and calibration instructions for the device and its intended use and repair.

ii). These shall be supplied as part of the maintenance manuals.

f). All portable testers shall be rugged and suitable for the shop environment.

i). Weight shall not exceed 20 pounds.

ii). There shall be no high voltage connections (greater than 150 volts) required between the car and any portable test device.

iii). It shall not be necessary to remove, dislodge, dismount or disconnect any component in order to use or connect the portable test devices.

g). The function of the portable test devices shall be to produce all of the operating commands and other input signals necessary to fully exercise all functions and components of the particular system under test, and to measure or indicate all of the signals, responses and outputs produced by a system by means of indicators such as lamps, meters, oscilloscopes, gauges, etc.

i). It will be acceptable to require a visual check for system response such as closure of a contactor or a relay, or lighting an indicator, provided that the responding item of equipment does not require the test device engineer to move more than 15 feet to make the required observation.

h). The portable testers will supplement the built-in diagnostic features specified herein for particular subsystems and in those cases shall not duplicate the specified features but shall complement them by providing deeper and more comprehensive diagnostic capability.

i). The portable test device shall not be used to calibrate high-current and high-voltage devices.

i). It shall not be permissible to require connection of external apparatus to the portable test devices without the prior written approval of Amtrak.

i). In such cases, terminals shall be provided to allow connection of the required apparatus to the portable test device.

ii). However, such apparatus shall be considered part of the portable test device and shall be supplied with it on a one-to-one basis.

iii). Portable test equipment shall be supplied for, but not limited to, the following:

(1) Air Brake/Wheelslide

(2) Truck/Ride Quality

(3) Powered Doors

(4) HVAC

(5) Lighting Controllers

(6) OTIS/PA/Train Information

(7) Battery/Chargers/Power Systems

(8) Food Service Equipment (appliances, cart lifts, dumb waiters)

(9) Water and Waste (Tankless water heaters, gray water recycling, tank levels, etc.)

(10) Automatic Vehicle Location System/GPS

(11) Car Temperature Monitoring

(12) Elevators and onboard mobility lifts

(13) Room entry door lock and key system

(14) Smoke Detectors and Fire Suppression

(15) Powered Rotating Seats (option)

(16) Powered Adjustable Queen Bed (option)

24.6 Bench Test Equipment

a). To allow the proper testing, troubleshooting and calibration of car components on a test bench in a specialized workshop environment, the Contractor shall supply six complete sets of each type of bench type shop test equipment, to be delivered by the fifth trainset. **[CDRL 24-09]**

i). Each tester shall be delivered as a completely wired and assembled unit and use shop electrical power and/or compressed air.

ii). Each tester shall have a receptacle for connecting to the device under test.

iii). The connections to the device under test, if not contained in the receptacle, shall be from the front of the tester and shall have provisions to neatly store out of the way when not needed.

iv). The Contractor shall coordinate to ensure compatibility with maintenance facilities.

b). Testers shall be used for the purposes of testing, troubleshooting, and calibrating electric, electronic, mechanical, pneumatic and electro-mechanical components of each car subsystem.

i). They shall contain provisions for the rapid testing, troubleshooting and calibration of each system LRU.

ii). Design of the testers shall be such that all inputs can be varied over the full working range of the device.

c). The bench test equipment shall be automated to the extent possible.

i). If the unit under test is defective, the bench test unit shall allow the technician to troubleshoot the unit to determine which component is defective.

ii). It shall also include a manual mode to allow application of inputs to the unit under test as selected by the technician for troubleshooting.

d). Shop test equipment shall be provided for, but not limited to, the following:

i). Wheelslide control unit

ii). Low voltage power supplies

iii). Brake units and controls

iv). All printed circuit boards

v). Plug-in relays

vi). Lighting Controllers

vii). OTIS/PA

viii). Battery/Chargers/Power Systems

ix). Elevators and onboard mobility lifts

x). Food Service Equipment including dumbwaiters and cart lifts

xi). Water and Waste

xii). Automatic Vehicle Location System/GPS

xiii). HVAC units

xiv). Car wiring

xv). Microprocessor, EPROM, EEPROM's and other electronic device reprogramming for all car systems, except as approved by Amtrak

xvi). All electronic units not identified above

24.7 Air Brake Test Rack Adapters

a). The Contractor shall supply by delivery of the fifth trainset of two sets of brake rack adapters to allow the mounting of each car's friction brake and pneumatic system valve or control device (and coupler pneumatic control devices, if necessary) to the existing Amtrak brake test racks.

i). Each adapter shall be a complete, unitized assembly for each valve, without the need to assemble loose hoses, fittings, etc. for use.

b). The Contractor shall inspect the Amtrak current air brake test racks and inventory all current brake rack adapters.

c). Complete parts lists, drawings and tabulations giving the proper adapter for each device shall be provided.

d). The air brake system test rack adapters and its details shall be approved by Amtrak. **[CDRL 24-10]**

24.8 CDRLs

CDRL	Description	Due
CDRL 24-01	Central Diagnostics System detailed Functional Description	30 days prior to Diagnostics System PDR meeting
CDRL 24-02	Subsystem Integration Details	30 days prior to Diagnostics System PDR meeting
CDRL 24-03	Fault Management Plan	30 days prior to Diagnostics System IDR meeting.
CDRL 24-04	Wayside Server and Train to Wayside Details	30 days prior to Diagnostics System IDR meeting
CDRL 24-05	Security and Safety Analysis of the Network	30 days prior to Diagnostics System IDR meeting
CDRL 24-06	Car Temperature Monitoring system	30 days prior to Diagnostics System IDR meeting
CDRL 24-07	Eight additional sets of all portable test equipment	30 days prior to Brake System IDR meeting
CDRL 24-08	Eight additional sets of all portable test equipment	With 5th Trainset Delivery
CDRL 24-09	Six complete sets of each type of bench type shop test equipment	With 5th Trainset Delivery
CDRL 24-10	Air Brake System Test Rack Adapters	With 5th Trainset Delivery

* End of Chapter 24 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

25. Safety

Revision 1

Table of Contents

Table of Figures

25.1 Overview

a). Safety is of primary importance in the design of the Long-Distance fleet.

b). The cars shall present a safe, hazard-free environment to passengers, crew members and the public.

c). Compliance to the specification, as well as all applicable laws, regulations and standards must be achieved.

d). The Contractor shall research NTSB Amtrak passenger train accident reports and ensure the past mistakes relevant to train design are avoided. Passage from car to car shall be easy and safe.

e). No sharp edges or corners or pinch points shall occur where passengers, crew, or maintenance personnel may come into contact with them.

f). Adequate handholds shall be provided throughout the trainset. Handhold placement shall consider the needs of semi-ambulatory individuals and the risks associated with walking in a moving train.

g). Passengers and crew shall not be exposed to tripping hazards, exposed electrical voltage, toxic materials or similar hazards.

h). Location, illumination levels, colors, graphics and surface finishes shall be selected to maximize visibility of door thresholds, controls and other objects with which the passengers and crew must interface.

i). 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.

j). Passenger emergency signs shall also be embossed in Braille raised typeface unless otherwise approved.

k). Power capacitors shall self-discharge.

l). Refer to signage requirements in Chapters 11 and 29.

25.2 General Safety Design Requirements

a). The general safety design requirements and the guidelines listed below shall be incorporated into the design of all car systems affecting safety.

b). Only components with high reliability and predictable failure modes, and which have been proven in conditions similar to the projected service shall be utilized.

c). Whenever possible, all systems are to be designed to prevent single point failures from negating the ability of such systems to perform safely as intended.

d). All systems that passengers or crew members interact with shall be designed with ergonomic best practices, taking into consideration human factor principles.

e). All electronic circuits shall be assumed capable of failing in permissive modes.

f). Software shall be considered capable of failing in an unsafe mode unless it is safety verified while operating in the proposed hardware.

g). All safety circuits not wholly within an enclosure shall be of a double-wire, double-break design.

h). 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.

i). 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.

j). 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.

k). 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.

l). 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.

m). Wires for safety critical trainline functions shall not be located at the bottom pins of cable connectors mounted in areas where water incursion may occur.

n). The location of pins and wires of safety critical circuits in connectors shall be designed to minimize the possibility of unsafe conditions resulting from shorts to adjacent pins or wires.

o). Circuit breakers shall be guaranteed by the manufacturer to successfully interrupt rated currents. Circuit breakers shall be applied such that the maximum circuit fault currents cannot exceed the manufacturer's guaranteed operating ranges.

p). 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.

q). 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.

r). Mechanical systems which apply force to achieve safe states shall not depend upon the application of fluid pressure or electrical energy, unless specifically approved.

s). All locks, catches, and similar devices affecting safety shall be passive with no other effort required to achieve the safe state.

t). All systems shall function safely under all combinations of supply voltages, fluid pressures, shock, vibration, dirt accumulation and the railroad environment.

u). All safety related systems, and devices within those systems, shall be clearly identified in all operation and maintenance manuals, procedures, and training materials.

v). Exposure of maintenance personnel to lethal or injurious voltages shall be minimized through compartmentalization, interlocks and similar measures.

w). Exposure of maintenance personnel to occupation injury/illness risks shall be minimized through ergonomic measures.

x). 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.

y). No sequence of operations, or the simultaneous activation of any controls, shall result in unsafe conditions.

z). All systems shall protect against unsafe conditions resulting from human error.

aa). The Amtrak maintenance facilities and storage yards only have ground-level access at track bed height. It is required that the cars have the capability for ground-level access for maintenance access, passenger emergency evacuation and fire/rescue access to the car interior.

bb). Carbuilder shall identify all safety enhancements to improve situational awareness and overall passenger and crew safety. Additional safety enhancements may be proposed based on emergent technologies (i.e.: alerts for locational awareness or fatigue/attention) or on innovative approaches in vehicle design.

25.3 Safety Certification Program

a). The contractor shall conduct a Safety Program throughout new design, manufacturing, testing, pre-revenue operations, and warranty to ensure that the vehicle achieves a level of safety consistent with the Amtrak network.

b). The Safety Program shall identify potential hazards and initiate actions to eliminate or control them to an acceptable level.

c). It is Amtrak's intention to conduct a Safety Certification Program. The Contractor and sub-suppliers shall support Amtrak in the Safety Certification process.

25.4 System Safety Program Plan

a). The Contractor shall develop, implement and maintain a comprehensive System

Safety Program Plan (SSPP) conforming to the Federal Transit Administration (FTA) Handbook for Transit Safety and Security Certification (FTA-MA-90-5006-02-01), Final Report," November 2002; the latest Amtrak System Safety Program Plan; and any other applicable Federal guidelines or requirements. **[CDRL 25-01]**

b). This SSPP shall assess, analyze and document the safety aspects of all components, systems, managements and materials used on the trainsets, and the operation, maintenance, repair and performance of those components, materials and systems, from the viewpoint of crews and passengers.

c). The SSPP shall identify all hazards related to the cars 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 Amtrak.

d). The SSPP shall be developed in the earliest phases of the Contract and shall be continuously maintained throughout, as design and construction evolve.

e). The formats for reports, listings, analyses and other required submittals shall be jointly determined between Amtrak and the Contractor.

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

g). Software safety requirements shall treat software as an integral part of a hardware/software system.

h). 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. Refer to Chapters 26, 27 and 28 for more details.

i). 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. Refer to Chapter 26, 27 and 27\8 for more details.

j). All systems affecting safety shall undergo a thorough safety review as part of the design review process, with emphasis on credible faults, results, risk, etc. Requirements of 49 CFR 238.105 and other applicable parts of 49 CFR 238 Subpart - B shall be met as part of this review. It shall include, but not be limited to:

  i). Brake control/Anti-Wheel Slide

  ii). Truck

  iii). Smoke/Fire Alarm system

  iv). Fire suppression

v). Emergency access & egress

vi). Door system

vii). Windows

viii). Communication (Radios & Public Address Systems)

k). The completed SSPP shall be submitted to Amtrak for review and approval within 60 days of NTP.

25.5 Preliminary Hazard List

a). The Contractor shall within 60 days of NTP provide an initial Hazard list.

b). This hazard list shall identify all potential hazards associated with the vehicle including those caused by, mechanical failures, electrical/electronic component failures, software errors or defects, environmental impacts, human error, maintenance, and operational conditions. **[CDRL 25-02]**

25.6 Preliminary Hazard Analysis (PHA)

a). Based on the approved Hazard list the Contractor shall provide a Preliminary Hazard Analysis which defines the potential cause of the hazards, the probability of the hazard, the severity of the hazards, potential or proposed mitigation and the residual probability and severity.

b). The PHA shall be submitted prior to any Preliminary Design Reviews. **[CDRL 25-03]**

25.7 Hazard Tracking Log (HTL)

a). Based on the approved PHA the contractor shall develop a Hazard Tracking Log.

b). This HTL shall track the status of all supporting documentation for each of the hazards.

c). All hazards in the Hazard Tracking Log must be closed for Safety Certification to be closed.

d). The HTL shall be submitted prior to any Final Design Reviews and be updated monthly until approved. **[CDRL 25-04]**

25.8 Failure Modes, Effects and Criticality Analysis (FMECA)

a). The Contractor shall provide a comprehensive FMECA(s) for all components on the vehicle.

b). For the purpose of this section, components shall be defined as hardware, electronic/electronic components and software at a minimum it shall be to the level of an assembly (i.e. relay, contactor, actuator, valve, switch etc.) but many be to sub assembly level if required by the authority in order to more clearly define the hazard.

c). The FMECA shall also identify if the failure is annunciated.

d). In the event that the failure is not announced, the analysis shall be extended to include subsequent failures until the subsequent failure is annunciated.

e). The FMECA shall be submitted as part of the IDR and FDR submittals. **[CDRL 25-05]**

f). Information provided in the FMECA shall include:

i). A system overview including schematics.

ii). A complete list of system and subsystem components that will be analyzed.

iii). Identification of the “modes” or ways the components can fail.

iv). Assessment of the effects of the failure on the system.

v). Determination of the severity and probability of failure.

vi). Determination whether the failure is a single-point failure.

vii). Determination of methods to eliminate or control the identified failure.

viii). Identification of single-point failures and hazard-level categorization, which should confirm the adequacy of fail-safe design features.

25.9 Fault Tree Analysis (FTA)

a). The Contractor shall provide a quantifiable Fault Tree Analysis for all Category/Severity one and two hazards.

b). These fault trees analyses shall be fully integrated across sub system such that if events span multiple sub systems the top event vehicle level hazard reflects all sub system events.

c). The FTA shall be submitted prior to FDR. **[CDRL 25-06]**

25.10 Subsystem Hazard Analysis (SSHA)

a). The Contractor shall submit a subsystem hazard analysis for each vehicle subsystem.

b). These subsystems safety analysis shall include subsystem Hazard Tracking log, FMECA, and FTA.

c). The documents shall be submitted as part of the IDR and FDR submittals. **[CDRL 25-07]**

25.11 Operating and Support Hazard Analysis (O&SHA)

a). The Contractor shall submit an Operating and Support Hazard Analysis (O&SHA) to identify and assess hazards introduced during system operation, maintenance, and support activities.

b). The O&SHA shall be submitted prior to FDR. **[CDRL 25-08]**

c). At a minimum, the analysis shall consider:

i). Hazards associated with personnel and procedures during operations, maintenance, and emergencies.

ii). Human interface during the on-car, off-car and facility-level support activities.

iii). Operations and maintenance tasks against human engineering factors, such as task complexity, system criticality, task frequency, new technology, known problems, etc.

iv). The context in which Operators and maintainers work.

25.12 Probability, Severity Risk

a). For the purpose of this Chapter, the Contractor shall utilize the following definition for hazard severity category, hazard frequency levels and acceptable risk.

Figure 25-1: Hazard Severity Categories

Severity	Value	Meaning
Catastrophic	1	Risk realization expected to result in one or more of the following: death, permanent total disability, loss of passenger/crew occupied volume with equipment damage causing separations in structure, infrastructure damage due to railroad operations/activities that suspends service through the affected area for greater than 24 hours.
Critical	2	Risk realization expected to result in one or more of the following: permanent partial disability, injuries/illness that results in hospitalization, loss of passenger/crew occupied volume with equipment damage that causes openings but no separations in structure, infrastructure damage due to railroad operations/activities that suspends service through the affected area for greater than 2 and up to 24 hours.
Marginal	3	Risk realization expected to result in one or more of the following: injury or illness resulting in one or more lost workday(s), loss of passenger/crew occupied volume with equipment damage that causes no separations/openings in structure, infrastructure damage due to railroad operations/activities that suspends service through the affected area for more than 30 minutes and up to 2 hours.
Negligible	4	Risk realization expected to result in one or more of the following: injury or occupational illness that does not result in a lost workday, equipment damage that does not result in

Severity	Value	Meaning
		neither loss of passenger/crew occupied volume nor separations/openings in structure, infrastructure damage due to railroad operations/activities that does not suspend service or cause a delay through the affected area for more than a maximum of 30 minutes.

