PERFORMANCE SPECIFICATION
110 mph-Capable Coaches and Business Class/Food Service Cars

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SECTION 1

1 GENERAL REQUIREMENTS

1.1 Scope

This Performance Specification establishes the general design parameters for the procurement of locomotive hauled, push-pull, intercity rail cars for IDOT or its designee. The Department will accept a variety of car types (single-deck, individual cars; double-deck, individual cars; articulated trainsets, etc.) so long as the capacity of the cars/trainset meets the IDOT's requirements. A car/trainset train shall have an overall length of no more than 340 feet over pulling faces; independent of a locomotive or locomotives and shall provide at least 260 coach-class seats, 27 business class seats and 18 seats at tables in a food service area. The stated maximum length and capacity is equal to that of four 85-cars.

The cars or trainsets supplied shall be configured as cab cars and trailer cars. For all parts and components, designs which have a documented satisfactory operating history, as defined in Section 2 shall be provided. The Contractor shall provide equipment which is proven in equivalent or more severe climatic and operating environments. Systems and equipment with limited rail transit service experience will be given consideration by IDOT or its representative, at IDOT's discretion, only if accompanied by timely presentations containing sufficient information for IDOT or its representative to weigh the merits of the design.

Any car or trainset design proposed for consideration for the IDOT application shall be FRA-authorized for sustained 110 mph operation. If the vehicle/trainset has not previously been authorized by the FRA for this maximum operating speed, the Contractor shall submit a test program as part of its proposal which includes all the necessary tests and demonstration runs required to obtain this authorization and perform all testing necessary for such certification. The Contractor's test/demonstration program shall obtain this authorization without excessive delay in the receipt of the cars for revenue service. It is IDOT's intent to place these cars in service as early as possible.

The Contractor shall provide a production schedule to expedite delivery. Right of way and signal work (by others) is scheduled to be in place to allow 110 mph passenger train operation to occur on a portion of the Chicago-St. Louis "Lincoln Service" corridor by first quarter 2012.

The 110-mph capable cars are being bought principally for service on the IDOT-Amtrak "Lincoln Service" corridor – a 284-mile line between Chicago and St. Louis. Portions of this line are being upgraded (by others) to be suitable for sustained 110 mph passenger train operation. The section of line to be so upgraded extends between Joliet and Alton, IL. While not all trains make all stops on this 225-mile line section, the cars/trainsets shall be designed to operate successfully and reliably on services making all stops. There are six intermediate stops on this 225-mile section, so the average spacing between stations is approximately 37 miles.

However, the new cars/trainsets may also be used on other IDOT-Amtrak routes within the State of Illinois and extending into neighboring states. When used in these services, the cars/trainsets may run at maximum speeds less than 95 mph. The cars/trainsets shall be suitable for these services and there shall be no deleterious effect on maintenance requirements from operation at lower-speed services, including those where the stopping pattern may be more frequent.

The requirements and conditions in these Performance Specifications for the IDOT vehicles are intended to represent the "minimum acceptable" conditions for the design, manufacture, test and operation of the vehicles and its systems. IDOT or its representative will entertain the use of other proven designs, methods and standards to be used to meet the intent of the Specification provided the alternative that is proposed can be shown to have successful, documented, service proven history. IDOT is under no obligation to accept any of these alternative designs and shall not be responsible for any expenses incurred as a result of the Contractor's efforts to gain approval of an alternative design.

The vehicles specified herein shall be required to be safe, reliable, maintainable and available, as defined in Section 2. As indicated above, it is essential that service-proven hardware is incorporated into vehicle design.

The Contractor shall provide each manufacturer/subcontractor of major items of equipment; for example: brakes, air conditioning, heating and cooling controls, door operators and controls, seats, trucks, couplers, lighting, with a complete copy of the Technical Specification. Cross-referencing between sections of this Specification is provided for convenience only and may not be all inclusive. The Contractor shall be responsible for meeting all of the requirements of the Specification whether or not provided by a cross-reference.

The Contractor shall design and construct the vehicles to accommodate passengers and Operators that range in size from the 5th percentile female to the 95th percentile male.

1.2 Quantity of Cars and Options

The base order of cars to be provided under this procurement shall be (data below is representative of individual nominal 85-foot single-level cars; for other car types/trainset configurations, an equivalent minimum capacity of 260 coach seats, 27 business class seats and 18 table-seats with food service shall be provided in the format of twelve trainsets):

- Cab Cars – 15 cars, having a total coach capacity of at least 1080 seated passengers (72 seats minimum per Cab Car).
- Coaches – 18 cars, with a total coach capacity of at least 1440 seated passengers (80 seats minimum per Coach).
- Business Class/Food Service Cars – 15 cars with a total business class capacity of at least 405 seated passengers – 27 seats in Business Class, minimum. In addition, these cars shall provide 17 seats minimum with 18 table-seats in the lounge area per BC/FS Car (the table-area seats are not considered as revenue seats). Each BC/FS car shall also include a lockable crew compartment with four facing seats and a work table between the seats.

Optional quantities for each type/configuration of car or trainset may be identified by IDOT or its designee. These options may be identical to the cars specified in the IDOT base order, or there may be differences in the equipping or other aspects of the optional cars. For the purposes of this proposal, the Proposal Form includes one option for an additional 8 cars of each of the three car types (or equivalent capacity in additional trainsets) configured and equipped identical to the base order.

1.3 Definitions

When the following terms are used in these Specifications, the intent and meaning shall be interpreted as follows:

A-End of Car: Defined as the end of the car opposite from the B-end of the car, also designated as F-end of cab car.

AAR Standards: Means the latest issue, as of Contract Award Date, of the Association of American Railroads *"Manuals of Standards and Recommended Practices".*

Addendum, Addenda: Written interpretation(s) of, or revision(s) to, any of the Contract Documents issued by IDOT or its designee before proposal opening.

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

Alteration: A change or substitution in the form, character, or detail of the work done or to be done within the original scope of the Contract.

AMTRAK: Refers to the National Railroad Passenger Corporation.

Analysis: Written report of the systematic examination of parts, components, and systems against Contract and Technical Specification requirements.

Approval: Review and acceptance, in writing, by IDOT or its representative. IDOT approval in no way relieves the Contractor of meeting all requirements of the Specification.

Approved or Approved Type: Design, type of material, procedure, or method given approval by IDOT or its representative.

Approved Drawings: Shall mean those final drawings issued by the Contractor, executed in accordance with the requirements of these specifications, and showing the Work as actually constructed. The review and concurrence granted by the Engineer does not relieve the Contractor from any and all contractual obligations and responsibilities under this Contract.

APTA: The latest issue as of Contract Award Date, of the APTA Standards as provided in the APTA PRESS Manual of Standards and Recommended Practices for Rail Passenger Equipment.

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

Baseline Design: The design of the vehicles or any of its components, apparatus, systems, subsystems, or materials which has received both drawing approval and first article approval by IDOT or its representative.

B-End of Car: The end of the car where the hand brake is located, the end opposite the A-end or F-end.

Buff: Compression, as occurs during coupling.

Burn-In: A 400 mile, trouble-free, operational test conducted by IDOT or its designee after all other tests are successfully completed.

Calculations: Numerical computations performed to demonstrate compliance with the Specifications.

Calibration: Comparing a response of a measuring device of unknown accuracy against one of known. It is performed to detect and eliminate, by adjustment, any variation in accuracy of the unknown measuring device.

Car: (or Vehicle) refers to a single 4-axle unit or an articulated set of equivalent capacity to and having the same amenities as four, coupled cars.

Carbuilder: see Contractor.

Car History Book: A document specific to an individual car containing records of technical and parts data pertinent to that individual car.

Change Order: An order executed by IDOT or its designee and issued to the Contractor amending the Contract Documents. The Change Order establishes the basis for payment and program adjustments, if any, of the work affected by the changes. The Change Order becomes a part of the Contract when executed by the Contractor and IDOT or its designee.

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

Commissioning: Pre-acceptance Contractor activities involved in delivering, adjusting, and testing the cars to demonstrate compliance with Specification requirements.

Conformed Specification: These Specifications as revised to include and reflect all changes made by Addenda, by Change Orders or approved by the Engineer during design or construction.

Contract: The written agreement executed between IDOT or its designee, Party of the First Part, and the Contractor, Party of the Second Part, setting forth the obligations of the Parties thereunder, as modified by all executed Change Orders to the Contract Documents issued subsequent to the original execution of the Contract.

Contract Amendment: See "Change Order".

Contract Award Date: The date on which the Contract between IDOT or its designee and the Contractor has been signed for the construction of the cars described by these Specifications.

Contract Data Requirements List (CDRL): Each and every item to be delivered by the Contractor to IDOT or its representative under this Contract.

Contract Documents or Contract: The Contract Documents include the Contract; Technical Specifications including Addenda; Contract Drawings; Change Orders; Instructions to Proposers Special Provisions; Performance Bond; Non-Collusion Affidavit -- all of which constitute one instrument.

Contract Drawings: An initial set of drawings showing the general Base Consist layout and arrangement provided by IDOT or its representative as part of the Contract Documents.

Contracting Officer: Director of IDOT, or designated representative, responsible for executing the contract and all Change Orders on behalf of IDOT or its designee.

Contracting Officer's Technical Representative: A designated representative of IDOT, responsible for technical issues on behalf of IDOT.

Contractor: The person or persons, firm, partnership, corporation, or combination thereof which has entered into a contract with IDOT or its designee to meet all of the requirements of the Contract.

Contractor's Drawings: Items such as general arrangement drawings, detail drawings, graphs, diagrams, and sketches which are prepared by the Contractor to detail its work.

Days: Unless otherwise designated, days as used in the Contract Documents shall be understood to mean calendar days.

Days, Working: Days during which regular business is conducted, excluding Saturdays and Sundays and all IDOT-observed Federal, State, and municipal holidays.

Delivery, Delivered: The transfer of the completed vehicle (with all in-plant testing completed and results accepted by IDOT or its designee) to IDOT or Host Railroad property, ready for commissioning and acceptance testing.

Defect: A defect shall be interpreted as any malfunction, wear, or damage (excluding normal wear and tear or consumable part failure) which results in the vehicle:

a. Being removed from revenue service.

b. Requiring a maintenance call during revenue service for a malfunction, wear, or damage.

c. Logged by the crew during revenue service.

d. Found during routine maintenance.

Dependent Failure: The failure of a component, subsystem, or system induced by the failure of another component, subsystem, or system.

Derating: Using an item in such a way that the required performance is below the manufacturer's rated value.

Designee: Another operating entity as may be determined by IDOT to have operations and maintenance responsibility for the cars/trainsets procured under this contract.

Engineer: The Engineer shall be that person or persons, firm, partnership, corporation, or combination thereof, designated by IDOT or its designee to act on its behalf in those areas specifically identified in the letter of delegation of authority.

Equal: Whenever the words "equal" or "approved equal" are used in connection with make or quality of material or equipment in these Contract Documents, the Engineer's decision as to whether any material or equipment proposed is equal to that specified shall be binding and final on both the Contractor and IDOT or its designee.

Equipment: Refers to the rolling stock to be provided by the Contractor in accordance with the Contract documents.

Evaluation: An appraisal to determine whether or not production and quality control systems are capable of producing a quality product or service, and generating evidence that support decisions of acceptability.

Fail-Safe: A characteristic of a system which insures that any malfunction affecting safety shall cause the system to revert to a state that is known to be safe.

Failure: An improper condition which requires unscheduled equipment maintenance or replacement to restore affected equipment to its normal operating condition.

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

F-End: The end of the cab car where the control cab is located. Also known as front end of the cab car or the A-end.

First Article: The first one of any production component of the prototype vehicle that is produced. The Specification provides that nothing be manufactured prior to approval, so the First Article shall have been made to approved drawings.

First Article Approval: The examination of and approval by the Contractor of an initial production part, major assembly, subassembly, system, subsystem, apparatus, or material, manufactured or assembled by a subcontractor. IDOT or its representative shall have the right to witness these examinations/approvals.

First Article Inspection (FAI): An inspection of a First Article, conducted by the Contractor. IDOT or its representative shall have the right to witness these inspections. The First Article Inspection is usually the first point at which maintainability of the component can be evaluated, inasmuch as it is the first point at which relationships between elements can be appreciated. IDOT or its representative shall have the right to approve the design that is revealed at the First Article Inspection, or may require changes in order that the component can meet the requirements of the Contract. The FAI also establishes the quality level of workmanship that shall be maintained for the balance of the components. IDOT or its representative shall have the right to approve or reject the level of workmanship as displayed at the FAI.

Host Railroad: The railroad which owns, maintains and dispatches a given rail corridor on which the IDOT-procured cars may operate.

IDOT: The Illinois Department of Transportation

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

Indicated: As used in these Contract Documents, "Indicated" shall be understood to mean, "as shown on the Contract Drawings", or "as described in the Contract Documents".

Inherent: Fundamentally present in the design.

Inspection: The careful examination, measurement, and testing of the characteristics of materials and services to ensure conformance with contract requirements.

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

Inspector: The person(s) or firm designated by IDOT or by the Engineer as its quality assurance representative.

Interface: The points where two or more systems, subsystems or structures meet, transfer energy, or transfer formation.

Jerk Rate: Time rate of change of acceleration and deceleration, equal to the second time derivative of velocity.

Jumper: A short piece of wire or cable with appropriate terminations on each end to permit connection to terminals within a terminal board or to an adjacent terminal strip. Also, a single or multi-conductor cable used to carry current or trainline signals between coupled cars and/or locomotives.

Left Hand Side: The side of the car on the left, when standing inside the car and facing the A-end.

Lowest Level Replaceable Unit (LLRU): Unit (component) or subsystem which is normally replaced at the Service and Inspection Facility (S&I).

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

Manufacturer: The original builder or producer supplying materials, equipment, or apparatus for installation on the vehicle.

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

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

Mean Time Between Failures (MTBF): The mean operating time between independent failures.

Mileage, Operating: The total distance traveled by the car during scheduled and un-scheduled movements over established routes as recorded by IDOT or its designee.

No-Motion: A referenced state of vehicle velocity of 3 mph or less.

Notice: A written announcement.

Objective Evidence: Any recorded results of measurements, tests, or observations which, provide facts pertaining to the quality of the work which, can be verified.

Owner: IDOT or its designee

Party, Parties: Entity (ies) entering into the Contract.

Population: The number of similar things forming a specified group.

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

Project Manager: Person designated by IDOT or its designee to be its liaison with the Contractor on all matters pertaining to the work. The Project Manager is empowered to act on behalf of IDOT in such matters as approval of Contractor's drawings, test procedures and vehicle acceptance and contractual issues.

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

Redundancy: The existence of more than one means for accomplishing a given function; such means are not necessarily identical.

Reliability: The probability of performing a specified function without failure and within design parameters for the period of time specified under actual operating conditions.

Repair: Implies that the nonconforming product shall meet the Contract requirements once repaired by means of a repair procedure approved by the Engineer prior to commencing the repair.

Representative: A person or group of persons employed by a professional firm and under contract to IDOT for the purposes of providing technical oversight and assistance on the rolling stock procured under this or other contracts.

Rework: Restoring nonconforming material to meet Contract requirements.

Right Hand Side*:* The side of the car on the right, when standing inside the car looking towards the A-end.

Safe: The condition in which passengers, crew, or repair personnel are secure from threat or danger, harm, or loss arising from improper design, manufacture, assembly, malfunction, or failure of the vehicles or any of its components or systems.

Service, as in Service Use, Service Braking: The operation of the vehicles under normal conditions with passengers.

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

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

Shipment: The physical departure of the car from the Contractor's facility to IDOT or its designee.

Slide, Wheel: During braking, the condition existing when the rotational speed of the wheel is less than that for pure rolling contact between the wheel tread and the rail.

Special Tools: Tools which are not commonly available for purchase "off-the-shelf". A common, off-the-shelf tool becomes a special tool when it is altered in any way to make it more suitable for any specific use.

Speed, Balancing: The steady-state speed attained by a vehicle or train when resisting forces exactly equal the maximum available tractive forces on level tangent track.

Speed, Design: The anticipated maximum possible operating speed of the car. The design speed for this program is 110 mph. The car and its components shall be suitable for safe, sustained operation at this speed.

Speed, Schedule: The average speed of a vehicle or train from terminal to terminal obtained by dividing the distance between these points by the time taken to make the trip, including time for intermediate station stops.

Spin, Wheel: During acceleration, the condition existing when the rotational speed of the wheel is greater than that for pure rolling contact between the wheel tread and the rail.

Standards and Specifications: When industry, government, association, or society standards, or specifications are referred to, the applicable issue at the time of Contract signing shall be used.

State: State of Illinois. IDOT may designate adjacent states to be a part of this definition as this program advances.

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

Stop, Service: The stopping of a vehicle or train by application of service braking. Brake application can be released and reapplied.

Subcontractor: An individual, firm, partnership, corporation, or joint venture to whom the Contractor sublets any part, subsystem, component or hardware services and other work for the Contract.

Subsystem: Generally a defined portion of car equipment e.g. "*Specification Section 9 - Brake Equipment*".

Supplier: Person, firm, partnership, corporation of combination thereof who builds, produces or supplies materials equipment or apparatus for installation on the vehicles.