Figure 25-2: Hazard Frequency Levels

Likelihood	Value	Qualitative Meaning	Quantitative Meaning
Frequent	A	Opportunity for risk to be realized expected to occur often MTBHE is less than 1E103	Probability of occurrence greater than or equal to 10-1 (10%) Continuously experienced throughout system life.
Probable	B	Opportunity for risk to be realized expected on a recurring basis MTBHE is less than 1E105 but greater than 1E103	Probability of occurrence less than 10-1 (10%) but greater than or equal to 10-2 (1%) Will occur frequently throughout the life of the system.
Occasional	C	Opportunity for risk to be realized expected to occur MTBHE is less than 1E107 but greater than 1E105	Probability of occurrence less than 10-2 (1%) but greater than or equal to 10-3 (0.1%) Will occur several times throughout life of the system.
Remote	D	Opportunity for risk to be realized not expected to occur but possible MTBHE is less than 1E109 but greater than 1E107	Probability of occurrence less than 10-3 (0.1%) but greater than or equal to 10-6 (0.0001%) Unlikely but can be reasonably expected to occur.
Improbable	E	Opportunity for risk to be realized not expected and almost inconceivable.	Probability of occurrence less than 10-6 (0.0001%)

Likelihood	Value	Qualitative Meaning	Quantitative Meaning
		MTBHE is greater than 1E109	Unlikely to occur in the system life, but possible.

Figure 25-3: Risk Matrix

Risk Likelihood	Risk Severity			
	Catastrophic 1	Critical 2	Marginal 3	Negligible 4
Frequent – A	**1A** (Red)	**2A** (Red)	**3A** (Orange)	**4A** (Yellow)
Probable – B	**1B** (Red)	**2B** (Red)	**3B** (Orange)	**4B** (Yellow)
Occasional – C	**1C** (Red)	**2C** (Orange)	**3C** (Yellow)	**4C** (Green)
Remote – D	**1D** (Orange)	**2D** (Yellow)	**3D** (Yellow)	**4D** (Green)
Improbable – E	**1E** (Yellow)	**2E** (Yellow)	**3E** (Yellow)	**4E** (Green)

Hazard Risk Index (HRI)		
Red	1A, 2A, 1B, 2B, 1C	CEO/President approval required.
Orange	3A, 3B, 2C, 1D	CSO and Dept E3-Level approval required.
Yellow	4A, 4B, 3C, 2D, 3D, 1E, 2E, 3E	Dept E2-Level and VP Operations Safety approval required.
Green	4C, 4D, 4E	Dept E1-Level approval required

b). For software failure probability rates used in the safety analysis, it shall be assumed that all software has a Safety Integrity Level (SIL) of zero as defined by EN-50128. For common mode failure of comingled or redundant software a BETA or common mode failure rate of one shall be assigned. Alternatively, if the Contractor can provide independent certification (i.e. TÜV certification) for a higher SIL level this may be used if approved by Amtrak. Refer to Chapters 26 and 27 for additional details.

c). Unless it is shown otherwise through daily test or preventative maintenance inspection the “Time at Risk” for all failures probabilities shall be design life of the vehicle. All time at risks shall be approved by Amtrak.

d). At a minimum, emergency brake application, emergency power removal, door opening, door/propulsion interlock and no motion detection shall be required to meet requirements for of Category I or II hazards for elimination of hazard or reduction of risk to an acceptable level.

e). Emergency brake control shall be fail-safe. No detectable single point failure in the friction brake system, or series of common-mode or common-cause failures added to any combination of undetected failures, can result in the availability of less than 75 percent of emergency braking effort in a train.

25.13 Hazard Resolution Process

a). The overall goal of a system safety program is to design systems that do not contain hazards. However, the nature of most complex systems makes it impossible or impractical to design them completely hazard-free. As hazard analyses are performed, hazards will be identified that will require resolution. Risk management is a decision-making process consisting of evaluation and control of the severity and probability of a potentially hazardous event.

i). By assigning a Hazard Risk Index (HRI), a determination can be made as to whether hazards should be eliminated, controlled, or accepted. System safety precedence is a methodology that can be used by the Program Manager to define the order to be followed for satisfying system safety requirements and reducing risks. Alternatives for eliminating the specific hazard, or for controlling its associated risk, will have to be evaluated so that an acceptable method for risk reduction can be pursued.

b). It is not possible to remove all potential hazards from the railroad, and therefore a means for determining which hazards are acceptable is required. In general, the more severe the hazard, the more unlikely it should be.

c). For the long-distance trainsets, the following requirements have been established:

i). Hazards with an initial Hazard Risk Index of red or orange should be mitigated such that the Hazard Risk Index is reduced to HRI of yellow or green.

ii). Where it is not possible to reduce the risk to Level yellow or green, specific detailed analysis shall be provided by the Contractor to obtain approval of Amtrak. It should be noted that Amtrak would normally expect the Contractor to introduce design changes to reduce the risk to an acceptable level.

iii). Items with an HRI of red shall not be accepted.

iv). Items with an HRI of orange will only be accepted when it is proven to the satisfaction of Amtrak that the Contractor has exhausted all reasonable alternative approaches.

25.14 Fire Safety

a). Fire safety shall be achieved through adherence to the following requirements:

i). Those materials and products generally recognized to have highly toxic products of combustion shall not be used.

ii). All non-metallic components used on the vehicle shall be smoke, flame, and toxicity tested to NFPA 130, 49 CFR part 238, and BSS 7239.

(1) Maximum smoke developed, maximum flame spread indices, and toxicity emission limits shall be detailed in the specification.

iii). Materials used to fabricate miscellaneous, discontinuous small parts that will not contribute materially to fire growth in end-use configuration may be exempt from smoke, flame, and toxicity testing requirements with waivers approved by Amtrak.

iv). Exempt parts shall be less than 16 in^2 (100 cm^2) in surface area in end-use configuration and may include, but are not limited to, the following:

(1) Knobs

(2) Rollers

(3) Fasteners

(4) Clips

(5) Grommets

(6) Small electrical parts

v). The Contractor shall submit for approval a list of all adhesives to be used on the vehicle, with a description of the physical, chemical, and fire safety properties of each. **[CDRL 25-09]**

(1) This requirement does not apply to adhesives used in extremely small quantities.

vi). The Contractor shall furnish a combustible material matrix including all combustible materials used in the vehicles showing all combustible properties, weight (density), total surface area, total weight per vehicle, heat value per pound and per vehicle, flame spread, and flashpoint, and documentation references **[CDRL 25-10].**

vii). All FST Test reports shall be within five years of Notice to Proceed (NTP). Any test reports that are older than five years, the contractor shall submit a letter from the material manufacturer stating the composition of the material has not changed. The material must be approved by Amtrak before use.

viii). All heat sources on the vehicle shall be protected with redundant levels of protection so that circuits are open before unsafe temperatures exist.

ix). Battery boxes, electrical cabinets, and the machine rooms shall be equipped with melting thermowire or thermocable to initiate a fire suppression via aerosol system when a fire or high temperature is detected.

x). Smoke Detectors shall be located in each fresh/return air mixing plenum and supply duct. Automatic dampers shall prevent external smoke from entering the vehicle.

xi). Smoke Detectors shall be mounted on the central ceiling panel. The smoke detector used in this location shall be identical to the smoke detectors used in other locations in the trainset for ease of maintenance and replacement.

xii). Fire Suppression and Smoke Detection systems shall report alerts and failures to the diagnostic system.

xiii). Protection from smoke and fire originating under the vehicle floor shall be proven through successful completion of a 30-minute floor fire test in accordance with ASTM E-119, NFPA 130, and 49 CFR, part 238.

xiv). Emergency egress shall be provided through vehicle end doors to adjacent cars.

xv). Two fire extinguishers shall be located in each level of a car.

xvi). The option of compartmentalized fire extinguishing, i.e., fire suppression in individual rooms instead of car wide, with water vaporization shall be considered and evaluated.

(1) For this option, the Fire Equipment Services (FES) shall have manual activation, e.g., at crew rest area, in addition to automatic activation.

xvii). Windows intended for emergency escape or emergency access shall be designed for easily removable by a passenger, employee or rescuer and shattering of the glazing must not be required to remove the window.

xviii). Trash containers shall be fire containing and prevent the propagation of fire outside of the enclosure.

b). The Contractor shall develop a Fire Safety Analysis complaint with 49CFR238.103(c) for the new equipment. The Analysis shall be submitted to Amtrak for Review and approval as part of FDR.

25.15 CDRLs

CDRL	Description	Due
CDRL 25-01	System Safety Program Plan (SSPP)	NTP + 60 days
CDRL 25-02	Preliminary Hazard List (PHL)	NTP + 60 days
CDRL 25-03	Preliminary Hazard Analysis (PHA)	30 days prior to PDR
CDRL 25-04	Hazard Tracking Log (HTL)	30 days prior to FDR
CDRL 25-05	Failure Modes, Effects and Criticality Analysis (FMECA)	30 days prior to IDR
CDRL 25-06	Fault Tree Analysis (FTA)	30 days prior to FDR
CDRL 25-07	Subsystem Hazard Analysis (SSHA)	30 days prior to IDR

CDRL 25-08	Operating and Support Hazard Analysis (O&SHA)	30 days prior to FDR
CDRL 25-09	List of all adhesives	30 days prior to IDR
CDRL 25-10	Combustible material matrix	30 days prior to IDR

* End of Chapter 25 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

26. Digital Technology

Revision 1

Table of Contents

Table of Figures

26.1 Overview

a). Background

i). Amtrak shall be provided with direct access to onboard, and offboard information in near-real-time via machine-to-machine communications with as little human involvement as possible.

ii). In the rare circumstance of a railway incident, Amtrak has a statutory obligation to provide information to regulatory authorities in support of their post-incident investigative activities.

iii). Contractor shall provide a secure, robust, railway rated, and standardized API-based Information Technology platforms to facilitate Amtrak access to all data generated by and for the rolling stock, its onboard systems, as well as any and all wayside components of this contract.

iv). These APIs shall provide standardized integration points between any car and Amtrak's systems for the purpose of onboarding and offboarding information.

v). These APIs shall facilitate Amtrak design and development of all aspects of the customer experience solutions within its own content management and other programming facilities.

vi). The rolling stock and its systems shall support receiving content updates via these Amtrak systems or intermediary vendor services via APIs.

vii). The Amtrak system shall be capable of retrieving telemetry, performance, events and other data from the trains or intermediary vendor services via APIs on a push, request, and near real-time basis.

b). Required APIs

i). At a minimum, the following data integrations shall be provided in these APIs:

(1) Journey programming for the On-Train Information System (OTIS) and any outputs from that system.

(2) Journey performance, including GPS track, announcements made, performance of on-board display screens, and errors identified after a completed journey is detected by the OTIS.

(3) Train handling including all events in the cab, by conductor staff, and by passengers.

(4) Train telemetry and events, including access to one-time and streamed process data from all onboard networks both in response to on-demand requests, configurable periodic transmissions from the train, and configurable event-based transmissions.

(5) Video surveillance system real-time and recorded video

(6) Event Recorder and Positive Train Control (PTC) data

(7) All other safety-related information

(8) Equipment faults, events and occurrences

(9) Train performance

(10) Automated measurements and readings

(11) Passenger Emergency Intercom requests and calls

(12) Attendant call requests and responses

(13) Reservation Display System

(14) Electronic Room Accommodation Door Lock System

(15) Data Communication System

(16) Network Intrusion Detection System

c). Data & Information Ownership

i). All Information Technology components including applications, integrations, data and the corresponding infrastructure shall be delivered according to Amtrak Standards.

ii). The Solution Architecture, Designs, and Specifications shall be submitted for review and approval by Amtrak throughout the design reviews, with approval a condition of an acceptable Final Design Review (FDR).

iii). All data collected or generated by the system is the property of Amtrak and can be reused at Amtrak's discretion.

iv). All Information Technology components shall support both Operational and Security monitoring in alignment with Amtrak Standards.

26.2 System Continuity, Criticality and Disaster Recovery

a). Amtrak System Assessment Methodology

i). Amtrak assesses and categorizes all systems according to impact on safety and business operations based on the matrix in Figure 26-1.

(1) Contractor shall indicate which *operational continuity* tier they support, as well as any *disaster recovery* (if applicable) and the overall *criticality level* of provided on-board and wayside systems

(2) Systems that require real-time train movement or passenger safety shall conform to C1 criticality, and systems that support customer experience shall be at a C2 criticality level

Operational Continuity (Planned & Unplanned Downtime)					Disaster Recovery			
Adjusted Availability Ceiling*	Planned Downtime Acceptable	Acceptable Recovery Time (Hours)	Acceptable Data Loss (Hours)	Reduced Performance Acceptable (AZ Loss)	Recovery Time Objective (Hours)	Recovery Point Objective (Hours)	Reduced Performance Acceptable (Large Scale)	Criticality Level
Up to 99.999%	N	0	0	N	n/a	n/a	n/a	C1
Up to 99.99%	N	1	0	N	4	1	N	C2
Up to 99.9%	Y	4	0	N	24	1	Y	C3
Up to 99.8%	Y	24	1	Y	48	24	Y	C4
Up to 99.7%	Y	Best Effort	24	Y	Best Effort	24	Y	C5

Figure 26-1 System Assessment Categorization

26.3 Engagement

a). Program/Project Management

i). Contractor shall work with Amtrak IT to establish appropriate elements to properly manage effort including:

(1) Schedule and Key Milestones

(2) Primary Deliverables Definition and Success Criteria

(3) Resource Plan with:

(a) Contact List

(b) Working Groups Definition

(c) Roles & Responsibilities

(4) Scope Definition with Backlog/Requirements

(5) Status Reporting Mechanisms including

(a) Status Reporting Definitions

(b) Artifacts

(c) Status Meeting Cadence

(6) Meeting/Workshop Plans for Information Sharing/Discovery

b). Working Team

i). Contractor shall work with Amtrak IT to ensure Resource Plan is comprehensive including representatives from third parties providing Software or Services to the solution.

ii). Third party providers shall be required to participate in working groups unless Contractor can provide expertise, information, and documentation for the solution.

iii). Amtrak reserves the right to request direct access to third parties if deficiencies are identified in the delivery of the solutions.

c). Hosting & Environment Support

i). Amtrak recognizes four primary approaches for the operation of systems or solution:

(1) Installed and Operated in Amtrak environments

(2) Installed and Operated by the Contractor directly within Contractor's environment

(3) Installed in Third Party environments and Operated by Contractor

(4) Installed and Operated in Third Party environments on behalf of Contractor

ii). Each approach has specific requirements for utilization at Amtrak for Delivery and Operations.

iii). Contractor shall be expected to work with Amtrak to understand and align with these requirements where appropriate as agreed upon between parties.

iv). Non-Production Systems

(1) Along with a Production environment aligned to System Criticality as defined in Section 26.2, the Contractor shall support the delivery of appropriate Non-Production environments sufficient to support Delivery and ongoing Operations.

(2) This includes the establishment of Test Labs for testing onboard systems without the need to disrupt train operations.

(3) Non-Production systems shall replicate relevant Production Capabilities and Functions.

(4) Contractor and Amtrak will mutually agree to the level of support and additional compensation related to the delivery of appropriate Non-Production environments sufficient to support Delivery and ongoing Operations.

d). Testing Support

i). Contractor shall support relevant aspects of testing, as agreed upon by all parties, including:

(1) Unit Testing

(2) Integration Testing

(3) End to End (E2E) Testing

(4) Smoke/Business Acceptance Testing

(5) Performance Testing

(6) Security/Vulnerability Testing (A Full Test will be completed to Qualify Design and subsequent testing will be based on new releases and the systems impacted by the change)

(7) Regression Testing

(8) Continuity Testing (A full test will be completed as part of Factory Testing, and subsequent testing will be defined as part of the Design effort as agreed upon by all parties.)

(9) Continuous uptime testing for electronic equipment, demonstrating the equipment remains functional without user action in the context of Amtrak long distance operations

ii). For systems utilizing third party software or services, Grey Box testing may be required to validate underlying components operate to specification.

iii). Testing shall be aligned to best practices for execution and documentation of results, where appropriate.

e). Delivery Training & Change Management

i). Contractor shall work with Amtrak IT to establish a comprehensive training and change management plan aligned to systems and/or working groups as well as business users impacted by the program.

ii). Contractor shall utilize Train-the-Trainer approach and the training will be part of the initial training scope with the delivery of the railcars (as per Chapter 23).

iii). Any further training will have to be priced and compensated separately. This plan shall include, but not be limited to:

(1) Communications Structure & Plan

(2) Comprehensive Documentation for relevant Systems for Utilization and Administration

(3) Training Plans & Materials, as agreed upon by all parties.

(4) Additional collateral, such as graphics, images, videos to support Change Management & Training work throughout the program.

26.4 Operational Support

a). Operational Support Shared Responsibilities

i). Per Section 26.3.c, the way that the platform is delivered and operated can vary by hosting method.

ii). Contractor shall work with Amtrak IT to define a clear Operating Model for the solutions that:

(1) Work with Amtrak IT to establish Service Level and Operating Level Agreements for systems aligned to best practices, as agreed upon by all parties.

(2) Define clear roles & responsibilities for all aspects of the solution aligned with Section 26.3.a.

(3) Establish mutually agreed upon Operational and Support processes that include:

(a) Incident, Problem, and Change Management aligned to best practices

(b) Notification criteria and methods of escalation

(c) Reporting necessary to support SLA and OLA compliance, as well as failure analysis

(d) Services provided as software as a service (SAAS) remain within Contractor's responsibility

iii). The Contractor shall identify all Contractor or Contractor sub-supplier maintenance or operation support agreements available related to the on-going support of equipment, services, or licenses of on-board and wayside software. **[CDRL 26-01]**

iv). The Contractor shall prepare and submit for Amtrak review and approval a transition to operations plan and schedule that provides a clear path for transitioning support throughout all phases of the procurement, including pre-revenue service, revenue-service, and from Contractor-maintained maintenance and licensing included as a part of the base procurement, to on-going maintenance, support, and software licensing at the conclusion of any such periods. The plan shall provide any expectations required for Amtrak support of the transition. **[CDRL 26-02]** b). Operations & Security Monitoring

i). For services offered as SAAS with the focus to ensure continuity and performance of solutions, the contractor shall implement monitoring and logging based on the recommendations in ISO/IEC 27017 and NIST 800-53 and as required in Chapter 28 of this specification.

(1) Based on the tenancy configuration and capabilities of the Contractor's SASS solutions, security alerts shall be forwarded to Amtrak's Cyber Fusion Center.

ii). Contractor will work with Amtrak and report any vulnerabilities as they are related to Amtrak data.

iii). Contractor shall work with Amtrak IT to define data lifecycles and classifications for relevant logged information and establish testing that validates compliance to these best practices where appropriate.

c). Third Party Software & Services

i). Contractor shall disclose relevant use of third-party software and services.

ii). If Contractor identifies issues with third party software or services, Amtrak IT must be notified per the defined notification process in Section 26.4.a.

d). Defect & Vulnerability Management

i). Relevant defects and vulnerabilities must be disclosed, logged, and remediated per the defined Incident and Problem management processes in Section 26.4.a.

ii). Relevant modifications to delivered products must tested to the same test cases as defined in Section 26.4.d. with identified defects and vulnerabilities remediated or provided an exception before release.

e). Software Management

i). Contractor shall provide sufficient methods and/or tools for the troubleshooting and administration of relevant software provided. These capabilities should be aligned to best practices and Amtrak tools as mutually agreed upon in Section 26.4.a.

ii). Contractor shall work with Amtrak DT to ensure relevant software is maintained to the latest version as mutually agreed upon in Section 26.4.a.

f). Ongoing Training & Change Management

i). For relevant updates to delivered products, Contractor shall work with Amtrak DT to support required training and change management related to the update aligned to methods and deliverables as defined in Section 26.4.e.

ii). Additional training required from software/feature updates will be jointly assessed and priced separately.

g). Technology & Performance Audits/Reviews

i). Contractor shall work with Amtrak to complete regulatory audits and reviews as required by Amtrak or applicable Regulatory bodies and assist in the remediation and response of these audits and review.

26.5 Onboard System Requirements

a). Onboard Train Information System (OTIS)

i). Amtrak's goal is to provide customers with a holistic experience including near-real-time travel information about their journey from Amtrak's operational and onboard train systems. To the greatest extent possible, Amtrak prefers that all new railcars should deliver these capabilities via commercial, off-the-shelf systems rather than customized solutions.

(1) Contractor shall deliver a solution that:

(a) Provides critical train and journey information to customers in an ADA-compliant manner and that conform to the ADAAG standards for Transportation Vehicles.

(b) Show seat assignments dynamically based on reservation city pair, including individual updates per seat

(c) Reduces conductor workload by automating the delivery of routine passenger messages

(d) Utilizes on-board cellular capabilities and the Ethernet Train Backbone (ETB) for onboard communications, and that provides provisions for utilizing the latest available cellular technology throughout the life of the vehicle. The selection of the cellular technology (e.g., 5G, 6G) shall be based on the latest available commercial networks at the time of design review.

(e) Provides two-way connection to/from back-office systems to exchange data between train and ground

b). General Capabilities

i). OTIS shall be an out-of-box COTS package with an established track record in revenue service trains

ii). Open Standards shall be used (HTML5, JavaScript, etc.)

iii). Programming in OTIS shall have access to all displays, independently addressable and by Amtrak-defined groups.

iv). Access to all Contractor APIs shall be provided to facilitate programmatic access in addition to the use of Contractor supplied user interfaces v). All OTIS components shall be capable of being monitored remotely, and problems should be capable of being validated locally as well as alerts and detailed errors send to remote monitoring systems

vi). OTIS shall be able to log and store events with enough detail to analyze and diagnose root cause of faults

vii). In the event of loss of the train to ground interface, the OTIS shall be able to continue operation with the pre-load mission data. Dynamic updates such as seat assignments and train statuses should automatically re-commence when T2G communication is restored.

viii). Access to On-Board Variables

(1) Amtrak experienced programmers should be able to reference and display train mission variables based on a variety of contexts (for example, in-service at origin station, in-service at a station, in-service between stations, in-service at a terminal station, under daily test, under maintenance).

(2) Through a template system, to be approved by Amtrak, displays shall be capable of being programmed to accept and display on-board variables. The list of on-board variables shall be submitted for approval by Amtrak **[CDRL 26-03]**. The variables shall include at a minimum:

(a) Velocity

(b) GPS Location

(c) Line Map with Current Location, direction of travel, intermediate stops, and destination in a variety of scales

(d) Origin, Current, Next (including full sequence) and Final stops

(e) Date & Time

(f) Restroom status, to facilitate identification of nearest working and unoccupied restroom to that particular sign

(g) Status of PA/IC system, including status of audio broadcast, functioning of hearing loop, PEI call information, and intercom status

(h) Smoke detector status

(i) Seat reservation system variables

(j) Relevant maintenance information – including onboard system status - which could be incorporated into a special workshop display templates to facilitate maintenance and operations staff in daily, scheduled, and unscheduled maintenance.

(3) In addition, the OTIS system shall support data pushes from the ground-based systems in near-real-time to facilitate weather updates, news, and service updates.

(4) To accommodate a long-distance network that has periods of cellular carrier outages, the onboard systems shall be capable of storing data pushes for replay, contingent upon a configured data validity and expiration.

ix). Triggers

(1) Amtrak expects to be able to program the on-board experience in an event-driven fashion. Events shall include at minimum:

(a) Mission start and end

(b) Geolocation with geofences to trigger events

(c) Time since or time-projected-before a geofence

(d) State of operations (start of movement, cruise, emergency stop, etc.)

(e) Manual operation

x). Off-Board Customer Experience Simulation

(1) Amtrak must be able to simulate and validate the complete customer experience prior to loading the programming to railcars, and to diagnose issues identified in the field with communication system operation, including content.

(2) The Contractor shall deliver a turn-key content management lab which shall include the full complement of onboard equipment necessary to fully simulate the on-board communication system operation.

(3) All OTIS equipment necessary to simulate all car types shall be supplied as a part of the off-board customer experience simulation lab.

(4) For clarity, this includes minimally the following equipment:

(a) All types of displays, of type and quantity necessary to simulate all car types

(b) PA/IC controllers

(c) PEI units

(d) amplifiers

(e) speakers

(f) cameras

(g) HMI displays, including Control Terminals and Passenger Compartment Control Units

(h) reservation display system components

(i) attendant call system components

(j) data communication system

(k) electronic room accommodation and door lock system components

(l) control units which make up the OTIS system

(m) Video Surveillance System / Network Video Recorders

(5) The Contract shall also deliver ancillary hardware which provides the capability to perform automated, semi-automated, and manual route simulations.

(6) The system shall support mission simulation with playback of telemetry and events from a recorded from actual on-board journeys, and through manually prepared journeys.

(7) The system shall support:

(a) Interfacing with the same production systems used for the revenue fleet that facilitate the upload of programming and content, such that the same APIs as production are used

(b) Playback of telemetry and event logs to animate the simulation in real-time, accelerated, and slow modes

(c) Simulation of customer experience for samples of all interaction types (all display types, audio)

(8) The simulation shall incorporate the capability to simulate end users interaction with the on- and off-board system during all stages of the train’s operation, including:

(a) Train staff operation of the Control Terminal and on-board HMIs, including authentication, and operation of system integrations with the Video Surveillance System, Public Address System, Intercom System, Attendant Call, and PEI

(b) Train staff operation of Amtrak electronic devices, and their interaction with the OTIS equipment

(9) The Off-Board Customer Experience simulation lab shall be implemented in a modular and extensible fashion, allowing future modifications and upgrades which will occur on the vehicles to be implemented in the lab.

(10) The Contractor shall be responsible for delivery and setup support to a location specified by Amtrak.

(11) It is Amtrak's expectation that the Contractor and Amtrak will negotiate a mutually acceptable on-going maintenance and support agreement with Amtrak for the lab proximate to the delivery and setup of the lab.

(12) The detailed system description, functionality, and infrastructure requirements shall be submitted to Amtrak for review and approval. **[CDRL 26-04]**

c). Train Telemetry

i). Data telemetry includes data generated by operator inputs, onboard sensor data, event recorder data and other diagnostic and status information.

ii). Train Control and Monitoring

(1) Amtrak's assumption is that train data will first flow to Contractor's back office systems that analyzes the data and shall trigger maintenance and other actions based on analysis.

(2) In addition, Contractor shall provide a set of services that allow Amtrak to retrieve all data generated by the train using a set of API's/Services that allow Amtrak to pull data in near real-time or to push the data in near-real time to Amtrak.

(3) This does not preclude Contractor from providing a portal for Amtrak personnel to review any data analysis or data visualizations provided to enhance operational awareness of a train's condition.

(4) A data dictionary of the data feed is required. This shall include definition of all data fields, all possible data values, conditions that generate each value and/or the trigger for each field and data value.

iii). Safety/Event Related Information and Video

(1) Today Amtrak collects data in real-time during extraordinary events to understand and assess the impact of those events.

(2) Specifically, Amtrak sets trigger types based on specific input from the operator or sensors to trigger an event. When an event is triggered, the event record data and user defined segment of video data is immediately relayed to Train Operations to provide situational awareness.

(3) A typical example is when emergency braking is activated, the event recorder and video for a limited time before and after the incident are sent via the cellular network to Amtrak's network operations center for immediate review.

(4) The triggers and video lengths should be configurable as well as the type of information needed. A data dictionary of the data feed is

required. This should include definition of all data fields, all possible data values, conditions that generate each value and/or the trigger for each field and data value.

(5) Refer to Chapter 14 for additional specific requirements.

iv). Data Definition

(1) Complete data dictionaries and schema shall be provided for all data recorded on the train, along with the format of any data transmitted to the wayside.

(2) Data dictionary shall provide full access to the complete fidelity of the recorded information

(3) In addition to user operated PTU, DTE, and other software packages provided by the contractor, utilities to export all binary data into an open, machine-readable format (e.g., CSV, JSON, XML), with full fidelity of the data represented, in a way that can be interpreted by end users (e.g., in engineering units) shall be supplied by the Contractor

(4) The tool shall provide all means necessary to decrypt and/or decode the data.

(5) The details of the data dictionaries and documentation of the tools shall be submitted along with the utilities for review and approval by Amtrak 90 days prior to delivery of the first vehicle **[CDRL 26-05]**.

(6) Updates of the data dictionaries, documentation of the tools, and the utilities shall be provided prior to the deployment of software which modifies the data formats.

d). System Extensibility and Upgrades

i). Amtrak recognizes that many onboard systems will require technology refresh throughout the life of the rail vehicles.

ii). Display screens, data communication systems, system controllers, cameras, control terminals, passenger compartment equipment, and other customer facing onboard equipment will go through multiple upgrades or refreshes.

iii). The on-board and wayside systems provided as a part of this shall be designed in a flexible and extensible method in order to minimize the impact of these anticipated changes.

iv). As shown, this is business view of the TSSSA process, with service order creation from Contractor optionally being created in their own systems.

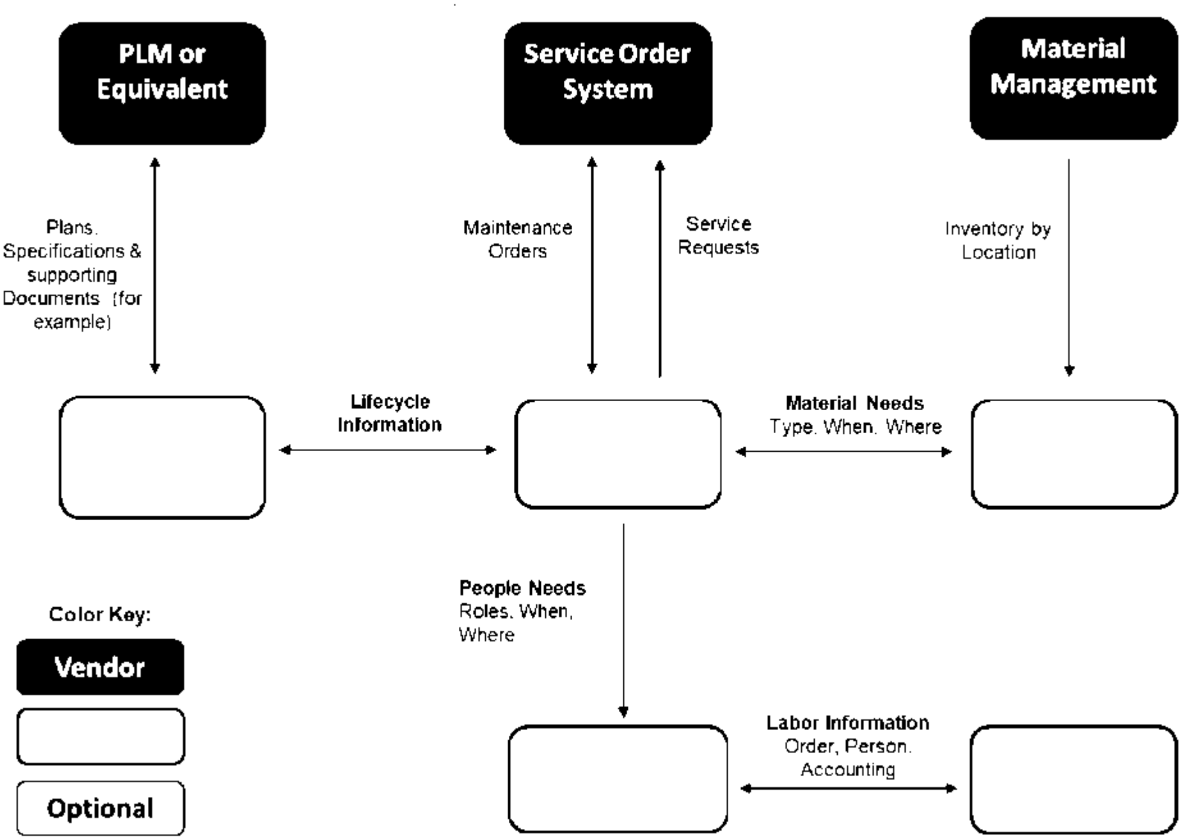


Figure 26-2: Business Process Viewpoint

e). Service/Work Order

i). If maintenance orders originate from Contractor, there shall be enough information provided to Amtrak to complete the work without directly referencing Contractor's systems.

ii). If Contractor will not integrate their service order system to Amtrak, work orders shall be created in Amtrak's maintenance execution system

iii). Work order status shall be provided to Contractor

iv). Job plans (task lists, tools, materials) should be provided with the maintenance orders

f). Material Availability

i). Since Contractor shall provide materials to complete maintenance requests, it is assumed Contractor shall ensure materials will be available prior to the execution date(s) of the work order g). Back Office

i). Additional interfaces shall be required to integrate billing. These are not included in the diagram since this may differ based on the technologies used by Contractor

h). Technical considerations

i). The following technologies are in use at Amtrak:

(1) PLM – Siemens Teamcenter

(2) Workorder Management – Maximo & EAMS Braid Mainline Rail

(3) Warehouse & Material Management – SAP

(4) Financial Systems – SAP

(5) Integration/Service Bus – MuleSoft AnyPoint

(6) EDW/Analytical Capabilities - Amazon Redshift/Tableau

(7) EDW/Analytical capabilities are available to support insights into asset condition.

(8) Genetec Security Center (Video Surveillance System, see section 14)

26.6 Train-to-Amtrak Integration Requirements

a). General Integration Requirements

i). To support the Amtrak DT vision of centralizing and standardizing information management for journey systems across the entire fleet, we prefer to securely communicate with railcars via APIs wherever possible.

ii). In this regard, Amtrak supports the following two API-based integration patterns.

iii). Depending on the capabilities of the proposed solution, Amtrak can support a combination of the following sections.

iv). Whatever solutions are proposed shall conform to Amtrak's overarching Architectural Principles, Identity and Security standards.

v). Amtrak must be notified in advance of any software or system changes that will result in changes to the approved interface specifications.

b). Train Systems as Client

i). The below diagram depicts the model where the train systems function as the client of Amtrak APIs for the purposes of both disseminating information from the train and retrieving information to be used by the train.