Tamperproof: Fasteners are designated as tamperproof when they are selected so that they cannot be easily loosened with common tools such as a flat blade or Philips screwdriver or pliers.

Technical Specifications, Specifications or specifications: Portion of the Contract Documents that detail the technical requirements for the supply of rail vehicles and associated equipment, including any changes or addenda made.

Tight (used as a suffix): Apparatus is designated as watertight, dust-tight, etc., when so constructed that the enclosing case will exclude the specified material.

Time, Build-up: Time interval from the beginning of change of a controlled variable (defined as being at 10% of the new steady state value) in response to a step-forcing function to the attainment of 90% of the new steady state value of the controlled variable.

Time Constant: Time interval from the beginning of change of a controlled variable in response to a step-forcing function to the attainment of a stated value.

Time, Dead (also, Time, Reaction): Time from the occurrence of a step change of the control signal to the beginning of a change of the controlled variable defined as being to the attainment of 10% of the new steady-state value of the controlled variable.

Time, Down: The elapsed time during which equipment is not capable of doing useful work because of maladjustment, malfunction, or maintenance in progress.

Time, Response: Time interval from the occurrence of a step change of control signal to the attainment of 90% of the new steady-state value of the controlled variable, equal to the sum of dead time and build-up time.

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

Trainset: This may be a four-car, coupled consist of individual cars, or it may be an articulated car set, which provides the same capacity and amenities as the four coupled cars exclusive of a locomotive(s).

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

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

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

Whenever in the Specifications or on the Plans the words “required", "determined", "directed", "specified", authorized", "ordered", "given", "designated", "indicated", "considered necessary", "deemed necessary", "permitted", "reserved", "suspended", "established", "approval", "approved", "disapproved", "acceptable", "unacceptable", "suitable", "accepted", "satisfactory", "unsatisfactory", "sufficient", "insufficient", "rejected", "condemned", or words of like importance are used, it is understood as if such words were followed by the words, in writing, "by the Engineer", "to the Engineer", unless otherwise specifically stated.

Vehicle: Same as car.

Vital Circuit: Any circuit and its elements, the function of which affects the safety of train operations.

Weight, Actual: The measured weight of a finished empty vehicle, ready for passenger carrying service, and with all fluid levels filled to the top.

Weights, Assigned: The loaded vehicle categories assigned by IDOT as the basis for structural design, traction system design, and for subsystem and vehicle testing as indicated.

Four weight categories are assigned:

AW0 Empty vehicle ready to run

AW1 Vehicle (coach) with full seated load

AW2 Vehicle (coach) with full seated load and a standee load equal to 50% seated passengers

AW3 Vehicle (coach) with full seated load and a crush standee load equal to 100% seated passengers

Wherever the words "provided", "supplied" or "installed" are used in the Specifications in reference to work to be performed by the Contractor, it is understood to mean "furnished and delivered completed".

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

1.4 Abbreviations

The following is a list of abbreviations used in the Specification. The list is not intended to be all inclusive.

A	Amperes
AAR	Association of American Railroads
AATCC	American Association of Textile Chemists and Colorists
ac	Alternating Current
ADA	Americans with Disabilities Act of 1990
AFBMA	Anti-Friction Bearing Manufacturer's Association
AFI	Air Filter Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving & Conditioning Association
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
APS	Auxiliary ac Power Supply
APTA	American Public Transportation Association
AREMA	American Railway Engineering and Maintenance of Way Association
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASC	Air Spring Cutout
ASCII	American Standard Code for Information Interchange
ASIC	Application Specific Integrated Circuit
ASM	American Society for Metals
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association of America
AVI	Automatic Vehicle Identification
AWG	American Wire Gauge
AWS	American Welding Society
AW0	Empty Vehicle Ready-to-Run Weight

AW1	Vehicle with Full Seated Load
AW2	Vehicle with Full Seated Load and a Standee equal to 50% seated passengers
AW3	Vehicle with Full Seated Load and a Crush Standee Load equal to 100% seated passengers
BTL	Battery Trainline
Btu	British Thermal Unit
BC/FS	Business Class/Food Service Car
° C	Degrees Centigrade
C	Capacitance
CAD	Computer Aided Design
CBM	Certified Ballast Manufacturer's Association
CGHAZ	Coarse Grain Heat Affected Zone
CDA	Copper Development Association
CDR	Critical Design Review
CFC	Chlorofluorocarbon
cfm	Cubic Feet per Minute
CFR	Code of Federal Regulations
COTS	Commercial Off the Shelf
COT&S	Clean, Oil, Test & Stencil
CPM	Critical Path Method
CRF	Critical Radiant Flux
CSA	Canadian Standards Association
dB	Decibel
dBA	Decibel, A Scale Reading
DB	Dry Bulb
DBU	Disc Brake Unit
dc	Direct Current
Ds	Specific Optical Density
DTE	Diagnostic Test Equipment
DTMF	Dual-Tone Multi-Frequency
E	Modulus of Elasticity
ECR	Engineering Change Request
ECU	Electronic Control Unit

EER	Energy Efficiency Ratio
EIA	Electronic Industries Association
EMI	Electromagnetic Interference
EMC	Electromagnetic Control, also Electromagnetic Compatibility
EMCP	Electromagnetic Compatibility Plan
EPA	The Environmental Protection Agency of the U.S. Government
ESNA	Elastic Stop Nut Division
ETFE	Ethylenetetrafluoroethylene
ETP	Electrolytic Tough Pitch
° F	Degrees Fahrenheit
FDB	Degrees Fahrenheit Dry Bulb
FWB	Degrees Fahrenheit Wet Bulb
FAA	Federal Aviation Administration
FAI	First Article Inspection
FCC	Federal Communications Commission
FDA	Food and Drug Administration
FEA	Finite Element Analysis
FH1	Floor Heat 1
FH2	Floor Heat 2
FMEA	Failure Mode and Effects Analysis
FMVSS	Federal Motor Vehicle Safety Standards
fpm	Feet Per Minute
FRA	Federal Railroad Administration
FRP	Fiberglass Reinforced Plastic
FTA	Federal Transit Administration
ft-lbs.	Foot-Pounds
g	Gravity Acceleration
GP	General Purpose
GPS	Global Positioning System
GTO	Gate Turn-Off
HAZ	Heat Affected Zone
HCFC	Hydrochlorofluorocarbon

HEP	Head End Power
HFC	Hydrofluorocarbon
HP	Horsepower
HPPL	High Performance Photoluminescent Material as defined in APTA Standard SS-PS-004-99
HSCB	High Speed Circuit Breaker
HVAC	Heating, Ventilation, and Air Conditioning
Hz	Hertz
IDOT	Illinois Department of Transportation
I/O	Input/Output
IACS	International Annealed Copper Standard
IC	Integrated Circuit, also Inter-Communication System
ICCU	Intercommunications Control Unit
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IFD	Indentation Force Deflection
IPC	Institute of Printed Circuits
IPS	Iron Pipe Size
ISO	International Standards Organization
Is	Flame Spread Index
J	Joules
JEDEC	Joint Electronic Device Engineering Council
JIC	Joint Industrial Council
kHz	Kilohertz
km/h	Kilometers per Hour
kN	Kilonewtons
LAHT	Low Alloy High Tensile Strength (Steel)
lbs.	Pounds
lbf	Pounds Force
LCD	Liquid Crystal Display
LED	Light Emitting Diode
L/s	Liters per Second

LLRU	Lowest Level Replaceable Unit
LVDN	Low Voltage Distribution Network
LVPS	Low Voltage dc Power Supply
MC	Master Controller
MDBF	Mean Distance between Failures
MDS	Monitoring and Diagnostic System
MDU	Maintenance Display Unit
MHz	Megahertz
m	Meter
MIL	Military Specification
mm	Millimeter
mph	Miles per Hour
mphps	Miles per Hour per Second
mphpsps	Miles per Hour per Second per Second
ms	Millisecond
MTBF	Mean Time between Failures
MTTR	Mean Time to Repair
MU	Multiple-Unit
µA	Mirco Ampère
NBS	National Bureau of Standards
NCA	Noise Criterion, Alternate
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NFL	No Field Lubrication
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NTP	Notice-to-Proceed
NTSB	National Transportation Safety Board
OD	Outside Diameter
ODK	Operator’s Display Keyboard
OEM	Original Equipment Manufacturer
OFE	Oxygen Free Electronic
OHDS	Overhead Heat Duct Sensor

OH1	Overhead Heat 1
OH2	Overhead Heat 2
OSHA	Occupational Safety and Health Administration
PA	Public Address
PC	Printed Circuit
PCB	Printed Circuit Board
PCBs	Polychlorinated biphenyls
PCMCIA	Personal Computer Memory Card International Association
PCU	Pneumatic Control Unit
PDR	Preliminary Design Review
PEI	Passenger Emergency Intercom
PFC	Pulling Face of Coupler
PIV	Peak Inverse Voltage
ppm	Parts Per Million
PROMS	Programmable Read-Only Memories
PS	Pressure Switch
psi	Pounds Per Square Inch
psia	Pounds per Square Inch, Absolute
psig	Pounds per Square Inch, Gauge
PTE	Portable Test Equipment
PTFE	Polytetrafluoroethylene
PTU	Portable Test Unit
PWM	Pulse Width Modulation
QA	Quality Assurance
R-C	Resistive-Capacitive
RAM	Random Access Memory
RFI	Radio Frequency Interference
RH	Relative Humidity
rms	Root Mean Square
ROM	Read-Only Memory
rpm	Revolutions Per Minute
R-22	Refrigerant 22
R-407c	Refrigerant 407c
s	Second

S	Flexural Strength
SAE	Society of Automotive Engineers
scfm	Standard Cubic Feet Per Minute
SCR	Silicone Controlled Rectifier
SDD	Software Design Description
SIC	Standard Industrial Code (U.S. Department of Labor)
SPL	Sound Pressure Level
SSP	System Safety Program
S&I	Service and Inspection Facility
S/N	Signal To Noise
STB	Surface Transportation Board
T_a	Ambient Temperature
T_i	Interior Temperature
TBU	Tread Brake Unit
TCS	Train Control System
TFE	Tetrafluoroethylene
TIG	Tungsten Inert Gas
TIR	Total Indicated Runout
TSDL	Technical Specification Deliverable List
TOR	Top-of-Rail
TXV	Thermal Expansion Valve
UA-Factor	Carbody Heat Transmission Factor
US, U.S.	United States
UL	Underwriters Laboratories Inc.
UNC	Unified National Course
UNF	Unified National Fine
USASI	United States of America Standards Institute
USDOT	United States Department of Transportation
USPHS	United States Public Health Services
UV	Ultraviolet
Vac	Volts, Alternating Current
Vdc	Volts, Direct Current
VHS	Very High Frequency
VOM	Volt-Ohm Meter

VPI	Vacuum Pressure Impregnation
VSWR	Voltage Standing Wave Ratio
W	Watt
WB	Wet Bulb
WPS	Weld Procedure Specifications

1.5 Compliance

The cars shall comply in all respects with any and all applicable regulations and rules of the FRA as well as the American Public Transportation Association (APTA) PRESS Standards and Recommended Practices and the Association of American Railroads and with any and all applicable Federal, State and Local laws, rules, regulations and orders that are in effect at the time of Contract Award Date. Should there be a conflict, the most restrictive shall apply.

It shall be the responsibility of the Contractor to determine the applicable laws, rules, and regulations as they apply to the design and construction of the equipment and, where required, obtain the necessary approvals and/or certificates.

The Engineer's approval of a particular system or feature in no way relieves the responsibility of the Contractor with respect to design, performance, safety, compliance with the laws, or suitability of the system or feature for the service intended.

1.6 Delivery and Commissioning

Each car (or trainset) shall be delivered completely assembled, in running condition, with all adjustments made.

A qualified service representative, provided by the Contractor, shall be required to supervise the commissioning of the cars to show compliance with the FRA and FTA Requirements for Safety Certification (49CFR659) and the making of necessary adjustments to all pieces of equipment. The Contractor shall provide this service irrespective of an individual's vacations and/or sickness. In the event that more than one person is used to fulfill the various functions of service representative, the Contractor shall advise the Engineer of the identity and clearly define the responsibilities of each appointee. The credentials of the service representative(s) shall be submitted for Engineer approval 3 months prior to shipment of the first car. Replacement of a Service Representative(s) shall not be permitted without prior Engineer approval.

Post delivery vehicle routine tests as detailed in Section 14 are to be performed and documented in a manner and form acceptable to the Engineer.

1.7 Owner Facility

IDOT or its designee will provide, for the Contractor, during the period required to discharge the responsibilities outlined in Section 14.6:

1. Reasonable shop space for the storage of small tools and test equipment.

2. Permission to park a mobile trailer, if required, at a mutually agreed location for the storage of materials or for use as a work area. The costs for such a trailer and any

services needed (Vac electrical power connections, water and sewerage hookups, heating, etc.) shall be at the responsibility of the Contractor.

3. Storage space appropriate for Contractor-stocked warranty spares.

1.8 System Design Responsibility

The Contractor shall assume complete responsibility for design, implementation of design, construction and satisfactory operation of all subsystems and the total vehicle system.

Where specifications for materials, tests, etc. are referred to, this shall mean the latest revisions thereto in effect at the time of award of the Contract. The Contractor shall be responsible for maintaining all documentation in a current state and to obtain and maintain all required Certificates of Compliance.

Safety of passengers shall be enhanced by providing components and assemblies with gentle shapes and surfaces and, wherever possible, energy absorbing characteristics.

Sharp corners and edges shall be eliminated.

Maintainability shall be enhanced through the incorporation of the following features and procedures:

1. Provision of adequate access and working clearance.
2. The use of modular designs.
3. Interchangeability of components performing similar functions.
4. Accessibility of components and fasteners.
5. Adequate provisions for lifting.
6. Permanent identification of components.
7. Reparability including the provision of applicable data.
8. Minimization of required personnel skill levels and special training.
9. Appropriate self-test features.
10. Built in, quick-disconnect test points for pneumatic, air conditioning and electrical systems.
11. Design of simplified test equipment for use as trouble finding aids.
12. Equipment covers and access panels incorporating simple, rugged, quick-removal fasteners, e.g., square key latches, toggle type and quarter-turn fasteners, except for junction boxes mounted under the car.

13. Tapping plates or anchor nuts used with threaded fasteners where possible. The use of self tapping screws or tapped holes in aluminum as a fastening medium for covers or equipment shall be prohibited.

1.9 *Appendices*

Appended to, and forming a part of these Specifications, are the following:

Appendix	*Description*
A	*Cab Signal Information*
B	*Locomotive MU Control Trainline Assignments*
C	*Communication Control Trainline Assignments*
D	*Amtrak Drawing A-06-7577*

1.10 Maintenance Contract Services

The Contractor shall provide a quote for the long-term maintenance and upkeep of the cars. The term of these services shall begin when the cars leave the warranty period and extend in five-year increments through 32 years or service including a 15-year mid-life overhaul.

The maintenance services quote shall include identification of suitable facilities and equipment required to properly maintain the cars in a condition suitable for sustained, high-speed operation, as well as operation on the other IDOT-supported routes in the State.

The Contractor's maintenance program shall ensure that a minimum availability of 97% is achieved throughout the duration of the program, and that the program is in compliance with all recommended maintenance practices and requirements of the OEM. If changes are made to the cars or the maintenance procedures during the on-going contract services program, the Contractor shall have the responsibility to ensure that all maintenance manuals, parts catalogs and other documentation are updated and kept current, reflecting these changes.

The Contractor's quote shall address union issues, demonstrating awareness of existing unions, arrangements and responsibilities in the maintenance of the cars assigned to the IDOT-supported routes.

The maintenance program shall include a half-life overhaul of all cars, to occur during their 15th year in service.

IDOT may or may not pursue this option, but the Contractor's quote shall be complete in every aspect such that an informed decision can be made relative to these services.

SECTION 2

2 DESIGN PARAMETERS

2.1 General

This Section establishes system performance, environmental and general design criteria for the IDOT intercity rail passenger cars/trainsets. Included are configuration, capacity, dimensional, performance, environmental, noise and vibration, ride quality, weight, and other requirements that impact vehicle system and subsystem design. These requirements shall apply to all aspects of vehicle and equipment design.

The vehicles shall be designed and manufactured to operate successfully within the IDOT environment and in particular, on the IDOT-supported network of intercity routes, or those routes that are planned to be added to the IDOT-supported system. All requirements identified herein shall be met. If questions or conflicts arise within these Specifications, IDOT shall be notified so that the subject questions or conflicts can be resolved without impact to design and manufacturing schedules.

The vehicles shall be designed, manufactured, inspected and delivered to be in full compliance with all applicable FRA Tier I rules, and regulations, AAR Standards and APTA Standards that are in effect at time of contract award for a four-to-six car train (or equivalent trainset) of more than 600,000 pounds empty weight.

Maximum sustained operating speed shall be no less than 110 mph. Subject to the maintenance intervals specified in Section 2, and also to the Contractor's recommended maintenance practices, the vehicles shall be designed for a minimum service life of 32 years in the IDOT environment, based on an average annual operating distance of 150,000 miles per vehicle. A mid-life overhaul with equipment upgrade may occur within a 16-year period.

Weights and dimensions shall be as shown in Section 2 and in Section 3.1.1. The Contractor shall submit static and dynamic clearance and contour diagrams of the cars for review and concurrence by the Engineer.