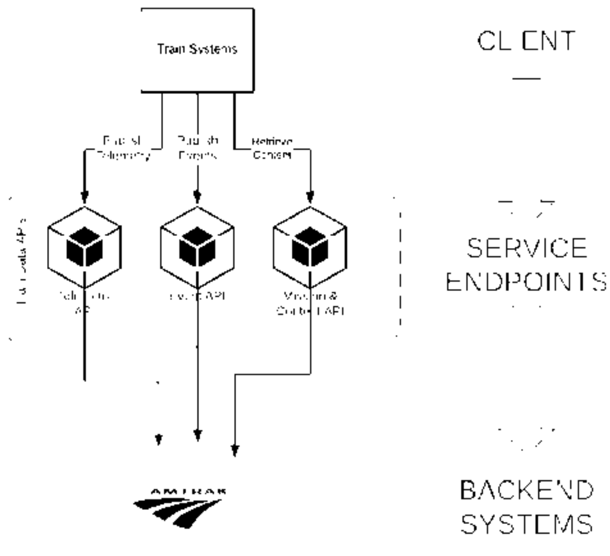


Figure 26-3: Train Systems as Client

c). Train Systems as Service Provider

i). The below diagram depicts a pattern where the train systems are exposed as services and Amtrak develops a middleware orchestration layer to serve as an intermediary between Contractor APIs and Amtrak's APIs.

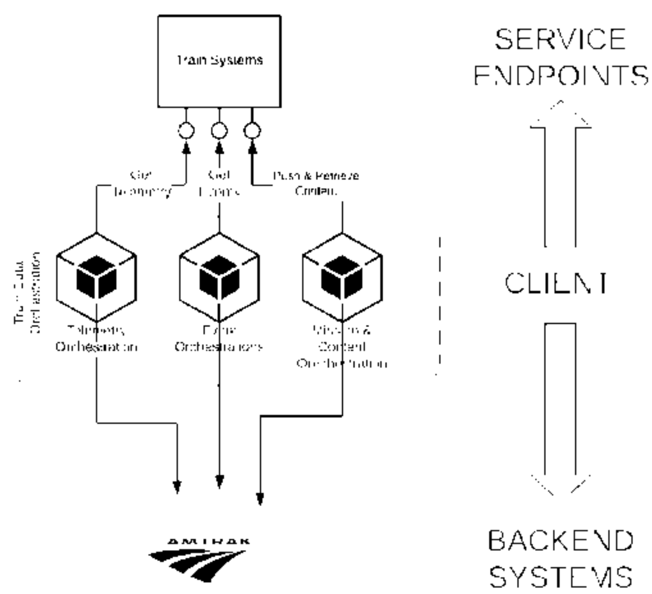


Figure 26-4: Train Systems as Service Provider

26.7 Identity Requirements

a). General Identity Requirements

i). Amtrak has an adopted identity standard for all authentication and authorization scenarios. Amtrak's core identity solution is Microsoft Azure AD and all solutions shall conform to patterns as supported by that platform.

ii). Contractor supplied software and systems requiring authentication of Amtrak users shall incorporate Amtrak's Microsoft Azure AD for identity. This shall include:

(1) Contractor supplied SAAS applications

(2) Contractor's sub-supplier SAAS applications

(3) Software supplied to run in/on Amtrak's environments

iii). Amtrak requires the DT solution for this solicitation to conform this standard including:

(1) Amtrak Employee or Contractor logins

(2) Non-Amtrak Personnel logins

(3) Machine-to-Machine Communications

iv). Microsoft Azure AD Reference is located at the following URL:

https://docs.microsoft.com/en-us/azure/active-directory/fundamentals/

26.8 CDRLs

CDRL	Description	Due
CDRL 26-01	ID of Contractor or Sub-Supplier Support Agreements	30 days prior to PDR; on-going updates
CDRL 26-02	Transition to Operations Plan and Schedule	30 days prior to PDR; on-going updates
CDRL 26-03	List of On-Board Variables	30 days prior to PDR; on-going updates
CDRL 26-04	Off-Board Customer Experience Simulation Lab – detailed system description, functionality, and infrastructure requirements	30 days prior to IDR; on-going updates
CDRL 26-05	Train Telemetry – details of the data dictionaries and documentation of the tools	30 days prior to IDR; on-going updates

* End of Chapter 26 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

27. Software and Microprocessor-Based Systems

Revision 1

Table of Contents

Table of Figures

27.1 General

a). This section applies to all software, microprocessor-based systems supplied for this project, including vehicle subsystem controls, test equipment, data analysis, fault analysis and training deliverables.

b). This section shall also apply to the programming of all programmable devices, including microprocessors, microcontrollers, Programmable Logic Devices (PLD), Application-Specific Integrated Circuits (ASIC), or Field Programmable Gate Arrays (FPGA), etc.

27.2 Software Systems Justification

a). Suppliers shall submit a life cycle cost justification for each software application not explicitly required by this specification.

b). This justification shall include, but not be limited to, a comparison between a hardware (e.g. relays, and discreet electronic) and a software based system.

c). For this calculation, the supplier shall use an "end of life" or obsolescence of the hardware (microprocessor and associated ICs) of 10 years and Military Handbook (MIL-HDBK)-217, Ground Mobile.

d). Based on this analysis, Amtrak will approve or disapprove the use of additional software systems.

27.3 Software Systems Requirements

a). Software System Classification

i). Hardware and software requirements depend on the degree to which the hardware and/or software is custom designed for or applied to this project.

(1) "Commercially available" or "Commercially Off The Shelf" (COTS) hardware or software shall be readily available in the US through retail and wholesale sources and shall be subject to all requirements, except as noted in this section.

(2) "Non-commercially available" hardware or software shall be developed or modified according to the requirements in this section.

(3) Hardware shall be viable for a railway application in terms of robustness and security.

b). Time and Date Processing

i). All software and hardware delivered or developed under this Contract shall be capable of handling dates in the range from 2000 to 2099.

ii). The date data processing shall not experience abnormal ending and/or invalid or incorrect results from the hardware, software, data repository or firmware in operation as part of Amtrak's business processes.

iii). Each hardware, software, data repository or firmware's date data interface shall support a four-digit year format.

iv). The master real time clock for all subsystems that are connected to the vehicle network shall be provided by the Central Diagnostics Unit (CDU).

v). All subsystems shall synchronize to the master clock.

vi). All time displayed to the train crew, maintenance personnel, or passengers shall be adjusted to the local time and shall automatically be adjusted to daylight saving time.

vii). The start and end dates for daylight savings time for all systems shall be adjustable by Amtrak via a configuration of the CDU.

27.4 Software

a). Software Development Process

i). All Non-COTS software shall be in accordance with IEEE Std 1558-2004, Standard for Software Documentation for Rail Equipment and Systems, and the requirements stated within this specification.

ii). The IEEE Std 1558 requirements shall be for a "Type 5" procurement as defined within that standard except as noted below.

b). General Features

i). Software shall perform the following basic functions:

(1) Implement the desired control scheme such that the specified performance is achieved.

(2) Monitor all inputs for unsafe, erroneous, or unknown conditions or combinations of conditions.

(3) Sample all input conditions at rates sufficient to detect and remedy all unsafe or damaging conditions in the shortest possible time.

(a) 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.

(b) All software shall be designed to ensure that the timing requirements for safety related tasks are always met.

(4) Limit all output commands to safe levels for all combinations of input conditions, to avoid equipment damage and hazards to personnel.

(5) Perform system self-diagnostic routines and respond promptly, safely, and predictably to detected faults.

(a) The self-diagnostics shall include tests for program corruption and integrity in read/write memories such as (Electronically Erasable Programmable Read Only Memory) EEPROM and flash Programmable Read Only Memory.

(6) Respond safely and predictably when powering up or recovering from power interruptions.

(a) All power interruptions likely to have corrupted temporary storage shall be detected and cause the system to reinitialize all affected routines and temporary data.

(b) Detection of power interruptions may be by hardware.

(7) Permit thorough interrogation of all input, output, and internal conditions (values calculated or computer by software or logic) by internal, system level, vehicle level and external diagnostic equipment.

ii). Undocumented software features are prohibited.

c). Contractor Activities

i). The Contractor, as system and software integrator, shall be responsible for the overall quality of all software supplied as part of this contract.

(1) If the Contractor also develops software, it shall consider the team that develops software as a supplier.

ii). Quality Control Plan **[CDRL 27-01]**

(1) The Contractor shall develop a car level software quality control plan which defines how it will manage and oversee the software development of its suppliers.

(2) The software quality control plan may be a section within the Contractor's Project Quality Plan.

iii). Software Quality Audits

(1) The Contractor shall conduct periodic software quality audits of all Non-COTS suppliers.

(a) Amtrak reserves the right to attend any audit along with the Contractor.

(2) Amtrak reserves the right to conduct a software quality audit at any time during the software design and development phase.

(3) At a minimum, the suppliers shall plan for an audit to be performed at the Final Design Review (FDR). **[CDRL 27-02]**

(4) The results of all audits shall be submitted to Amtrak for review and acceptance. **[CDRL 27-03]**

(5) Remedial action for all open comments from any audit shall be submitted to Amtrak for review within 90 days of the audit. **[CDRL 27-04]**

(6) The audit shall include:

(a) A software process audit –on each software supplier and its sub suppliers which shall include at a minimum

(i) Project management

(ii) Requirement Tracing

(iii) Configuration Control

(iv) Coding standards

(v) Change process and Defect tracking

(b) Physical audit as defined by IEEE, Std 730 on each SCI – This report shall be submitted with **[CDRL 05-04]**

iv). Software Testing

(1) The Contractor shall witness all software verification and validation testing (STPr/SD) prior to the release of any software.

(2) Amtrak reserves the right to attend these tests along with the Contractor.

v). Configuration Control

(1) The Contractor shall develop a Software Configuration Control Plan (SCCP) **[CDRL 27-05]** for tracking software changes to individual cars on Amtrak property until the end of the warranty period and all retrofits are complete.

(a) This plan shall be submitted for review and acceptance by Amtrak.

(b) The SCCP shall also control software on non-car equipment such as PTU's, BTE's, and the like, and shall include a mechanism to ensure continuing compatibility between car software and non-car software.

(c) It shall be consistent with the Contractor's approach to configuration control of hardware and require similar approvals and tests.

(2) The Contractor shall maintain a database of the software version of every software item on each car and in each piece of non-car equipment.

(a) The database shall be kept current by the Contractor at all times and be submitted each time software is updated on any system. **[CDRL 27-06]**

(3) The software version status of every software item on the car shall be provided in the Car History Book. **[CDRL 27-07]**

(4) The software version status of every software item on each piece of non-car equipment shall be provided by the Contractor with the delivery of the equipment. **[CDRL 27-08]**

vi). Delivery of Software

(1) At the end of the warranty period and for each software release thereafter, the Contractor shall provide to Amtrak on Compact Disc Read-Only Memory (CD-ROM), USB Drive, Digital Video Disc (DVD), or an acceptable technology at the time:

(a) All executables **[CDRL 27-09]**

(b) Updated software documentation **[CDRL 27-10]**

(c) Updated user documentation **[CDRL 27-11]**

(d) Software Version Description (SVD) **[CDRL 27-12]**

(2) The requirement for CD-ROM, USB Drive or DVD copies and documentation shall apply to every delivery of software for non-car equipment.

(3) The SVD shall contain a description of problems addressed, known problems yet to be addressed, features added, requirements added or changed, design changes, compatibility between other versions of software, other system and other cars in the train, changes to related software documents and evidence of document review, test plan, and test results.

d). Software Developer Documentation

i). All suppliers who develop software shall submit for Amtrak's review and approval, documentation to ensure a mature software development process that has been fully verified and validated, and can be maintained in the future. **[CDRL 27-13]** Amtrak offers two paths listed below:

(1) Submit all the documentation as required by IEEE, Std 1558, for type 5 software.

Figure 27-1: Required Software Documentation (Option 1)

Document Name	Software Type	PDR	IDR	FDR	New Software Releases
Software Project Management Plan (SPMP)	All	Yes	No	No	No
Software Quality Assurance Plan (SQAP)	All	Yes	No	No	No
Software Configuration Management Plan (SCMP)	All	Yes	No	No	No
Software Verification and Validation Plan (SVVP)	All	Yes	No	No	No
Software Verification and Validation Report (SVVR)	All Non-COTS	No	No	No	Yes
Software Requirement Specification (SRS)	All Non-COTS	Yes	Yes	Yes	Yes
Interface Control Document (ICD)	All	Yes	Yes	Yes	Yes
Software Design Description (SDD)	All Non-COTS	No	No	No	Yes
Database Design Description (DBDD)	All	Yes	Yes	Yes	Yes
Software Requirement Traceability Matrix (SRTM)	All Non-COTS	Yes	Yes	Yes	Yes
Software Test Plan (STP)	All Non-COTS	Yes	No	No	No
Software Test Procedure (STPr)	All Non-COTS	No	Yes	Yes	Yes
Software Test Report (STR)	All Non-COTS	No	No	No	Yes
Software Version Description (SVD)	All	No	No	No	Yes
Software User Manual (SUM)	All Non-COTS PTU/BTE	Yes	Yes	Yes	Yes

(2) In order to reduce the amount of submittals, the Contractor may combine the documents by IEEE, Std 1558, for type 5 software as follows:

(a) The SPMP, SQAP, SCMP, SVVP, and STP shall be combined into one document entitled Software Development Plans (SDP). This SDP shall include all the requirements of the individual documents.

(b) The SRS, SDD, DBDD, STPr, STR, and SVVR shall be combined into one document entitled Software Documentation (SD). This SD shall include all the requirements of the individual documents.

(i) It is expected that this document would be developed as a database and would be expanded and updated as the software is developed and tested.

(c) The ICD and DBDD shall be combined into one document entitled Software Interface Document (SID).

(i) This SID shall include all the requirements of the individual documents.

(d) The SVD and SUM, if required, shall be stand-alone documents.

Figure 27-2: Required Software Documentation (Option 2)

Document Name	Software Type	PDR	IDR	FDR	New Software Releases
Software Development Plan	All	Yes	No	No	No
Software Documentation (SD)	All Non-COTS	Yes	Yes	Yes	Yes
Software Interface Document (SID)	All Non-COTS	Yes	Yes	Yes	Yes
Software Version Description (SVD)	All	No	No	No	Yes
Software User Manual (SUM)	All Non-COTS PTU/BTE	Yes	Yes	Yes	Yes

ii). Regardless of which path is chosen, the Contractor or software supplier shall develop the SRS based on the technical specification requirements.

(1) The SRS shall fully link to each technical requirement.

(2) The contractor shall submit an SRTM with the first release of the SRS to Amtrak.

(3) The SRTM shall use the technical section reference identification numbers as defined in the technical specification as the reference to link to the SFD, SRS, SDD, and STPr or SD.

(4) The Contractor shall update and submit an updated version of the SRTM with each document released, strictly following the software life cycle process.

(5) The Contractor and supplier shall not proceed in the software development until the SRS document is reviewed and approved by Amtrak.

(6) The Contractor shall submit software documentation to Amtrak based on the software life cycle.

iii). In order for Amtrak to update, modify, or replace a system on the cars at a later date, the following documents shall be marked "Non-Proprietary": ICD, DBDD, SID and SUM.

iv). The Contractor shall perform a demonstration to ensure that the ICD and DBDD or SID is complete and accurate. **[CDRL 27-14]**

e). Operating Systems and Languages

i). Software may be written in a high or low-level language; however, high-level languages such as C/C++ are preferred.

ii). The language, compiler, and its implementation for the selected microprocessor system shall be commercially available in English.

iii). All languages and operating systems shall have an acceptable customer base and be in widespread use.

iv). Use of commercial operating systems such as Windows™ for onboard applications is prohibited, unless approved by Amtrak on a case-by-case basis.

v). Where approved for non-onboard applications such as PTU and BTE, software running on Windows™ shall include a Windows™ format help file to provide context sensitive help to the user of the software.

vi). All compilers shall be approved by Amtrak based on previous service history.

vii). The suppliers shall have a software coding standard for each programming language which shall define header information, comment requirements, module size, etc., Similar to NASA C Style Guide SEL-94-003 or MISRA C.

f). Commercial Off-the-Shelf Software

i). Some software supplied under this contract may be commercial-off-the-shelf when approved by Amtrak such as operating systems supplied for PTU and BTE.

ii). For Commercially Available Software, the following shall be supplied:

(1) The original data storage/transfer media functional and usage details **[CDRL 27-15]**

(2) All manuals and instructions to configure and install the software **[CDRL 27-16]**

(3) All licenses required for Amtrak's site use **[CDRL 27-17]**

g). Software Testing

i). Software testing shall be a prerequisite to higher level testing, such as system level and vehicle level tests.

ii). All system or subsystem level features and functions of software systems which implement system or subsystem-level requirements of the Technical Specification that are allocated to software shall be testable.

iii). Field testing shall use the PTU and procedures provided under this Contract.

iv). For features which are only testable off the car with special equipment, all such equipment shall be supplied by the Contractor as test equipment and become the property of Amtrak.

(1) This equipment shall provide the logic, sequencing, and emulation necessary to verify that the software functions as intended.