Clearance shall meet, as a minimum, Amtrak drawing No. A-06-7577, Rev. Nil except where noted (the side steps, mirrors and pilot). Refer to Appendix D for Amtrak drawing No. A-06-7577, Rev. Nil.

2.2 Ambient Conditions

The vehicles shall be capable of being operated, stored and maintained at the specified performance levels, without impairment resulting from the natural or induced environmental conditions within Illinois and the adjacent Midwestern states area. The following climatic factors shall be used as design guidelines and shall be considered as operational requirements. Actual localized temperatures and conditions within and under the carbody may be more severe than the ambient climatic conditions and the Contractor shall be responsible for evaluating these conditions during its design effort and providing vehicles which can continue to operate under these more strenuous conditions. Additionally, the Contractor shall be responsible for advising IDOT or its designee if there are any special environmental factors to which its equipment may be sensitive that are not listed below.

Temperature & Solar Load for Car Design:

- Minimum ambient air temperature -34° FDB
- Maximum ambient air temperature 114° FDB, 86º FWB

Temperature & Solar Load for HVAC Design:

For HVAC system design, conform to ASHRAE Design Conditions (from Fundamentals Handbook) for Chicago, Illinois:

- -5° FDB Heating
- 91.7° FDB Cooling

Precipitation:

- Maximum rainfall rate: 2” per hour

Wind:

- Maximum sustained: 35 mph
- Maximum gusting: 60 mph

Snow/Below Freezing Conditions

- Average snowfall per year: 40”
- Average No. of days below 32° F per year: 140

The vehicles shall operate under the atmosphere, track bed and wayside contamination and debris-conditions, experienced on rights-of-way in the IDOT service area.

2.3 General Parameters

1. Maximum number of cars in train: 10.
2. Maximum safe speed of train: 120 mph.
3. Normal operating speed of train: 110 mph, sustained.
4. Average annual distance operated/car: 150,000 miles.
5 Minimum number of coach passenger seats: 72 Cab/80 Trailer.
6. Minimum number of business class seats (in 2-1 arrangement) per trainset: 27.
7. Number of food service seats (at two- and four-person tables) per trainset: 18 (plus 17 seats not at tables in the lounge area).
8. The business class/food service car shall also include a lockable crew compartment with four facing seats and a work table between the seats.

9. Seat pitch shall be a minimum of 40 inches (with the maximum being as required to achieve the capacity requirements of these cars).

10 A Car/Trainset shall be a train with a minimum of 260 coach seats, a minimum of 27 business class seats, food service area and 18 table-seats and 17 non-table seats in a lounge area.

For performance purposes, the weight of each vehicle shall be per the following table:

Symbol	Condition	Maximum Weight Trailer	Cab
AW0	Ready to run tare weight (No passengers)	150,000 lbs. Estimate to be adjusted upon seat selection and general arrangement	153,000 lbs. Estimate to be adjusted upon seat selection and general arrangement
AW1	With maximum of 80 seated passengers	AW0+14,500 lbs.	AW0+14,800 lbs.

Average weight of passenger: 165 pounds; with 30% of the passengers each having 30 pounds of luggage.

2.4 Car Dimensions

The dimensions listed below are nominal and based on a typical, conventional, coupled-car design. While the Contractor may propose articulated trainsets or low center-of-gravity trains, etc., this does not relieve the Contractor from ensuring (and demonstrating to IDOT or its designee) that these trainsets can successfully and safely operate in the same environment, on the same lines and in the same services as the conventional equipment.

1. Length of an uncoupled car over coupler faces: 85'-0"
2. Length of an articulated set, having the same capacity and amenities as a four-car coupled set: 340’-0"
3. Width of car: 9'-10"
4 Height of car: 15'-11"
5. Wheel diameter, new: 33"
6. Radial wheel wear: 1-1/2"
7. Number of door openings per side: 2
8 Width of side door opening: 52"

9. Width of end door opening

    a. Trailer car minimum: 28"
    b. Cab car minimum: 22.5"

10. Minimum height of ceiling from floor at car center line: 6'-7"

11. Height from top of rail to top of station platform: 24”

12. Height from top of rail to top of side door step (if applicable): 18" and 24.625”

13. Height from top of rail to top of lower level floor: 25"

14. Height from top of rail to car end floor at intercar passageway with new wheels and empty car: 51"

15. Truck spacing: 64'-0"

16. Truck wheel base: 8'-6"

17. Height of coupler from top of rail to center line of coupler, empty car, with new wheels: 34-1/2”

Articulated trainsets shall have couplers on each end of the trainset which are compatible with existing IDOT or designee’s cars and locomotives and can be mechanically and electrically coupled to that other rolling stock.

2.5 High Voltage System

2.5.1 Carborne and Trainline

The head end trainline power shall be at a nominal 480 Vac, 3 phase, 60 Hz. Carborne equipment shall function at its rated performance level between 430 and 530 Vac, and between 57 and 63 Hz. The quality of the head end power will be maintained within the above limits and no carborne devices shall be provided to protect against an out of tolerance power supply.

2.5.2 Wayside Power Supply

The vehicle shall be configured to be connected to wayside power, at either end or at a designated location on each side, supplied to the vehicles for layover by a 480 Vac, 3 phase, 60 Hz wayside power source.

2.6 Auxiliary Power Systems

The nominal voltage of the dc low voltage system and the dc low voltage trainline system shall be a nominal 72 Vdc +/- 5 Vdc.

The nominal voltage of the ac low voltage supply shall be a nominal 120 Vac +/- 5 Vdc, single phase, 60 Hz.

However, subsystems or their components may operate below 120 Vac or 72 Vdc within that subsystem or component.

The nominal voltage for galley equipment shall be 208 Vac. Other voltages may be necessary to operate selected galley equipment.

2.7 Operating Environment

2.7.1 Platform Interface

Station platforms may be of high-level or low-level design. High-level platforms will be 24 inches above TOR (if a single-deck car with different dimensions is being proposed, Contractor shall submit these dimensions, along with stated advantages of this design to IDOT or its designee), with the platform edge set back approximately 5 feet 8 inches from centerline of track. The horizontal distance of the platform edge to the vehicle passenger threshold or door step shall be no greater than three inches. The Contractor shall submit a preliminary design for IDOT or its designee's approval of the "outside" step to platform interface distance. The design shall be such that the car can be boarded by passengers at the 24 inch raised platform or by an 8-inch low level boarding platform with minor modifications to the outside step on the rail car.

2.7.2 Track Limitations

The physical constraints of the track, yard and wayside include the items below:

- Rail Types: 112 RE, 115 RE, 119 RE, 132 RE, 136 RE, 132 HF
- Minimum horizontal curve radius: 250'
- Minimum vertical curve radius, crest: 2,000'
- Minimum vertical curve radius, sag: 2,000'
- Nominal track gauge: straight and curve 4'-8.5"
- Maximum track super elevation: 4-1/2"
- Maximum gradient: 5%

NOTE: the above rail types and dimensions reflect some of the current conditions found on the IDOT-supported rail lines. Sections of these lines that will be operated at 110 mph will be reconstructed with premium rail, concrete ties and wide track center spacing.

Minimum undercar running clearance, including vertical curves after all wear and deflection under AW3 condition, to TOR:

- Under truck 2-3/4"
- Between trucks, between rails 6"

The vehicles shall be capable of operating safely on trackage maintained in accordance with FRA requirements for Track Classes 1 through 6 inclusive at the maximum passenger train speed authorized for each track class.

2.8 Electromagnetic Interference and Compatibility

The Contractor shall establish minimum requirements for an EMC Program which is designed to prevent Electromagnetic Interference (EMI) in rail equipment to ensure that these vehicles will operate satisfactorily as per APTA SS-E-010-98 Standard for the Development of an Electromagnetic Compatibility Plan and 49CFR238.225(d).

The vehicles shall be electrically compatible within themselves and with other vehicles operated by IDOT and/or Amtrak in the Midwest medium-to-long distance passenger network. IDOT or its designee shall supply the Contractor with information pertaining to the signal systems used in the territory in which IDOT-supported trains currently operates (or is planning to operate in the near term) with communications equipment and other electrical and electronic equipment used in these vehicles.

The Contractor shall develop a plan with a program that achieves and documents electromagnetic compatibility. Details of the program shall be submitted to the Engineer for review and approval.

2.9 IDOT or Amtrak Service-Proven Design

Vehicle system and subsystem designs shall be service-proven. IDOT or its representative will evaluate the applicability of "service-proven" according to the risk associated with each particular design. In general, a service-proven design shall meet all the following criteria:

- Used successfully in a fleet of vehicles in revenue rail operation for at least three years,
- Has a vehicle availability of 97% minimum,
- Has achieved a MTBF consistent with IDOT or its designee’s requirements.

To establish a design's service-proven history, the Contractor shall submit, as part of the proposal, specific details of the application history. The Contractor may offer, for approval, a design which is basically unchanged from a service-proven design, but which may be varied slightly in design or manufacture to meet IDOT or its designee’s requirements. The Contractor shall show, in detail, what has been changed in the equipment and why such changes will not adversely affect operation and performance. The following elements shall be included in this portion of the Contractor’s proposal:

- Carbody structure
- Coupler, draw bars and draft gear (as well as for end-of-trainset couplers and for intermediate articulation, if provided)
- Friction brakes and control
- Door operators and control
- Air comfort system and control
- Trucks

- Wheels
- Low voltage power supply
- Event recorder
- Batteries and battery charger
- Power conversion equipment

IDOT or its designee may waive some requirements for detailed design review and design conformance testing when service-proven equipment is provided. In general, the decision to waive design and test requirements shall be based on IDOT's understanding of the historical success of the equipment.

SECTION 3

3 CAR BODY

3.1 Physical Requirements

The car body shall be designed and constructed in full compliance with any and all applicable Tier I regulations of the FRA, standards of the AAR and of APTA, including but not limited to: 49 CFR 38, ADA Accessibility Specification for Transportation Vehicles; 49 CFR 238, Passenger Equipment Safety Standards; APTA SS-C&S-034-99, Standard for the Design and Construction of Passenger Railroad Rolling Stock; 49 CFR 223, Safety Glazing Standards – Locomotives, Passenger Cars and Cabooses; 49 CFR 239, Passenger Train Emergency Preparedness; 49 CFR 229, Railroad Locomotive Safety Standards.

All specified equipment on the car shall be arranged so that the proportion of the vehicle tare weight carried by each truck of the car shall be within 5 percent of each other. Similarly, the weight distribution from side to side of the car shall be within 5 percent.

The car body structure shall permit lifting or jacking of a car, with or without trucks attached, without damage to or deformation of the structure or equipment. Lugs for lifting of the car shall be provided at the top of the end door collision posts at each end of the car. The lifting area shall have a suitable removable cover sealed to prevent ingress of water or snow. Each end of the car shall have two jacking pads along the side sill at each corner; and the other beside the truck, approximately 5 feet from the end of the car. Jacking pads shall be of an approved size with a suitable surface to avoid slippage. It shall be possible to jack up a complete car, or either end of a car utilizing portable jacking devices and to subsequently support the car with portable stands with the trucks remaining on the rails and remove the portable jacks. It shall be possible to manually roll the trucks from under the end of the car.

The car body structure shall provide for the mounting of all ancillary equipment; the applicable mounts and the applicable equipment shall be designed and constructed in accordance with requirements of the FRA regulations and rules, and the APTA standards (ref. Section 5.7 of APTA SS-C&S-034-99) that require equipment to withstand the forces caused by the accelerations shown below:

1. Vertical: $\pm$4g
2. Longitudinal: $\pm$8g
3. Lateral: $\pm$4g

Housings for externally mounted equipment shall be completely weatherproof when covers are in place, excluding battery boxes, which are ventilated.

All exposed trim and metal parts shall have sharp edges removed. Drain holes shall be provided in underframe shear plates.

All carbon steel surfaces of the underframe structure shall be shot blasted and thoroughly cleaned immediately before priming, painting, and undercoating.

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

1. Car tare weight.
2. Crush passenger load (AW3).
3. Vertical dynamic load due to wheel/rail interaction.
4. Loads due to vehicle pitching caused by braking.
5. Snow or ice loads.
6. Aerodynamic load.
7. Side wind loads.
8. Buff load. Compressive and lateral loads caused by another train passing in the opposite direction on an adjacent track with relative speeds of 220 mph.
9. Standing on maximum super elevation curve with full standing and seated load upstairs and other reasonable conditions from above to give the worst combination. (See Section 2.7)

3.2 Industrial Design Requirements

The Contractor shall apply industrial design standards, practices, and recommendations, and human factor engineering design criteria during the design development and engineering phases of the program to assist in the following tasks:

1. Evaluation of Federal, State, and local ADA compliance issues.
2. Evaluation of maintenance accessibility and maintainability of components and assemblies.
3. Review issues involving human factors/ergonomic and safety conditions.
4. Integration of all materials, finishes, colors and arrangements.
5. Preparation of exterior marking scheme.
6. Preparation of interior signage and service markings.
7. Selection of interior fabrics and furnishings and the presentation of interior color and material boards.
8. Construction of any soft mock-ups required to resolve packaging, spaces, human factors/ergonomics criteria, or ADA issues.

3.3 Framing Structure

The framing and sheathing of the car body shall form an integrated structure capable of resisting, without permanent or destructive deformation, buff loads possible in normal commuter service operation. The carbody structure shall be designed and constructed in accordance with the requirements of the applicable FRA regulations and APTA standards, including but not limited to 49 CFR 238 and APTA Standard SS-C&S-034-99.

The car end structures shall be provided with vertical collision posts and corner posts designed and constructed to comply with applicable FRA rules regulations and APTA Standards

3.3.1 Collision Post Loads

The collision posts of the B-end of the cab car and each end of a trailer car shall resist the loads defined by APTA Standard SS-C&S-034-99, Section 5.3.1.4 and 49 CFR 238.211. Each collision post, supporting car body structure, and intervening connections shall resist each one of the following horizontal inward loads individually applied at any angle within 15 degrees of the longitudinal axis:

a) Minimum 300,000 pounds (1334 kN) applied at a point even with the top of the underframe, without exceeding the ultimate shear strength of the post.
b) Minimum 300,000 pounds (1334 kN) applied at a point 18 inches (457 mm) above the top of the underframe, without exceeding the ultimate strength.
c) Minimum 50,000 pounds (222 kN) applied anywhere along the post, including the top connection, above the top of the underframe, without permanent deformation.

The collision posts of the F-end of the cab car shall resist the loads defined by APTA Standard SS-C&S-034-99, Section 5.3.1.3.1 and 49 CFR 238.211. Each collision post, supporting car body structure, and intervening connections shall resist each one of the following horizontal inward loads individually applied at any angle within 15 degrees of the longitudinal axis:

a) Minimum 500,000 pounds (2224 kN) applied at a point even with the top of the underframe, without exceeding the ultimate shear strength of the post.
b) Minimum 200,000 pounds (890 kN) applied at a point 30 inches (762 mm) above the top of the underframe, without exceeding the ultimate strength.
c) Minimum 60,000 pounds (267 kN) applied at any height along the post, including the top connection, above the top of the underframe, without permanent deformation.

The collision posts shall be LAHT steel, located one on each side of the end door opening and shall be welded to the sill and extended to a suitable attachment to the roof structure, and shall be welded to the top and bottom plates of the end sill with the equivalent of AWS pre-qualified weld joint as per APTA Standard SS-C&S-034-99, Section 5.3.1.3.1. The welded joint of the collision posts to the end sills shall carry the end reaction developed by the collision post. The torsional strains developed in the collision posts shall be resisted by the end sill and transverse beams above the end sill. The upper attachment shall be as an integral part of an anti-telescoping roof structure and shall be designed to develop plastic deformation of the roof and not fail by shear or rupture.

3.3.2 Corner Post Loads

The corner posts of the B-end of the cab car and each end of a trailer car shall resist the loads defined by APTA Standard SS-C&S-034-99, Section 5.3.2.4 and 49 CFR 238.213. Each corner post, supporting car body structure, and intervening connections shall resist each one of the following horizontal loads individually applied toward the inside of the vehicle in any direction from longitudinal to transverse:

a) Minimum 150,000 pounds (667 kN) applied at a point even with the top of the underframe, without exceeding the ultimate shear strength of the post.
b) Minimum 30,000 pounds (133 kN) applied at a point 18 inches (457 mm) above the top of the underframe, without permanent deformation.
c) Minimum 30,000 pounds (133 kN) applied at point of attachment to the roof structure, without permanent deformation.
d) Minimum 20,000 pounds (89 kN) applied anywhere between the top of the post at its connection to the roof structure, and the top of the underframe, without permanent deformation.

The corner posts of the F-end of the cab car shall resist the loads defined by APTA Standard SS-C&S-034-99, Section 5.3.2.3.1 and 49 CFR 238.213. Each corner post, supporting car body structure, and intervening connections shall resist each of the following horizontal loads individually applied toward the inside of the vehicle in any direction from longitudinal to transverse:

a) Minimum 300,000 pounds (1334 kN) applied at a point even with the top of the underframe, without exceeding the ultimate shear strength of the post.
b) Minimum 100,000 pounds (445 kN) applied at a point 18 inches (457 mm) above the top of the underframe, without permanent deformation.
c) Minimum 45,000 pounds (200 kN) applied anywhere between the top of the post at its connection to the roof structure, and the top of the underframe, without permanent deformation.