(2) In lieu of separate equipment, appropriate test functions may be provided within the PTU.

v). Unit and Module Interaction Testing

(1) The supplier shall perform unit and module interaction testing on all software components.

(2) This unit testing shall provide 100% coverage, unless approved by the Engineer.

(3) Automatic test tools, such as Vector Cast or LDRA may be used.

(4) As a minimum, full branch testing, data range and boundary testing, and error trap testing shall be completed.

(5) All unit testing results shall be fully documented in a unit testing report which shall be submitted to Amtrak for review and approval. **[CDRL 27-18]**

vi). Software Type Testing

(1) Type tests of all software systems shall verify the proper operation of all software features, including diagnostics.

(2) The type tests shall demonstrate that the system under test can successfully recognize and report all faults listed in the CDU Fault Management Plan and all other events and parameters reported to the CDU.

(3) The Contractor shall submit the results of the type tests to Amtrak for review and approval. **[CDRL 27-19]**

(4) Where such tests may result in damage to the system hardware, the fault or event may be simulated to avoid damage to the hardware.

(5) Such testing shall be performed any time the software is changed, prior to putting it into service.

vii). Software Validation Test Procedures

(1) Software validation test procedures must be approved by Amtrak prior to the execution of the tests. **[CDRL 27-20]**

viii). Testing of Software Revisions

(1) After the initial version of software is installed on the cars, all software revisions shall be tested by the supplier in the supplier's facilities (laboratory) in accordance with its testing processing and procedures.

(2) After successful completion of such tests, a test version of the software revision shall be placed on a limited number of cars and dynamically tested for a period of time as approved by Amtrak.

(3) Only after results of the dynamic tests on a limited number of cars have been approved by Amtrak shall a new software revision be applied to the fleet or any portion of the fleet.

(4) Application of any software revision to any portion of the fleet at any time shall be in conformity with the approved Configuration Control Plan of this Section 27.c.v.

h). Software Version Numbers

i). Software version numbers shall be included within the firmware code and shall be accessible via laptop Portable Test Unit (PTU), the CDU, and on the system's display.

ii). Every change to software shall be reflected in an update to the version number.

iii). If the software includes data or parameter files which can be modified by the suppliers or by Amtrak, a modification to such files must be reflected in a change to the software version number or a separate data/parameter file version number

i). Software Security

i). The Contractor, as the systems and software integrator, shall implement disciplined security practices.

ii). These security practices shall align with industry best practices and ensure the confidentiality, integrity, and availability of the delivered software systems.

iii). To demonstrate its capability, the Contractor shall submit:

(1) The results of a current, independent, BSIMM and/or OWASP SAMM software security assessment **[CDRL 27-21]**.

(2) The assessment shall evaluate the security controls, vulnerabilities, and overall security posture of the software systems implemented by the Contractor, including but not limited to, the following areas:

(a) Authentication and access control

(b) Data protection and encryption

(c) Secure coding practices

(d) Security testing and vulnerability management

(e) Incident response and recovery

(f) Security documentation and training

j). Software Update

i). It shall be possible to update all application software with the exception of approved programmable devices (E.g. ASIC, CPLD, etc.) via the PTU connected to the system directly.

ii). Any partial or interrupted software update shall automatically return the system to the previous version of software and not leave the system in an unconfigured state.

iii). The time required to upload the entire software complement for a given system, including time to replace firmware embedded in FPGAs, CPLDs, etc., shall be no more than fifteen (15) minutes.

iv). The Contractor shall provide detailed instructions/procedure to install and configure the software.

k). Transfer of Software to Replacement Devices

i). In order to ensure the long-term maintainability of programmable devices, the Authority requires that to Contractor provide:

(1) Master copies of the compiled executable for all programmable devices such as ASICS, CPLD's, FPGA's and Read Only Memory Devices. **[CDRL 27-22]**

(2) Six (6) sets of the necessary equipment and software to transfer the compiled software to new devices and to verify the integrity of the copy. **[CDRL 27-23]**

ii). If the requirements of part i of this subsection are not possible to meet for any programmable device, the Contractor shall provide Amtrak with a sufficient number of replacement preprogrammed devices to supply the fleet for 30 years of service.

l). Software Escrow

i). The Contractor shall maintain in escrow all proprietary source code for all software used on the vehicle and the compilers, linkers, etc. used to develop it. **[CDRL 27-24]**

ii). The source code held in escrow shall be the latest version installed on the vehicles.

iii). The Contractor shall demonstrate that the source code held in escrow compiles to produce the same executive with the same CRC or checksum as installed on the vehicles. **[CDRL 27-25]**

iv). The contractor shall submit a Software Executable Generation Procedure (SEGP) **[CDRL 27-26]** that details the steps required to build the workstation and generate the executable file.

v). Should the compilation process prohibit matching of the CRC or checksum, additional techniques to inspect difference in the generated executive including the use of comparison software and functional testing on the BTE can be employed to prove equivalency.

(1) Such techniques are to be approved by Amtrak.

vi). Full instructions to assist in installation and configuration of the software development workstation, as well as building and verifying the executable software shall be provided. **[CDRL 27-27]**

vii). The Contractor shall provide sufficient documentation of the source code to allow Amtrak to maintain it, troubleshoot it and adjust parameters. **[CDRL 27-28]**

viii). The development software held in escrow, including any operating system used with the licensed development tools, shall be of the same version used to develop the software currently installed on the vehicle.

27.5 Hardware

a). Hardware Platform

i). All car borne and custom computer hardware shall be designed and constructed in accordance with the general electronic design principles of Chapter 15 Electrical System.

ii). Any computers, whether portable or not, and any microprocessor hardware shall be readily available through retail and/or wholesale outlets in the U.S.

iii). The microprocessor-based systems shall be based on an established family of microprocessors in wide use in the control system industry and the rail industry.

iv). The type and availability of each microprocessor shall be included in the design review package.

v). Any use of commercially-available computer boards for on car applications must be specifically approved by Amtrak on a case-by-case basis.

vi). Such approval will be based upon a technical review of the product's suitability for use in a transit rail environment, product documentation and proof that a supply will be available for the expected life of the vehicles.

b). Microprocessor Systems Shutdown

i). A special algorithm **[CDRL 27-29]** shall be provided to ensure that:

(1) Computer shutdown and restart occur in a safe and predictable manner.

(2) Spurious faults are not generated during shutdown or restart.

(3) Stored diagnostic data is not lost during shutdown or restart.

(4) Time stamp integrity is maintained on all diagnostic data through any shutdown and restart process, including immediately after restart.

c). Program and Data Storage

i). All onboard microprocessor based systems shall store software and diagnostic data in non-volatile flash memory, or EEPROMS.

ii). The use of mechanical hard drives or optical disks is prohibited for data storage on all systems, except the network video recorders.

iii). All flash memory and other memory devices with a finite number of read/write cycles shall be implemented in such a way that one sector or memory location is not written to repeatedly, thus shortening the life expectancy of the device.

iv). The life expectancy of such devices as used on the vehicle shall not be less than 30 years.

v). The memory and processor capacity shall be designed to allow program expansion without hardware modification.

vi). Expandability and capacity requirements are as follows:

(1) The memory needs of the installed software, backup copy, if required, during software update and data files shall not utilize more than 50 percent of the installed memory capacity at Type Test.

(a) This requirement applies individually to each type of memory installed, whether it is EEPROM, Flash PROM, or RAM.

(2) Peak processing time demands shall not be greater than 75 percent of the available processor capacity.

d). Electrical Isolation and Pre-Processing

i). All processor system input and output signals shall be isolated. High voltage inputs and outputs shall be isolated external to the microcomputer card rack.

ii). Low voltage (battery and logic voltage level) inputs and outputs shall be isolated from the supply power.

iii). The isolation for the outputs can be external to the microcomputer card rack.

iv). The isolation shall accomplish the following:

(1) Protect and isolate the system from damage due to over-voltage, under-voltage, transients, shorts and open circuits

(2) Perform necessary voltage translations

(3) Remove noise and undesired signals

(4) Pre-processing to limit, discriminate and format those signals that would otherwise require excessive processor time

v). Isolation devices shall consist of optical isolators, transformers, relays, and other circuits appropriate to the application.

e). Batteries and Super Capacitors

i). The use of super capacitors is acceptable for real time clock or other requirements typically performed by a battery, provided the super capacitor can maintain clock or data for a minimum of 90 days.

ii). The use of batteries within control units for maintenance of a real-time clock, or for safe shutdown must be approved by Amtrak.

iii). If approved by Amtrak, all batteries shall be implemented as follows:

(1) 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.

(2) Battery life shall be no less than 5 years, regardless of type.

(3) Systems using standby or back-up batteries shall annunciate the need for battery replacement such that the battery continues to perform its function until it can be replaced at the next periodic maintenance.

(4) Batteries shall not be connected by soldering.

iv). Necessary RAM control data shall not depend on battery back-up, but shall be stored in non-volatile memory and "shadowed" to RAM for use.

f). Maintenance and Related Tools

i). Portable Test Unit (PTU) and Bench Test Equipment (BTE)

(1) For custom software that is resident in test computers, Amtrak shall be given a license for unlimited use of the software for the approved purposes of this Contract. **[CDRL 27-30]**

(2) Licenses shall not be linked to specific hardware serial numbers.

(3) In addition, PTU and BTE equipment software documentation, compliant with this chapter, shall be furnished. **[CDRL 27-31]**

(4) PTU and BTE software shall be subject to the approved Configuration Control Plan of this Section.

(5) The operating system employed for the PTU shall be the most-advanced, user-friendly system available at the time of system design and development.

(6) While it is anticipated that the system will be Microsoft Windows™ based, advances in technology may preclude this from being the best choice.

(7) Accordingly, identification of the system to be used will be made by Amtrak at the time of design review.

27.6 Reliability

a). If more than two unplanned maintenance releases of any individual software configuration item (SCI) are required during formal type testing through the end of the warranty, Amtrak may require the Contractor to perform a full independent software quality review.

b). This review shall include all aspects of a software audit as listed in this section plus a full independent software verification and validation of the software.

27.7 Safety

a). The use of software in safety-critical or related applications must be approved by Amtrak.

b). If Amtrak approves the use of software in a safety-critical or related application, it shall be developed in compliance with EN-50128 SIL4, unless approved by

Amtrak.

c). In addition to the requirements of this chapter, any software, firmware, processing device or computer providing a safety-critical function shall comply with the requirements of Chapter 25, Safety.

27.8 CDRLs

CDRL	**Description**	**Due**
CDRL 27-01	Software Quality Control Plan	NTP + 60 days
CDRL 27-02	Non-COTS Software Supplier Quality Audits	FDR (at a minimum)
CDRL 27-03	Non-COTS Software Supplier Quality Audit Results/Reports	Within 30 days of each audit
CDRL 27-04	Non-COTS Software Supplier Quality Audit Remedial Action for Open Comments	Within 90 days of each audit
CDRL 27-05	Software Configuration Control Plan (SCCP)	30 days prior to IDR
CDRL 27-06	Database of Software Versions – Cars & Non-vehicle Equipment	30 days prior to IDR, then ongoing updates
CDRL 27-07	Software Version - Cars	In Car History Book
CDRL 27-08	Software Version - Non-vehicle Equipment	With delivery of equipment
CDRL 27-09	Software – all executables	At the end of warranty period for each software release
CDRL 27-10	Software – Updated software documentation	At the end of warranty period for each software release
CDRL 27-11	Software – Updated user documentation	At the end of warranty period for each software release
CDRL 27-12	Software – Software Version Description (SVD)	At the end of warranty period for each software release
CDRL 27-13	Software Developer Documentation	30 days prior to IDR, then ongoing updates
CDRL 27-14	Demonstration to ensure that the ICD and DBDD or SID is complete and accurate	FDR (at a minimum)
CDRL 27-15	COTS Software – Original data storage/transfer media functional and usage details	30 days prior to IDR, then ongoing updates
CDRL 27-16	COTS Software – All manuals and instructions to configure and install the software	30 days prior to IDR, then ongoing updates
CDRL 27-17	COTS Software – All licenses required for Amtrak's site use	30 days prior to IDR, then ongoing updates
CDRL 27-18	Test Reports for Software Unit Tests	30 days after performance of tests
CDRL 27-19	Test Reports for Software Type Tests	30 days after performance of tests

CDRL	Description	Due
CDRL 27-20	Software Validation Test Procedures	30 days prior to IDR, then ongoing updates
CDRL 27-21	Results of a current, independent, BSIMM and/or OWASP SAMM software security assessment of Contractor	360 days prior to shipment of first trainset
CDRL 27-22	Transfer of Software to Replacement Devices – Master copies of the compiled executable for all programmable devices	180 days prior to shipment of first trainset, then ongoing updates
CDRL 27-23	Transfer of Software to Replacement Devices – Six (6) sets of equipment and software to transfer the compiled software	180 days prior to shipment of first trainset, then ongoing updates
CDRL 27-24	Escrow of Proprietary Source Code	180 days prior to shipment of first trainset, then ongoing updates
CDRL 27-25	Demonstration that source code in Escrow is same as on vehicles.	180 days prior to shipment of first trainset, then ongoing updates
CDRL 27-26	Software Executable Generation Procedure (SEGP) to use Escrowed files	30 days prior to FDR, then ongoing updates
CDRL 27-27	Full Instructions for Workstation to use escrowed files	30 days prior to FDR, then ongoing updates
CDRL 27-28	Documentation of Escrowed Source Code to allow for maintenance, troubleshooting and adjustment	30 days prior to FDR, then ongoing updates
CDRL 27-29	Microprocessor System Shutdown Special Procedure	30 days prior to IDR, then ongoing updates
CDRL 27-30	License for unlimited use of software in test computers	360 days prior to shipment of first trainset, then ongoing updates
CDRL 27-31	PTU and BTE software documentation	30 days prior to IDR, then ongoing updates

* End of Chapter 27 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

28. Cybersecurity

Revision 1

Table of Contents

28.1 General

a). Overview

i). Amtrak places a high priority on cybersecurity and recognizes the inherent complexities and evolving challenges associated with safeguarding both IT and OT assets.

ii). The security of Amtrak's train network, which serves as a vital transportation lifeline for millions of passengers each year, is of paramount importance to Amtrak and its customers.

iii). To ensure the utmost protection, Amtrak has established a specialized organization of cybersecurity experts dedicated to preserving the security, integrity and resilience of their systems.

iv). Amtrak expects the same dedicated commitment from the Contractor and its Suppliers and sub-suppliers.

v). By maintaining a dedicated commitment to cybersecurity, Amtrak strives to uphold the trust and confidence of their passengers, partners and stakeholders taking proactive measures to ensure availability, reliability and safety of the train network while safeguarding sensitive information entrusted to Amtrak.

b). Requirements

i). This Chapter defines cybersecurity requirements for all hardware, software, software services and firmware (hereinafter referred to as the "products" for purposes of this section) to be provided under this Contract, whether resident within a microprocessor-controlled system, provided as part of test or interface equipment, provided for the purpose of post-download data analysis and processing, incorporated within training technology and manuals, Bench Test Equipment (BTE) or supplied as a part of a software based service.

ii). These requirements apply to all systems that include processors or other programmable components such as Programmable Logic Devices (PLDs).

iii). All products for this Contract are subject to these same requirements. Contractor shall respectively transmit and enforce these requirements to all subcontractors and require that these subcontractors flow these requirements down to all of their subcontractors and sub-suppliers, regardless of the tier.

iv). Thus, where the word "Contractor" is used, it includes all subcontractors and sub-suppliers, at every tier.

c). Failure to meet requirements

i). If the Contractor fails to comply with any of the requirements set forth herein, and fails to remedy such non-compliance upon demand from Amtrak, Amtrak may exercise all available legal, contractual and administrative remedies for such non-compliance, up to and including a default termination in accordance with the Termination for Default article in the Contract.

ii). This applies not only to Contractors as defined in the above paragraph, but to manufacturers of all hardware, software, and firmware installed in the railcar.

iii). Further, if the results of any penetration testing, vulnerability assessment or other examination or audit of the Contractor's cybersecurity protections yields any results that either the Federal Government or one of Amtrak's jurisdictional partners determines to require further examination and/or audit, Amtrak may share the results of such testing with Federal, state or local authorities for the purpose of protecting national security interests, the safety and security of the riding public, or personal and real property.

d). Minimum Requirements

i). These requirements represent the minimum set of security requirements and additional security requirements may be called out in other chapters of this contract.

ii). In the following text, the terms "cybersecurity" and "security" may be used interchangeably to meet the intention of the specific requirement.

iii). Where security or cybersecurity are referenced, they are inclusive of data privacy considerations where applicable.

e). Security Governance

i). The Contractor shall define, document, and submit to Amtrak for review and approval a listing of Contractor personnel involved in the trainset's development, maintenance, and operation who will be accountable for security-related decisions and actions. **[CDRL 28-01]**

ii). The document shall include:

iii). Personnel roles.

iv). Qualifications per person, including:

(1) any security industry certifications

(2) years of experience in IT and/or OT security

(3) years of experience in trainset security

(4) formal training in DT and/or OT security

(5) previous and current security positions held.

v). Responsibilities per role for security-related decisions and actions.

vi). Accountabilities per role for security-related decisions and actions

vii). This list shall be kept up to date and resubmitted to Amtrak upon any revision.

f). Risk Management Framework

i). The NIST SP 800-53 Framework shall be used as the underlying risk management framework to identify, detect, protect from, respond to and recover from security risks associated with the trainset over its lifecycle, evolving to maintain concurrency with current versions.

ii). If the NIST SP 800-53 Framework becomes obsolete during the term of this contract, Amtrak will determine an appropriate and compatible replacement.

iii). This risk management framework shall be used as the basis for all specified security initiatives within this contract (e.g., assessments and testing, application of controls, risk mitigation, etc.), unless alternate frameworks are approved by Amtrak on a case-by-case basis.

iv). In the case of alternate frameworks being referenced within this contract on a case-by-case basis, NIST SP 800-53 and the named alternate framework shall be leveraged, with the Contractor's ability to combine testing where the requirements of each framework are compatible.

v). Security Compliance Frameworks: "Security Compliance Framework" or "framework" shall imply law, regulation, specification, directive, framework or other as applicable.

vi). In certain scenarios, demonstrating compliance with a specific framework other than NIST SP 800-53 may become necessary, such as requiring compliance to PCI-DSS, HIPAA, and/or other more granular security compliance frameworks.

vii). Where demonstrating compliance to a specific framework becomes necessary based on the type of data in that environment and/or basis of the framework, the Contractor shall demonstrate compliance to the specific framework in addition to meeting all other security requirements of this contract, unless they conflict with the security compliance framework.

viii). If a conflict arises, the Contractor shall notify Amtrak, discuss the conflict, provide a recommended resolution, and Amtrak shall either approve the recommendation or provide a counter recommendation.

ix). Demonstrating compliance to specialized security compliance frameworks shall be required even if not specifically called out in any other chapter of this contract when the impact of the security compliance framework's basis on Amtrak is evident.

x). Consideration for ISA/IEC 62443 Security Compliance Framework:

xi). There are well-known security compliance frameworks for Control Systems such as ISA/IEC 62443 that can be applied to rail.

xii). Should the Contractor already align with one of these frameworks, they may submit a mapping of the designated framework against NIST SP 800-53 for Amtrak's review and consideration as an alternative to using NIST SP 800-53 as the primary risk management framework.

xiii). However, Amtrak reserves the right to reject the mapping and alternately require the use of NIST SP 800-53

g). Supply Chain Security

i). The Contractor shall conduct a thorough assessment of all entities involve in its collective underpinning.