3.3.3 Roof, Underframe and Body Structure Loads

The aperture in the end frame that contains the coupler shank shall resist an upward or downward load by the coupler as per 49 CFR 238.205(b). The aperture in the end frame that contains the coupler shank of both ends of a cab car and both ends of a coach car shall resist upward or downward loads by the coupler shank of 100,000 pound yield as required by the APTA standards. The structure shall be assembled by welding and mechanical fasteners in accordance with accepted industry practices.

Each passenger car shall be designed to accommodate the rollover strength requirements as per 49 CFR 238.215 and APTA SS-C&S-034-99, and the side structure requirements as per 49 CFR 238.217 and APTA SS-C&S-034-99.

The roof, underframes and body structure shall be manufactured from materials which meet the requirements of Section 11.2. Welded mechanically fastened or bonded sub-floor metal sheets shall be applied to the underframe. They shall be flanged and supported at all edges. The corners shall be welded. The sub-floor sheets shall be 100 percent sealed against ingress of moisture or drafts. The intermediate end sub-floor sheets shall be resistant to flying stones. This

installation shall be a high grade tolerance quality with any necessary cutouts designed for and consistent from car to car. When assembled to the car floor with required insulation, the interior sound pressure levels shall comply with Section 12.2.

The center sill and end floor substructure shall enclose the power train line (480 Vac) cables.

The body and roof sheeting shall be manufactured from aluminum alloy.

3.4 Attachment to Trucks

Longitudinal service loads of the truck to the car body connection shall be transmitted by radius rods. The bonded rubber elements in the ends of the rods shall not be prone to loss of preload. One lateral radius rod between the car body draft sill and the truck bolster with similar rubber-bonded elements shall transmit lateral dynamic loads.

The trucks shall be attached to the car body in such a manner as to prevent the car body from parting from the truck unintentionally, in accordance with the applicable FRA regulations and APTA Standards. The connection of the truck to the car body shall resist without failure, when applied separately, a 2g vertical force and provide for an ultimate horizontal shear strength of 250,000 lbs. in any direction as required by 49 CFR 238.219 and APTA SS-C&S-034-99 (refer to Section 5.6). The body attachment shall be of approved design and of sufficient strength that the trucks may be safely suspended from the car body.

3.5 Air Conditioning Ducting

All air conditioning ducting shall be designed to permit access for cleaning. The ducts shall be free from rattles, squeaks, whistles, and air leaks with suitable means to prevent ingress of the climatic elements into the car body. The supply air duct work of the A-end HVAC unit distributes conditioned air to the A-end intermediate level and the right side of the upper and lower levels and to the cab area of the cab car; the supply air duct work of the B-end HVAC unit distributes conditioned air to the B-end intermediate level and the left side of the upper and lower levels. The air ducts that supply air to the lower level as they pass over the passenger doorways are exposed and located on the upper level floor between the floor and the side wall. All exposed ducts shall be insulated. Equivalent duct work and air flows/capacities shall be proposed in the event that a single-deck car or trainset is proposed.

The outer shell of the exposed ducts shall be stainless steel with an embossed pattern, as approved by the Engineer. The Contractor shall be responsible for determining the design and size of ducts in compliance with all environmental, noise, performance and comfort requirements.

Fresh-air ducts shall be located under the car or end of car, with end of car ducts extending down to the coupler height, in order to preclude ingestion of diesel exhaust, snow and other contaminants. The fresh air duct system shall have motorized dampers and blowers in the fresh air ducts.

3.6 Roof

The car roof framing shall be designed and constructed to obtain adequate strength and rigidity in accordance with FRA regulations (Reference 49 CFR 238.215) and APTA standards (reference APTA SS-C&S-034-99).

The roof design shall incorporate a rain water control system at the roof ends where collection pockets and drain piping shall be installed. Drain piping shall prevent water from striking wheels, electrical cables, or batteries.

The design shall also facilitate the fastening of stanchions and ceiling lining, and installation of roof wiring, lighting fixtures, and other required equipment in a secure, convenient, and workmanlike manner. A non-skid surface shall be provided in the area of the two roof mounted air conditioning units.

Roof sheets shall be of sufficient strength as to not be permanently deformed when:

1. Supporting roof mounted equipment.

2. The vehicle passes through a mechanical car washer.

3. Supporting three concentrated loads of 250 pounds at 30 inch intervals in any direction to simulate workers on the roof.

4. The maximum ice and snow accumulations are incurred. See Section 2.2.

3.7 Interior Finish and Furniture

Interior fittings and surfaces shall comply with 49 CFR 238.233 and APTA SS-C&S-006, Standard for Attachment Strength of Interior Fittings for Passenger Rail Equipment. Interior component materials shall meet the flammability and smoke emissions requirements of 49 CFR 238.103.

The ceiling, side and end walls, and bulkhead walls shall be finished with integrally colored melamine, laminate plastic, molded reinforced plastic or similar approved material and color, applied and fastened in a manner to permit ready removal for maintenance. Use of visible fasteners shall be minimized. The use of tamper proof fasteners shall be as approved by the Engineer.

Melamine materials shall have a low glare or cashmere finish with balance sheets to minimize warpage. End walls, bulkheads, windscreens, and other partitions shall be solid core laminated melamine. Side wall window masks shall be vacuum formed thermoplastic sheets or fiberglass, in compliance with the flammability and smoke emissions requirements. The masks shall be retained by elastomeric glazing strips around the windows.

Joints between panels shall be concealed by approved trim strips. Edge radii design of the window masks, as well as the installation procedures, shall prevent stress cracking.

The ceilings shall be lined with 0.125 inch thick balanced melamine panels. Hinged access panels with limit chains and maintainer's key locks shall be provided for access to equipment mounted overhead, including air conditioning units, battery charger/LVPS, air tanks, and electrical junction boxes.

Liners, masks and associated trim pieces shall be developed by the Contractor and submitted to the Engineer for approval. Supporting data sheets for the materials to be used shall be submitted to the Engineer for approval. Bulkheads, end walls, windscreens, and other vehicle surfaces shall be developed by the Contractor and submitted to the Engineer for approval.

Supporting data sheets for the materials to be used shall be submitted to the Engineer for approval.

All joints shall be properly supported to prevent sagging and drumming and shall be covered with approved "snap-on" type moldings. Anti-squeak protection shall be provided at joints between frame, floors, interior finish, and any other area having potential for this type noise generation. The interior finish at the windows, armrests, and handholds shall be designed to minimize dirt collection.

Materials used shall minimize build up of static charge. The side lining below the windows shall be of sufficient strength and adequately supported to resist damage by kicking. Covers for door pockets shall be suitably framed for rigidity and hinged for access to equipment in the door pockets, using the maintainer's key lock. The covers shall be interchangeable by size and/or location.

At certain locations in the car, stainless steel trim shall be provided where vertical surfaces adjoin the floor. Design and installation shall be approved by the Engineer.

The use of integrally colored panels and liners shall not require additional painting. If and where painting is required, a synthetic enamel or urethane shall be applied as approved by the Engineer.

Carbon steel parts in electric lockers shall be painted prior to installation. Such lockers shall be finished inside with an approved non-conducting white paint.

All sign designs and styles shall be approved by the Engineer.

A Builder's name plate shall be located in an approved location.

Car number and car end designations (*"A"* or *"B"*) shall be attached over both end doors, in the lower vestibule, and in the upper passenger compartment at each end.

Permanent identification of switches, circuit breakers, and fuses shall be provided in each electrical locker.

A single digit number identifying each side door leaf shall be attached to the interior surface of each door leaf. The numbering scheme shall be approved by the Engineer. The size, location and material shall be approved by the Engineer.

On the interior of one of the electrical locker doors, a metal plate shall be mounted that identifies the car location, date completed, model and serial numbers. Record and log book holders shall be mounted inside the door used for destination sign controller access.

The cover of the emergency tool kit and fire extinguisher cases shall be labeled with access instructions.

The following, but not limited to, items shall be labeled:

1. Overhead heaters.

2. Emergency brake valves (red lettering).

3. DANGER DO NOT TOUCH (as appropriate - red lettering).

4. DANGER 480 VOLTS (as appropriate - red lettering).

5. HVAC temperature sensors.

3.8 Floors

3.8.1 Floor Panels

Floors at the lower and intermediate levels shall consist of plymetal panels with stainless steel cladding on both sides (See Section 11.12.1) applied on top of the transverse floor members.

Floors at the upper level shall be plywood faced with phenolic resin on both sides (See Section 11.12.2). All edges, holes and cutouts shall be sealed. Equivalent construction methods and durable materials shall be proposed for single-deck cars/trainsets.