(1) These assessments shall follow the Shared Assessments Standard Information Gathering (SIG) questionnaire and utilize the Agreed Upon Procedures to implement and manage third-party risk assessment and management and ensure compliance with applicable security and privacy laws, regulations, frameworks.

(2) The Contractor shall disqualify any Supplier and/or sub-supplier that poses an unacceptable level of risk, unless approved by Amtrak.

(3) Unacceptable risk levels shall be determined as moderate or higher, and detailed risk information shall be presented to Amtrak for consideration and approval if the Contractor wishes to proceed with the Supplier or sub-supplier.

(4) Any Supplier or sub-supplier engaged in any portion of this contract from sanctioned countries shall be identified as a critical risk.

(5) The comprehensive third-party security risk management scoring on any Supplier and sub-supplier approved for use in the trainset's development, maintenance, and operation shall be made available to Amtrak upon their request.

ii). Throughout the procurement and manufacturing process, the integrity and authenticity of trainset components shall be continuously validated.

(1) The Contractor shall implement measures to ensure that all components used in the trainset are obtained from trusted sources and are free from any tampering or unauthorized modifications.

(2) This includes rigorous checks and controls at each stage of the supply chain to maintain the security and reliability of the trainset's components.

iii). Software Bill of Materials / Hardware Bill of Materials

(1) The Contractor shall maintain a Software Bill of Materials (SBOM) and Hardware Bill of Materials (HBOM) throughout the design process, with regular updates throughout the warranty period.

(2) Prior to PDR, the Contractor shall submit the SBOM and HBOM format for Amtrak review and approval.

(3) SBOM and HBOM shall be submitted at the following intervals:

(a) at each design review

(b) at FAI

(c) prior to the delivery of the first vehicle, and

(d) annually throughout the warranty period.

(4) The SBOM shall detail all software components used to provide the required functionality of this technical specification, including all on-board software, and software supplied to support required off-board functionality.

(5) Each SBOM entry shall include:

(a) the system name

(b) the part name

(c) the software configuration item name

(d) the software component's name

(e) the version number and

(f) a cryptographic hash of the software.

(6) The SBOM shall identify any known vulnerabilities associated with each software component, referencing the Common Vulnerabilities and Exposures (CVE) identifiers where applicable.

(7) The SBOM shall be provided in an industry standard format as approved by Amtrak, such as SPDX, SWID, or CycloneDX.

(8) The HBOM shall be a comprehensive list of all hardware components which include microprocessors, programmable logic devices, or other memory and executable code. Each entry shall include the system, the component manufacturer, the component name, model, revision and any unique identifiers.

(9) The HBOM entry shall include supply-chain information including manufacturer location and places of origin for key sub-components.

iv). Country of Origin

(1) The Contractor shall identify the country (or countries) of origin of all products to be provided under this Contract, or any subcontracts, at any tier.

(2) The Contractor shall identify the countries where the development, manufacturing, maintenance, and service for the product are provided or will be provided.

(3) The Contractor must submit a list of the proposed products identifying the country of origin (“List” hereinafter) to Amtrak for approval. **[CDRL 28-02]**

(4) The Contractor shall notify Amtrak of any changes to the List no less than 90 days prior to the date that the change will be implemented.

(a) This is a mandatory requirement for all products that will be used on the project.

(b) The Contractor shall not be entitled to an equitable adjustment to the Contract for any costs incurred based upon any approved changes to this List.

h). Training and Awareness

i). All personnel performing work related to the development, operation, or maintenance of the equipment supplied as a part of this technical specification shall undergo adequate security training.

ii). This training shall cover their specific roles and responsibilities in delivering the equipment and services and effectively mitigating security risks.

iii). The Contractor shall ensure that all personnel are equipped with the necessary knowledge and skills to uphold the highest standards of security throughout the equipment’s lifecycle.

iv). Regular refresher training and awareness programs shall be conducted to keep personnel up to date with evolving security practices and requirements.

v). A listing of all security training conducted with a roster of who completed the training shall be provided to Amtrak upon their request.

i). Conflict of Requirements

i). If any security requirement of this contract conflicts with a safety and/or regulatory function of the trainset or any other specific contract requirement, the conflict shall be promptly raised to Amtrak.

ii). The Contractor shall provide a detailed explanation of the conflict along with a recommended approach for resolution, which will be subject to Amtrak’s review, approval, and/or counter-recommendation.

28.2 Cybersecurity Practices

a). General

i). The Contractor shall adhere to the specified cybersecurity practices detailed below.

ii). In the event that the Contractor knows that it cannot comply with a requirement at the time of its proposal, it shall specify in sufficient detail the justification for non-compliance and its proposed alternative method for meeting the requirement.

iii). The Contractor has the affirmative duty to seek and identify any and all information that would result in actual or potential non-compliance during the course of Contract performance.

iv). The Contractor shall immediately notify Amtrak so that corrective action can be taken.

v). Appropriate security controls shall be implemented for all aspects of the trainset that are susceptible to security risks, adhering to a minimum of NIST 800-53.

vi). These controls shall encompass a broad range of security measures and practices to ensure the protection of the trainset’s assets.

vii). In addition to implementing security controls based on NIST 800-53, appropriate security controls shall be implemented for all aspects of the trainset that are susceptible to security risks, following industry-specific guidance where available.

viii). This guidance may include TS/CLC 50701 for Rail, Cloud Security Alliance for cloud-based assets, CIS for system hardening/benchmarking, OWASP for software security hardening, and other applicable standards and best practices.

ix). By considering and implementing these explicit security controls, the trainset’s assets shall be optimized for enhanced safeguarding and protection.

b). Software and Services

i). The Contractor shall remove and/or disable, through software, physical disconnection, or engineered barriers, all services and/or ports in the product not required for routine operations, emergency operations, or troubleshooting.

(1) This will include communication ports and physical input/output ports (e.g., USB docking ports, video ports, UART ports, and serial ports).

(2) The Contractor shall provide documentation of disabled ports, connectors, and interfaces to Amtrak **[CDRL 28-03]**.

ii). The Contractor shall provide summary documentation of the product's security features and security-focused instructions on maintenance, support, and reconfiguration of the product's default settings. **[CDRL 28-04]**

iii). The Contractor shall disclose the existence of all known methods for bypassing computer authentication contained in the product, often referred to as "backdoors," and provide written documentation that all such backdoors have been permanently deleted from the product **[CDRL 28-05]**

c). Access Control

i). The Contractor shall configure each component of the product to operate using the "Principle of Least Privilege" (POLP).

(1) This includes operating system permissions, file access, device access, device/user accounts, and communications/data transfer.

ii). The software shall deny access by default and allow access by specific permissions.

iii). The Contractor shall provide, for each system relying on a human interface device, user accounts with configurable access and permissions associated with one or more defined user role(s).

(1) The Contractor shall provide, for the subject systems, a mechanism for changing users' roles (e.g., group) or associations.

iv). The Contractor shall document options for defining access and security permissions, user accounts, and applications with associated roles. The Contractor shall configure these options, as specified by Amtrak. **[CDRL 28-06]**

v). The Contractor shall recommend methods for Amtrak to prevent unauthorized changes to the Basic Input/Output System (BIOS) and other firmware.

(1) If it is not technically feasible to protect the BIOS to reduce the risk of unauthorized changes, the Contractor shall document this and provide mitigation recommendations when complying with this requirement.

vi). The Contractor shall install physical barriers on any network equipment that hosts one or more Ethernet Ports so as to prevent Physical Access to the subject ports from unauthorized personal.

vii). The Contractor shall secure any equipment connected to any railcar network in cabinets that use tamper resistant locking hardware.

(1) This requirement excludes any equipment that will require a direct interaction with the operator during the operation of the Railcar (e.g. operator displays, communication system HMI).

viii). The Contractor shall verify and provide documentation for the product, attesting that unauthorized logging devices are not installed (e.g., key loggers, cameras, and microphones), as specified by Amtrak **[CDRL 28-07]**

ix). The Contractor shall deliver a product that enables Amtrak to configure its components to limit access to and from specific locations (e.g., security zones, business networks, and demilitarized zones [DMZs]) on the network to which the components are attached, where appropriate, and provide documentation of the product's configuration as delivered.

d). Authentication / Password Policy and Management

i). The Contractor shall document the levels, methods, and capabilities for authentication and authorization of passwords.

ii). The Contractor shall deliver a product that adheres to standard authentication protocols which conforms to Amtrak Authentication and Authorization standards.

iii). The Contractor shall propose an authentication method (e.g., password based, multi-factor, IP-based, Certificate based authentication) subject to review and approval by Amtrak for the following types of connections:

(1) Wired connections:

(a) Local connection: temporary Connection between external equipment and a railcar subsystem (e.g., Portable Test Equipment connected to a subsystem)

(b) Network connections between railcar subsystems and railcar networks

(c) Network connections between external equipment and railcar networks (e.g., Portable Test Units connected through Ethernet Diagnostic Port)

(2) Wireless connections – remote access

(a) Mechanisms for secure remote access shall be implemented to ensure that only authorized individuals can access the trainset remotely.

(b) Strong authentication methods, such as multi-factor authentication, shall be used to verify the identity of remote users.

(c) All remote access sessions shall be encrypted using industry-standard encryption algorithms and secure communication protocols that meet strong security and integrity requirements (e.g., FIPS compliant).

(d) Logging mechanisms shall be in place to record and monitor remote access activities for audit and forensic purposes.

iv). The Contractor shall protect all passwords, including, but not limited to the following methods:

(1) Contractor shall not store passwords in clear text

(2) Contractor shall not hardcode passwords into software or scripts

(3) All default passwords shall be changed in all components

(4) the use of blank/null password shall not be supported unless explicitly agreed upon by Amtrak for specific component types.

e). Logging and Auditing

i). The Contractor shall provide logging capabilities or the ability to support Amtrak's logging system requirements, including transmission to Amtrak's Cyber Fusion center relevant on-board logs associated with cybersecurity.

ii). Logging capabilities provided by the Contractor shall be configurable by Amtrak and support security auditing requirements. As specified by Amtrak, the product shall cover the following events, at a minimum (as appropriate to their function):

(1) Information requests and device responses

(2) Successful and unsuccessful authentication and access attempts

(3) Account changes

(4) Privileged uses

iii). The Contractor shall time-stamp audit trails and log files, as specified by Amtrak.

iv). The Contractor shall provide comprehensive security protection of log files.

v). The Contractor shall implement an approach for collecting and storing security log files on the railcar. The Contractor shall also implement an approach for transferring security log files from the railcar to the wayside.

vi). The Contractor shall provide a list of all log management activities that the product is capable of generating and the format of those logs. This list shall identify which of those logs are enabled by default **[CDRL 28-08]**

f). Cryptography and Encryption

i). Cryptography/Encryption: Encryption shall be used as a security control to maintain confidentiality, verify authenticity or integrity, and provide non-repudiation.

ii). The use of encryption shall consider all relevant aspects, including but not limited to:

(1) Key Management: Procedures and controls for key generation, distribution, storage, and revocation shall be implemented.

(2) Protection of Cryptographic Keys: Measures shall be taken to protect cryptographic keys from unauthorized access, loss, theft, or compromise.

(3) Recovery of Encrypted Information: Procedures shall be implemented to enable the recovery of encrypted information in the event of key loss or compromise. Processes for key recovery shall be established.

(4) Compliance with Industry Standards: Encryption algorithms and protocols employed must adhere to industry standards for strong security and integrity. Compliance with relevant standards, such as FIPS (Federal Information Processing Standards), shall be ensured to maintain the highest level of encryption security.

g). Communication Security & Restrictions

i). Robust security measures shall be implemented to protect data transmitted between the trainset's onboard systems and/or external entities. This requirement encompasses various avenues of communication including but not limited to network, wireless, satellite, cellular, and analog.

ii). The Security controls shall be implemented to include, but not be limited to, the following:

(1) Network Security

(a) A comprehensive network infrastructure shall be established, incorporating secure architectures and technologies such as firewalls, intrusion detection/prevention systems, secure gateways, and network segmentation.

(b) The network shall be continuously monitored to identify and address sensitive traffic.

(c) Access controls shall be enforced to prevent unauthorized network access.

(d) Encryption algorithms and secure communication protocols, compliant with industry standards for strong security and integrity (e.g., FIPS compliant), shall be employed for all networks utilized within the cars.

(2) Wireless Security

(a) Strong encryption algorithms and secure communication protocols, meeting industry standards for security and integrity (e.g., FIPS compliant), shall be employed for all wireless networks used within the cars.

(b) Wireless access points shall be securely configured, and regular firmware updates shall be performed to mitigate potential vulnerabilities.

(3) Satellite Security

(a) Encryption algorithms and secure communication protocols, compliant with industry standards for strong security and integrity (e.g., FIPS compliant), shall be implemented to safeguard data transmitted over satellite links.

(b) Physical security measures shall be established to protect satellite communication equipment, and regular patching and firmware updates shall be conducted to mitigate potential vulnerabilities.

(4) Cellular Security

(a) Robust encryption algorithms and secure communication protocols, meeting industry standards for security and integrity (e.g., FIPS compliant), shall be implemented to protect data transmitted over cellular communication.

(b) Cellular devices and modules shall be configured with secure settings, including the disabling of unnecessary services and features that may introduce vulnerabilities.

(c) Regular updates of firmware and security patches shall be applied to mitigate potential vulnerabilities.

(d) Access control mechanisms, such as strong authentication and SIM card security measures, shall be employed to prevent unauthorized use of cellular devices and/or SIM cards.

(5) Analog Security

(a) Measures shall be implemented to protect analog communication signals from unauthorized interception, interference, or disruption.

(b) This may involve the use of encryption devices attached to the analog communication line or frequency hopping techniques to change the frequency of the analog signal at regular intervals.

(c) Physical access to analog interfaces and communication equipment shall be controlled to prevent unauthorized tampering or connection of malicious devices.

(d) Physical transmission lines shall be protected against unauthorized tapping, tampering and signal interference.

(e) Analog communication ports and infrastructure (e.g., antennas, transceivers) shall be physically secured from unauthorized access, tampering and sabotage.

(f) Analog communication networks shall be segmented from other networks and isolated from digital networks.

(6) Network Segmentation

(a) A secure network architecture and segmentation strategy shall be implemented to isolate critical systems and components from less critical ones, preventing unauthorized access, limiting lateral movement within the E, and mitigating potential attacks.

(b) Secure communication channels shall be established between trainset components to protect sensitive data and ensure secure interaction between systems.

iii). The Contractor shall provide information on all communications (e.g., protocols) required between Amtrak's network security zones whether inbound or outbound and identify each **[CDRL 28-09]**

iv). The Contractor shall provide a method to restrict communications traffic between different network security zones.

v). The Contractor shall provide documentation on any method or equipment used to restrict communications traffic.

vi). The Contractor shall provide Amtrak with access, including administrative access as needed, to the network components of the product.

vii). The Contractor shall document all remote access entry pathways and ensure that they can be enabled or disabled by Amtrak. **[CDRL 28-10]**

viii). The list of IP addresses assigned to each subsystem on the fleet is subject to approval by Amtrak.

ix). Asset tags, resource ids, and cloud providers of cloud-hosted Amtrak digital assets shall be provided to Amtrak.

x). The Contractor shall provide a method for managing the network components of the product and changing configurations. (e.g., addressing schemes).

xi). The Contractor shall certify that all interfaces which implement administrative management capabilities of onboard devices are secure **[CDRL 28-11]**

h). Data Protection

i). Robust measures shall be implemented to protect sensitive data, including passenger information, maintenance records, and operational data.

ii). Encryption of data at rest and in transit shall be implemented, meeting industry standards for strong security and integrity (e.g., FIPS compliant).

iii). Backup and recovery capabilities shall be established to ensure data availability and resilience.

iv). Data loss prevention mechanisms shall be in place to safeguard against unauthorized access, disclosure, or alteration of data.

v). Secure data disposal processes shall be implemented to permanently remove sensitive data when it is no longer required.

vi). Compliance with data privacy laws, regulations, frameworks, and directives that are impactful to Amtrak shall be demonstrated.

vii). Databases used for the trainset shall undergo regular updates and patching to mitigate potential vulnerabilities.

i). Hardware Security

i). Comprehensive procedures and controls shall be implemented to address all aspects of hardware security.

ii). This includes secure hardware design practices that consider protection against tampering, unauthorized physical access, and theft.

iii). Critical hardware components shall be physically secured and access shall be restricted to authorized personnel only.

iv). A trusted supply chain shall be established to ensure the integrity and authenticity of hardware components.

v). Hardware integrity verification processes shall be implemented to validate the integrity of hardware prior to installation.

vi). Only authorized configurations and firmware/software versions shall be deployed on the trainset's hardware.

vii). Tamper-evident and/or tamper detection mechanisms shall be employed on critical hardware components to detect unauthorized modifications.

viii). Secure hardware lifecycle management practices, including the secure disposal of hardware, shall be established.

ix). Physical security measures shall be implemented to protect hardware from physical attacks and theft.

j). AI and Machine Learning (ML Security)

i). Safeguards shall be implemented to protect the integrity and security of data and underlying technologies used for AI and/or ML purposes. This includes, but is not limited to the following measures:

(1) Prevention of data poisoning attacks and other known AI and ML attacks.

(2) Establishment of data validation processes to detect and mitigate anomalies.

(3) Ensuring the use of accurate and relevant data for model training,

(4) Employing secure model development practices.

(5) Monitoring deployed models for deviations or performance concerns.

(6) Protecting sensitive data used for AI and ML purposes.

(7) Conducting regular security testing of learning models to identify vulnerabilities and ensure their resilience against attacks.

k). Bluetooth Security

i). The Contractor shall ensure the security of Bluetooth-enabled devices through the implementation of comprehensive procedures and controls, addressing the following aspects as required by Amtrak:

ii). Encryption: Industry-standard encryption algorithms and secure encryption modes shall be implemented (e.g., FIPS compliant) to protect data exchanged between Bluetooth-enabled devices. The encryption mechanisms shall provide strong security and integrity to safeguard the confidentiality and integrity of the transmitted data.

iii). Secure Authentication: Bluetooth devices shall implement secure authentication mechanisms to ensure that only authorized devices can connect and communicate. Robust authentication methods shall be employed to verify the identity and trustworthiness of connecting devices.

iv). Strong Pairing Methods: Devices shall use strong pairing methods to establish secure connections. These methods should employ cryptographic mechanisms to generate and exchange secure keys during the pairing process, ensuring the confidentiality and integrity of the communication.

v). Access Control: Bluetooth devices shall employ access control mechanisms to restrict connections to trusted devices only. Unauthorized or untrusted devices shall be prevented from establishing connections with the trainset's Bluetooth devices to mitigate the risk of unauthorized access.

vi). Updated Bluetooth Versions: Devices shall use the latest Bluetooth version supported by the devices, avoiding the use of older Bluetooth versions that may have known vulnerabilities or weaknesses.

vii). Limited Visibility: Devices shall be configured to limit their visibility and unnecessary Bluetooth services, or profiles, shall be disabled.

viii). Secure Firmware and Software Updates: Bluetooth devices shall have a mechanism to receive and install firmware and software updates. All security patches, bug fixes, and updates provided by the device manufacturers shall be applied

l). IoT (Internet of Things) Security

i). Robust procedures and controls shall be implemented to address the unique security challenges posed by IoT devices.

ii). These measures include the support for strong authentication mechanisms, such as unique credentials or cryptographic certificates, to ensure that only authorized entities can access and interact with IoT devices.

iii). Each IoT device shall have a unique identifier to maintain its integrity and prevent unauthorized device impersonation and tampering.

iv). Secure provisioning and configuration practices shall be followed, including changing or disabling default passwords.

v). Regular security updates and patches shall be applied to ensure ongoing protection of the devices.

vi). Additional physical security measures shall be implemented for devices deployed in public or vulnerable areas to mitigate the risk of theft or unauthorized removal.

28.3 Software and Firmware Vulnerability Mitigation

a). General

i). The Contractor must demonstrate that the software products that will be delivered as a part of this procurement do not constitute a security threat to Amtrak.

b). Secure Software Coding Practices

i). The Contractor and suppliers shall ensure, by integrating robust procedures and controls and specific software security activities into their Software Development Life Cycle(s) (e.g., see Secure Software Development Framework (SSDF) Version 1.1: Recommendations for Mitigating the Risk of Software Vulnerabilities, February, 2022), that security vulnerabilities are identified and removed prior to the delivery of the source code for the Independent Assessment of Software and Firmware Quality (see Section 28.3.e), Independent Assessment of Software and Firmware Quality).

(1) These activities shall be described in the Contractor and Supplier Software Project Management Plans. These activities are subject to audit during Software Quality Assurance Audits.

ii). Code reviews, static analysis, dynamic analysis, software composition analysis, secrets scanning, and other comprehensive application security testing techniques shall be employed to identify and remediate potential security issues.

(1) While application security testing engines may leverage basic rule engine configurations during development to streamline DevOps cycles, application security testing tools shall leverage comprehensive rule engine configurations prior to functional testing and production and resolve all moderate and higher level security findings unless otherwise agreed upon by Amtrak.

iii). Secure configuration management practices shall be implemented to maintain the security of software configurations and settings.

(1) Access to software repositories shall be secured to prevent unauthorized modifications or tampering.

(2) A secure software supply chain shall be established, ensuring that only third-party software that has undergone thorough vetting and testing is used.

(3) Code signing and integrity checks shall be employed to verify the authenticity and integrity of software components.

(4) Prompt response procedures shall be in place to address any identified security issues or vulnerabilities in the trainset's software, including timely patching and updates.

c). NIST Checklist(s)

i). Where applicable, all software included within this procurement shall be configured in alignment with the NIST National Checklist Program.

ii). This requirement will be applied to all software components where NIST National Checklists are applicable.

iii). The repository for NIST National Checklist can be found at https://nvd.nist.gov/ncp/repository. The Contractor and suppliers shall submit the identification of each system, each system SCI, and applicable NIST checklists (s) for Amtrak Review and approval prior to the first design review. **[CDRL 28-12]**

iv). The Contractor shall provide completed NIST checklists prior to the Final Design Review. **[CDRL 28-13]**

d). Date / Time Dependent Functions

i). For all source code that is subject to the Independent Assessment of Software and Firmware Quality (see Section 28.3.e), Independent Assessment of Software and Firmware Quality), the Contractor and suppliers shall confirm as part of IDR that the subject source code does not include date/time-dependent functions.

e). Independent Assessment of Software Security

i). The results of a current, independent, BSIMM and/or OWASP SAMM software security assessment shall be provided by the Contractor. **[CDRL 28-14]**

ii). The assessment shall evaluate the security controls, vulnerabilities, and overall security posture of the software systems implemented by the Contractor, including but not limited to, the following areas:

(1) Authentication and access control

(2) Data protection and encryption

(3) Secure coding practices

(4) Security testing and vulnerability management

(5) Incident response and recovery

(6) Security documentation and training

iii). If the results of a current, independent, BSIMM and/or OWASP SAMM software security assessment are unavailable for the Contractor, supplier, or any entity providing software, submit:

(1) The full vulnerability reports from application security scans (SAST, DAST, SCA, secrets scanning, etc.) and manual and/or penetration testing along with a detailed description of software security practices and any technology used for the purpose for Amtrak's evaluation. For any vulnerabilities detected during application security testing, an action plan shall be provided that discusses:

(a) Finding(s) (i.e., verbatim finding text)

(b) Impact Description (i.e., a textual description of the negative consequences to the Project if the practice(s) is not implemented by a process used on the Project)

(c) Project-Specific Action

(d) Responsible Individual

(e) Progress Completion Percentage

(f) Due Date

iv). The independent BSIMM and/or OWASP SAMM appraisal shall include the use of an industry recognized assessor (e.g., Synopsys, etc.).

f). Independent Assessment of Software and Firmware Quality

i). The Contractor shall procure an independent third-party assessment of the application security lifecycle for the following categories of software and firmware:

(1) Software specifically developed or modified for this project; this requirement applies to all software provided on this project.

(2) Software re-used for this project; this requirement applies to software-based subsystems functioning on operationally critical networks only.

ii). The subject security assessment and corresponding requirements specified in this Chapter shall be implemented as per the requirements of NIST SP 800-53,

iii). The assessment shall be performed by a qualified, independent organization.

iv). The Contractor shall provide the name of the independent assessment organization for Amtrak review and approval.

v). The Contractor shall ensure that the third-party software security and quality assurance provider shall check software and firmware to ensure that critical application security weaknesses (including SANS' Top 25 Most Dangerous Software Errors and OWASP's Top 10 as applicable) are addressed.

vi). The Contractor shall ensure that the third-party software security and quality assurance provider shall check software and firmware to ensure that the cybersecurity requirements of this contract have been met.

vii). The Contractor shall ensure that the third-party quality assurance provider performs the software security assessment using a range of security assessment testing techniques including Fuzz, Dynamic, and Static testing.

viii). The Contractor shall provide the third party's Software Security Assessment Plan for Amtrak's review and approval prior to performing the assessment **[CDRL 28-15]**

ix). The Contractor shall ensure that the results of any independent software and firmware quality assurance assessment are sent directly from the third-party provider to Amtrak and the Contractor **[CDRL 28-16]**

x). The Contractor shall provide a response to the third-party's assessment including plans to correct identified vulnerabilities. The Contractor's response and corrective action plan shall be sent to Amtrak for approval. **[CDRL 28-17]**

xi). This independent assessment of software and firmware quality (including the Contractor's response and Corrective Action Plan) is to be performed at any time of Amtrak's choosing, as follows:

xii). One assessment after delivery of the first set of cars, but before their conditional acceptance;

(1) One assessment prior to completion of conditional acceptance of all base order cars; and

(2) One assessment for each option exercised and additional quantities ordered

xiii). The Contractor shall be responsible for implementing corrective actions to address any vulnerabilities that are identified during an independent assessment of software and firmware quality that would prevent the final product from meeting the security requirements defined in this Chapter.

g). Independent Penetration Test

i). To demonstrate compliance with specified functional and cybersecurity requirements relating to this Contract, the Contractor shall procure an independent third-party penetration test and vulnerability assessment.

ii). The Contractor shall provide the name of the independent third-party penetration test provide for Amtrak review and approval

iii). The subject security assessment and corresponding requirements specified in this Chapter shall be implemented in accordance with NIST SP 800-115.

iv). This shall include tests both onboard the railcar, as well as tests on all services and software which interface with the railcar, and other services and software that are otherwise supplied to meet the Technical Specifications. Tests onboard the railcar shall include all vehicle components, including control systems, communication devices, diagnostic systems, onboard computers, sensors, and all other microprocessor or programmable devices.

v). This penetration test/vulnerability assessment shall be performed by a qualified, independent organization with a demonstrated history of performing independent penetration tests in similar passenger rail environments.

vi). The Contractor shall provide the name of the independent assessment organization. The independent third-party is subject to Amtrak's approval.

vii). The Contractor shall provide the independent third-party's test plan and associated procedures **[CDRL 28-18]**

viii). The penetration test/vulnerability assessment shall cover all products included in or incidental to this procurement, as described in the other Chapters of the Technical Specifications.

ix). The Contractor shall ensure that any and all results (including trip reports, draft reports, and final reports) of any independent penetration test/vulnerability assessment are sent directly from the third-party provider to Amtrak and the Contractor **[CDRL 28-19]** x). The Contractor shall provide Amtrak with a response to the third-party assessment, including a Corrective Action Plan to correct identified vulnerabilities subject to Amtrak's approval **[CDRL 28-20]**

xi). This independent penetration test/vulnerability assessment is to be performed at any time of Amtrak's choosing as follows:

(1) One assessment after delivery of the first set of cars, but before their conditional acceptance;

(2) One assessment prior to completion of conditional acceptance of all base order cars; and

(3) One assessment for each option exercised and additional quantities ordered

xii). The Contractor shall be responsible for implementing corrective actions to address any vulnerabilities that are identified during Independent Penetration Test that would prevent the final product from meeting the security requirements defined in this Chapter.

28.4 Software Security Lifecycle

a). General

i). The onboard microprocessor equipment which includes software must be designed and delivered with consideration to the evolving cybersecurity threats, regulations, and operational requirements of Amtrak.

ii). The objective of the following technical specifications is to ensure that the software and equipment supplied as a part of the technical specification provide are built on a robust, comprehensive and resilient security architecture that provides the necessary tools and safeguards necessary to protect against security incidents, protects sensitive information, and ensures compliance with legal and regulatory obligations throughout the equipment lifecycle.

b). Asset Management

i). Comprehensive procedures and controls shall be implemented for the appropriate and secure handling of assets throughout their lifecycle.

ii). This includes processing, storing, communicating, and removing assets.

iii). For assets that are no longer required and that contain sensitive information (e.g., device with personally identifiable information), specific procedures shall be implemented and followed to ensure the secure destruction of the asset and/or its sensitive contents.

iv). These procedures shall comply with applicable privacy laws, regulations, directives, and best practices to safeguard sensitive information and prevent unauthorized access or disclosure.

v). Proper documentation and records shall be maintained to track the status and disposition of assets throughout their lifecycle.

c). Incident Response and Management

i). The Contractor shall deploy comprehensive mechanisms and capabilities shall be implemented to support the effective management of security incidents and breaches.

ii). These measures include robust detection systems to identify security incidents, efficient reporting mechanisms to promptly notify relevant stakeholders, thorough investigation procedures to determine the nature and scope of incidents, and effective mitigation strategies to contain and remediate security breaches.

d). Operations Security

i). The Contractor shall implement procedures and controls to ensure the secure operation of the trainset.

ii). These measures include backup and recovery processes to ensure data and system availability in the event of disruptions or incidents.

iii). Robust malware protection mechanisms shall be deployed to safeguard against malicious software and unauthorized access.

iv). Endpoint security measures, such as secure configurations, regular patching, and secure remote access controls, shall be implemented to protect endpoints from security threats.

v). System monitoring capabilities shall be established to detect and respond to anomalies and potential security incidents.

e). Continuous Monitoring and Intrusion Detection

i). The Contractor shall provide a facility to perform continuous monitoring of network traffic to detect anomalies and potential security breaches.

ii). Intrusion detection and prevention systems, as well as security event logging, shall be implemented on all on-board networks incorporating communication between Software Configuration Items (SCIs) supplied by different vendors, as well as between all network security zones, to promptly identify and respond to security incidents.

iii). The monitoring infrastructure shall leverage advanced technologies and techniques to detect both known and emerging threats.

iv). Regular audits of the monitoring system shall be conducted to ensure its effectiveness throughout the warranty period.

v). The on-board monitoring, detection, and response systems shall be integrated with Amtrak's Cyber Fusion Center (CFC).

vi). In addition to Contractor-supplied on-board network logging and detection, provisions shall be provided for an on-board IDS solution selected by Amtrak.

(1) Provisions shall include power, space, software connections for Amtrak specified and supplied hardware.

(2) Connectivity shall be provided for each on-board network for passive monitoring of transmissions between devices.

(3) Connectivity to Amtrak's CFC shall be provided through the on-board Data Communication System identified in Chapter 14.

(4) The contractor shall provide the ability for the Amtrak to identify and configure specific network devices, network ports, and network traffic to be spanned and forwarded.

(a) Identification and configuration may be through direct configuration of the on-board equipment, or

(b) through an API provided by onboard network devices to the Amtrak on-board IDS solution.

vii). The Contractor shall submit its design for on-board monitoring and intrusion detection and provisions for an Amtrak on-board IDS solution for Amtrak review and approval **[CDRL 28-21]**

f). Compliance and Issue Reporting

i). Robust mechanisms shall be established to monitor and verifying compliance with security requirements outlined in this contract.

ii). These mechanisms shall also facilitate timely and effective notification and reporting of security incidents, vulnerabilities, and breaches to Amtrak. Regular audits and assessments shall be conducted to ensure adherence to security requirements and relevant laws, regulations, frameworks, and directives.

iii). Any security incidents or breaches shall be promptly reported to Amtrak, providing comprehensive details and remediation actions.

g). Business Continuity Management

i). Procedures and controls shall be implemented to enable the continuity of operation of the vehicle and its critical assets during adverse conditions.

ii). In situations where existing security controls may not be sufficient to secure information during adverse conditions, alternate controls shall be implemented to maintain an acceptable level of security coverage until optimal conditions are restored.

h). Software Updates and Maintenance

i). A comprehensive process for software/system updates, patching and maintenance shall be implemented to ensure the integrity and authenticity of updates installed on the vehicle components.

ii). The Contractor shall establish a robust system for verifying the source and integrity of updates before installation, including the use of digital signatures from authorized entities.

iii). This verification process shall guarantee that updates are legitimate and have not been tampered with, maintaining the overall security and reliability of the equipment and software supplied with this contract.

28.5 CDRLs

CDRL	Description	Due
CDRL 28-01	Listing of Contractor personnel involved in the trainset's development, maintenance, and operation who will be accountable for security-related decisions and actions	NTP+90
CDRL 28-02	List of the proposed products identifying the country of origin	NTP+90
CDRL 28-03	Documentation of disabled ports, connectors, and interfaces	30 days prior to PDR, on-going updates
CDRL 28-04	Summary documentation of the product's security features and security-focused instructions on maintenance, support, and reconfiguration of the product's default settings	30 days prior to PDR, on-going updates
CDRL 28-05	List of all known methods for bypassing computer authentication contained in the product and provide written documentation that all such backdoors have been permanently deleted from the product	30 days prior to PDR, on-going updates
CDRL 28-06	Document options for defining access and security permissions, user accounts, and applications with associated roles	30 days prior to PDR, on-going updates
CDRL 28-07	Provide documentation for the product, attesting that unauthorized logging devices are not installed	30 days prior to IDR
CDRL 28-08	List of all log management activities that the product is capable of generating and the format of those logs	30 days prior to PDR, on-going updates
CDRL 28-09	Information on all communications (e.g., protocols) required between Amtrak's network security zones whether inbound or outbound and identify each	30 days prior to PDR, on-going updates
CDRL 28-10	List of all remote access entry pathways and ensure that they can be enabled or disabled by Amtrak	30 days prior to PDR, on-going updates
CDRL 28-11	Certification that all interfaces which implement administrative management capabilities of onboard devices are secure	30 days prior to FDR, on-going updates

CDRL 28-12	Preliminary NIST checklist	30 days prior to PDR
CDRL 28-13	Final completed NIST checklists	30 days prior to FDR
CDRL 28-14	The results of a current, independent, BSIMM and/or OWASP SAMM software security assessment shall be provided by the Contractor.	30 days prior to FDR, on-going updates
CDRL 28-15	Software Security Assessment Plan	30 days prior to IDR, on-going updates
CDRL 28-16	Results of any independent software and firmware quality assurance assessment	30 days prior to FDR, on-going updates
CDRL 28-17	Contractor's response to the findings of the software and firmware quality assurance assessment	30 days prior to FDR, on-going updates
CDRL 28-18	Independent third-party's penetration test plan	30 days prior to FDR, on-going updates
CDRL 28-19	Results of the independent third-party's penetration test plan	30 days after
CDRL 28-20	Contractor's response to the findings of the independent third-party's penetration test plan	60 days after
CDRL 28-21	Design for on-board monitoring and intrusion detection and provisions	30 days prior to PDR, on-going updates

* End of Chapter 28 *

Amtrak Long Distance Bi-Level Fleet Replacement

Technical Specification

29. Accessibility

Revision 1

Table of Contents

29.1 Overview

a). This Chapter defines the minimum accessibility accommodations for the Long Distance Fleet Replacement Program and serves as an index or reference guide to specific chapters in the rest of this specification for more information.

b). This is not intended to be an all-encompassing or exhaustive list of regulations listed in the Law. Please refer to specific standards listed for complete information and requirements.

29.2 Regulations

a). Regulatory Agencies and the specifications listed below must be referenced for complete understanding of the accessibility requirements by law.

b). ADA

i). Vehicles must accommodate persons with disabilities in accordance with the requirements of the latest revisions of: the Americans with Disabilities Act (ADA) of 1990, the 2010 (or newer) ADA Accessible Guidelines (ADAAG), FTA Circular 4710.1, 36 CFR 1192, and 49 CFR 27, 37 and 38.

c). FRA

i). Vehicles must accommodate persons with disabilities in accordance with the requirements of the FTA Circular 4710.1, 36 CFR 1192, and 49 CFR 27, 37 and 38.

d). RVAAC

i). Amtrak desires to incorporate as much of the recommendations presented in the Final Report of the Rail Vehicles Access Advisory Committee (RVAAC) as is feasible.

ii). Within 60 calendar days of NTP, the Contractor shall provide a summary of the recommendations it will incorporate and those it finds to be not feasible. **[CDRL 29-01]**

29.3 Maintenance of Accessible Features

a). Accessible features outlined in this Chapter shall be properly maintained to minimize ‘down-time’ for replacement and/or repair as outlined in 49 CFR 37.161.

b). From the carbuilder’s perspective, this means that maintenance requirements shall be clearly outlined and agreed upon, repairs and fixes shall require minimal time to repair/replace, all special tools for repair/replacement of items are made readily available.

c). Damage or maintenance to one accessibility feature shall not require that other features are also unusable.

29.4 Accessibility - Mobility

a). Accessible Path

i). The clear width of an accessible path shall be incorporated according to the recommendations from RVAAC Chapter 4, III to the extent possible.

ii). The floor surface shall be incorporated according to the recommendations from RVAAC Chapter 5, VI to the extent possible.

iii). The floors along the accessible path shall be high contrast flooring to help blind or low vision individuals follow the path through the train.

iv). Thresholds along the accessible path at each staircase and passageway between train cars shall have tactile feedback built into the floor to alert a blind or low vision individual of the transition in floor type.

(1) The tactile feedback shall be raised such that the top of the ridge is level with the flooring surface though out the train.

(2) The indentation shall be lower than the flooring surface to provide ridged tactile feedback for canes.

b). Entrances

i). Boarding and alighting accommodations shall be incorporated according to the recommendations from RVAAC Chapter 3 to the extent possible.

(1) Features to eliminate the gap between the train and the steps when boarding shall be incorporated.

ii). Doors

(1) Doors, steps, and thresholds shall comply with 49 CFR 38.113 and 49 CFR 38.117 within the train. This includes doorways and passageway requirements for clear openings, slip resistant floorings, and clear contrast of all steps.

(2) Lighting for entrances and doors shall comply with 49 CFR 38.119.

(3) Doors shall be incorporated according to the recommendations from RVAAC Chapter 4, I to the extent possible.

(4) Doors and passageways along the accessible path shall be wide enough to accommodate powered wheelchairs.

(5) Specific doors requirements for this fleet can be found in Chapter 12.

iii). Lifts

(1) Vehicle lifts onto the train

(a) Vehicle lifts shall comply with 49 CFR 38.113 (d) and 38.125 for boarding the train from any station platform. The design load for this lift shall be at least 800 lbs. The controls shall be easily operated by a crew member and emergency operation mode is required.

(b) Lifts shall be incorporated according to the recommendations from RVAAC Chapter 3, IV to the extent possible.

(c) Specific lift requirements for this fleet can be found in Chapters 6 and 11.

(2) Vehicle lifts to different levels of the train

(a) Vehicle lifts or elevators internal to the train shall be large enough to accommodate all of the following configurations of passengers and devices: powered wheelchair, manual wheelchair, passenger traveling with a service animal, passenger with an aide.

(b) In the case of an emergency, a simplified process must be implemented to ensure that a passenger can be safely and effectively extricated from the vertical lift.

(c) The emergency removal process may include the removal of walls and/or surrounding structure; however, this process needs to be designed into the surrounding area of the vertical lifts during the Design Review process.

(d) Further details on emergency requirements are provided in Chapters 6 and 11.

c). Grab Handles

i). All passageways, entryways and doors shall be equipped with appropriate handrails or stanchions. Handrails and stanchions shall comply with 49 CFR 38.115.

ii). Handrails and Stanchions path shall be incorporated according to the recommendations from RVAAC Chapter 4, VI to the extent possible.

iii). Specific handrail requirements for this fleet can be found in Chapters 6 and 11.

d). Intercar Gangways

i). Between car barriers shall be provided at a minimum according to the recommendations from RVAAC Chapter 3, V to the extent possible.

ii). Vertical grab handles shall be provided for ease of access for all passengers.

e). Emergency

i). At least one evacuation chair shall be provided in each of the food service car types.

ii). Egress plans for passengers who have mobility and visual impairments shall be presented by the Contractor for Amtrak alignment and approval during the design review process.

f). Elevators

i). Elevators shall be incorporated according to the recommendations from RVAAC Section 7 and Appendix D, to the best extent possible.

g). Service Animal Spaces

i). At least one service animal space per seating area shall be incorporated according to the recommendations from RVAAC Chapter 4, IX to the extent possible.

h). Sleeper Cabins

i). Sleeping

(1) Accessible sleeping compartments shall be provided and equipped with all amenities listed in 49 CFR 38.127. This includes sleeping location, restroom, and controls for passenger comfort.

(2) Accessible sleeping areas within the sleeper car shall be incorporated according to the recommendations from RVAAC Chapter 5, III to the extent possible.

(3) Note that all visual and auditory recommendations from RVAAC emphasized in 25.5 and 25.6 of this specification shall be incorporated in both coach and sleeper cabins.

(4) Specific Equity sleeper room requirements for this fleet can be found in Chapter 11.

(5) Securement locations for oxygen, CPAP machines, small coolers for medications, and other medical equipment shall be provided in each sleeper cabin.

i). Coach

i). Seating

(1) Accessible seating, transfer seats, wheeled mobility device or mobility aid seating, and storage locations for mobility devices shall be provided in compliance with 49 CFR 38.125 (d).

(2) Wheeled mobility device and mobility Aid Seating Locations shall be incorporated according to the recommendations from RVAAC Chapter

4, IV to the extent possible including clear space, number of seats and locations, and securement. Additionally, transfer seats shall be incorporated according to the recommendations from RVAAC Chapter 4, V to the extent possible.

(3) Seats shall be reconfigurable to account for a group of up to 12 passengers using wheeled mobility devices. This shall be incorporated according to the recommendations from RVAAC Appendix B, 2, to the extent possible.

(4) Accessible seating locations shall be provided near but not necessarily adjacent to accessible restrooms. Passengers requiring accessible seating locations shall not be forced to always sit adjacent to restrooms as this provides an inequity for passengers to be subjected to restroom noises and smells.

(5) Accessible seating shall be arranged such that two passengers using wheeled mobility devices can sit across the aisle from each other in at least one location in coach.

(6) Accessible seating shall be arranged such that two passengers, one using a wheeled mobility device and the other not using a device, can sit next to each other in at least one location in coach.

(7) Accessible seating shall be arranged such that a wheeled mobility device user can select to sit on either the right or left side of the train based on lateral dominant strength of the passenger.

(8) Specific seating requirements for this fleet can be found in Chapter 11.

ii). Tables

(1) Adjustable height workstation tables shall be provided in all accessible seating locations throughout the trainset. The adjustable height workstation tables shall range from 27" to 34" and should be presented to Amtrak during PDR.

j). Access to Amenities

i). Standards

(1) General outlines and information regarding access to amenities within the train are outlined in applicable sections of 49CFR 38.111.

(2) In general, all controls for passenger comfort shall be provided in an accessible manner according to the recommendations from RVAAC Chapter 5, V to the extent possible. This includes all manner of controls, control locations, buttons, and door opening.

ii). Restrooms

(1) Accessible restrooms shall be provided and equipped with all amenities listed in 49 CFR 38.123. This includes space for

maneuvering and turning, height of all amenities from the floor, required grab bars, controls, doorways, and proximity to seating accommodations.

(2) Restroom locations shall follow the quantity and location recommendations from RVAAC Chapter 4, VIII and Chapter 5, I, to the extent possible.

(3) Specific ATR requirements for this fleet can be found in Chapters 11 and 17.

iii). Café

(1) The Café shall be located along the accessible path of the train.

(2) The Café shall have an ADA service counter that is between 32” and 34” tall.

(3) The grab-and-go display case shall be accessible to passengers using wheeled mobility devices.

(4) The area adjacent to the ADA service counter shall have a wheelchair turnaround circle for passengers using wheeled mobility devices to turn around and travel back to their seating location in the train.

iv). Dining

(1) Accessible dining areas within the dining car shall be incorporated according to the recommendations from RVAAC Chapter 5, II to the extent possible.

v). Lounge

(1) Accessible seating areas within the lounge car shall be incorporated according to the recommendations from RVAAC Chapter 5, IV to the extent possible.

vi). Miscellaneous

(1) Designs shall incorporate accommodations and provisions for passengers of all sizes including larger passengers to fit in tight spaces such as restroom compartments, showers, aisles, etc.

29.5 Accessibility - Visual

a). Signage

i). Standards

(1) Symbols, Signs, and Videos shall be incorporated according to the recommendations from RVAAC Chapter 2, IX, X, and XI to the extent possible.

(2) Specific signage requirements for this fleet can be found in Chapter 11.

ii). Accessible Entrance

(1) All locations equipped with accessible entrances onto the train shall be marked and indicated according to 49 CFR 38.113 (e).

b). Braille

i). Contractor shall provide clear and accessible information to the visually impaired passengers through the implementation of Braille signage.

ii). Contractor shall utilize Grade 1 Braille for simplicity and ease of comprehension.

(1) Braille characters shall be raised at a height of 0.6mm to 1.5mm

(2) Dot diameter shall be 1.5mm to 1.6mm

(3) Character spacing shall be 2.5mm to 3.5mm horizontally while 6.0mm to 7.0mm vertically.

(4) Ensure rounded corners to prevent snagging.

iii). Contractor shall incorporate tactile pictograms alongside Braille for enhanced comprehension, where practical.

(1) Pictograms shall be raised and have clear, tactile distinction from Braille characters.

iv). Contractor shall utilize high-contrast colors between Braille dots and the signage background.

v). Contractor shall work with Amtrak and/or local community organizations with proofreading all Braille signage prior to implementation on any vehicle.

vi). All proposed Braille signage shall be submitted during IDR for Interiors **[CDRL 29-02]**

(1) All proposed Braille signage shall be included on all hard mockups for stakeholder review and approval.

c). Lighting

i). In addition to the lighting requirements for entrances listed in 49 CFR 38.119, lighting of other areas in the vehicle shall be considered. Lighting shall be incorporated according to the recommendations from RVAAC Chapter 2, V to the extent possible.

ii). Lighting shall be capable of being adjusted to less than 3000K in sleeper cabins and in coach reading lights.

iii). Specific lighting requirements for this fleet can be found in Chapter 13.

d). Warning Alerts and Communications

i). Standards

(1) Visual warning, alerts, and public information shall be announced with a public information system that complies with 49 CFR 38.121.

ii). Route information

(1) Variable Message Signs (VMS) shall be incorporated according to the recommendations from RVAAC Chapter 2, II and VIII to the extent possible.

iii). Emergency Alerting

(1) Visual indication of emergency notification announcements shall be incorporated according to the recommendations from RVAAC Chapter 2, VI to the extent possible.

(2) Specific information system requirements for this fleet can be found in Chapter 14.

iv). Call Buttons

(1) Visual indication that a call button has been depressed and the alert signal has been sent shall be incorporated according to the recommendations from RVAAC Chapter 2, VII to the extent possible.

29.6 Accessibility - Audio

a). Hearing Assistive Technology

i). Trainset shall incorporate the latest innovative technology for hearing assistive technology (inductive hearing loops, Bluetooth, etc.) as of Preliminary Design Review.

ii). Hearing assistive technology shall be incorporated according to the recommendations from RVAAC Chapter 2, IV to the extent possible.

b). Warning Alerts and Communications

i). Audible warning, alerts, and public information shall be announced with a public information system that complies with 49 CFR 38.121.

(1) Route Information

(2) Audible announcements shall be incorporated according to the recommendations from RVAAC Chapter 2, III and VIII to the extent possible.

(3) Emergency Alerting

(4) Audible indication of emergency notification announcements shall be incorporated according to the recommendations from RVAAC Chapter 2, VI to the extent possible.

ii). Voice to text translation from the PA system to alert on personal devices shall be incorporated.

iii). Specific information system requirements for this fleet can be found in Chapter 14.

c). Call Buttons

i). Audible indication that a call button has been depressed and the alert signal has been sent shall be incorporated according to the recommendations from RVAAC Chapter 2, VII to the extent possible.

ii). More details on call button requirements can be found in Chapters 11 and 14.

29.7 CDRLs

CDRL	**Description**	**Due**
CDRL 29-01	RVAAC Compliance Summary	NTP + 60 days
CDRL 29-02	Braille signage package	30 days prior to IDR

* End of Chapter 29 *