The floor panels shall be transversely installed panels, 0.75-inch thick. The panels shall be separated from the support structure by curing elastomeric sealant, and together shall form a monolithic, waterproof deck. All edges of the floor panels, including openings, shall be waterproofed and sealed.

The floor shall be suitably supported by the car framing to provide a structurally sound, and sealed installation which shall not deform permanently under passenger loads up to AW3.

The installed floor deck with respect to leveling shall be divided into two zones:

- Zone #1 shall be anywhere within 3 feet of any transition between levels and/or walls of each seating level; Zone #2 shall be all other areas of each seating level. The installed floor deck with leveling compound in

- Zone #1 shall be flat and level within 0.1875 inches over 3 feet in any direction.

The installed floor deck with leveling compound in Zone #2 shall be flat and level within 0.09375 inches over 3 feet in any direction. The preceding sentences describe the methods to be used for a bi-level or double-deck car design. Similar methods and materials shall be used in the event that a single-deck car/trainset is proposed. Floor joints shall not be visible or discernible under the floor covering. The floor structure shall be resistant to the effects of water, road salt, and carpet cleaning fluids.

3.8.2 Floor Covering

For all cars, the floors of the vestibule area, stairways, intermediate level stairway landing area (if required), and restrooms shall be covered with a tile floor material which meets the requirements of NFPA 130 and has appropriate anti-slip properties for this application. In addition for the cab cars, the control cab area and the adjacent electrical/storage locker shall be covered with a rubber tile floor material. The risers of the stairs between intermediate and upper levels (if required for the proposed car design/configuration) shall be covered with a floor material which meets the requirements of NFPA 130 and has appropriate anti-slip properties for this application. The risers on the stairs between the lower level and intermediate level (again, if required) shall be protected with stainless steel cover.

The area under the seats and in the aisle ways for all levels shall be covered with carpet material which meets NFPA 130. The carpet backing material shall provide water resistance. The method for securing the carpet to the floor panels shall be consistent in all locations and shall facilitate easy removal for maintenance purposes without damage to the substrate or floor panels. The carpet shall be arranged so that the aisle strips on all levels can be removed and replaced without disturbing any seats, interior components, parts or other furnishings.

The colors, patterns and materials shall be developed by the Contractor and submitted to the Engineer for approval. Samples of each with supporting data sheets and details of the floor covering installation system shall be submitted to the Engineer for approval. The interior arrangement of the floor covering shall be submitted to the Engineer for approval.

3.9 Windows

Window glazing materials shall conform to the requirements of Section 11.5 and shall comply with the requirements of 49 CFR 223 and 238. Car side windows shall meet the requirements of FRA Type II material. The cab car windshield and cab end door window shall be FRA Type I material.

3.9.1 Passenger Side Windows

Fixed passenger side windows shall be provided as shown on the general arrangement drawings. Passenger side windows shall be of an integral design and shall be coordinated with the seating and interior layout to provide as much passenger viewing as is practically possible. The windows shall comply with the applicable FRA regulations and APTA Standards.

Passenger side windows shall be tinted. The degree of tinting provided shall be recommended by the Contractor and submitted for Engineer approval.

The window assembly shall be capable of withstanding (with a safety factor of 2.5) both the positive and negative pressure caused by the combination of maximum wind speeds and train speed considering their relative direction created by trains passing in the opposite direction on adjacent tracks at a relative speed of 220 mph.

All glazing shall be installed using extruded seals approved by the Engineer. Clearances between edge of glazing and extrusion, and between extrusion and side skin or door skin shall be sufficient to prevent damage to glazing due to car body deflections. Proper tools shall be used when installing glazing to prevent damage to the window or seal. Exterior paint shall extend under the window seal extrusions to prevent unpainted metal from becoming visible due to the shifting of rubber during service or maintenance.

A total of twelve (12) windows on each car shall be emergency exit windows (the quantity specified is for a bi-level or double-deck car – the Contractor shall propose the functional equivalent number of emergency exit windows for a single-deck car, if proposed) and shall be identified and marked accordingly. The emergency exit window system shall use pull handle(s) colored red and suitably designed for either one hand or two hand unbraced pull action or other approved means to release the window assembly from its installation. All emergency windows shall also have the locking lace on the outside to permit removal from the outside. Each emergency exit window assembly shall incorporate two (2) handles appropriately sized and located or other approved means to permit easy removal of the window assembly from its installation. When the window assembly is removed from its installation, these handles shall be

suitable to lift and move the window assembly to provide an unobstructed exit route. The emergency exit windows shall be located as follows: two (2) on each side of the upper level, two (2) on each side of the lower level, and one on each side of each intermediate level. Comply with staggering recommendations of FRA as defined in 49CFR238.113. All emergency exit windows on the lower level (or those provided on a single-deck car), shall function as emergency access windows and shall be identified and marked accordingly. The design shall prevent the emergency exit window assembly and its lace and associated installation parts from becoming loose through normal operation, action of the car washing system or similar functions. Design and window removal functions shall be in accordance with relevant sections of the applicable FRA regulations and APTA standards including, but not limited to the requirements of 49 CFR 223, 238 and 239. The design of the window assembly, installation system and removal procedure shall be submitted to the Engineer for review and approval. Removal of one window of each type on the first coach and on the first cab car shall be demonstrated by the Contractor.

The Contractor shall ensure positive sealing of the windows against environmental conditions as well as machine car washing. Corners shall be rounded to facilitate cleaning. Ready repair and ease of replacement from inside the car are mandatory.

3.9.2 Sliding Side Door and End Door Windows

Glazing materials shall conform to the requirements of Section 11.5.

3.9.3 Cab Car Control Station Sliding Window

Glazing materials shall conform to the requirements of Section 11.5.

The cab side window shall be a horizontal pocket sliding sash-type with the sash sliding within a frame that is embedded in the sidewall. The sliding action shall be a manual operation. The sliding portion shall latch in the closed position and shall hold, but not necessarily latch, the sash in any position from closed to fully open.

The non-cab side window shall be a horizontal sliding sash-type with the sash sliding within a frame that has a fixed piece of glazing on the other half. The sliding action shall be manual operation. The sliding portion shall latch in the closed position and shall hold, but no necessarily latch, the sash in any position from closed to fully open. The side window shall also have provision for a crew member to lock the sash in the fully closed position using a crew key at the Door Control Station mounted directly above the window.

Under normal operating conditions, in either direction of car travel, the sliding window shall be weatherproof when in the closed position. The sliding window shall be retained in an aluminum sash frame. The frame material shall be extruded aluminum with a brush finish and shall be black anodized to withstand the mechanical and weather elements as well as cleaning chemicals. The frame shall confine the passage of water to the outermost portion of the car, collect it, and drain it overboard. In order to keep water from running down over operating personnel, a sloping gutter shall be installed over the sliding window to redirect water.

The cab pocket sliding window design and glass specifications shall be submitted to the Engineer for review and concurrence.

3.9.4 Cab Car Windshield

Glazing materials shall conform to the requirements of Section 11.5

The cab windshields shall meet FRA Type I requirements. The size and location of the Operator's side and front windshields, in conjunction with the location of the Operator's seat, shall ensure that optimal lines of sight are provided. Both windshields shall be electrically heated to prevent the formation of frost or moisture on the inside surface under all specified operating conditions. Windshields shall have a spall shield on the interior side of the cab.

3.10 Seats

The seats, seat arrangements and installations shall comply with requirements of the applicable FRA Regulations. *All seats shall also comply with APTA and FRA testing requirements.*

Details of the seats, seat arrangements and installation shall be submitted to the Engineer for review and approval. There shall be two basic types of seat assemblies; those to be used in coach class, arranged in two-two pattern; and, those to be used in Business Class, arranged in a two-one pattern. Minimum seat pitch in coach class shall be 40", while in Business class it shall be no less than 44".

All seats shall recline, with the extent of recline controlled by the occupant.

A foot rest shall be supported off the rear bottom of the seat, for use by and the control of the passenger in the seat immediately behind the one which has the footrest. The footrest shall have fixed detents allowing the passenger to adjust in through a reasonable arc of motion to meet the needs of most adult travelers, location and shape of the footrest shall be consistent with human engineering criteria.

Each seat shall have an adjustable height headrest cushion attached. Control of the headrest shall be by the passenger occupying that seat, with four fixed detents allowing for the headrest to be at various reasonable heights for the comfort of the typical adult passenger, with the location and shape of the headrest consistent with human engineering criteria.

The backs of all seats shall incorporate a fold-down tray table, which it shall be possible to hold in place (in the back of the seat to which it is attached) when not being used.

Coach class seats shall be covered with transportation grade woven fabric as defined in Section 11.15 Upholstery and Covering Materials. Color and pattern shall be approved by the Engineer.

Business class seats shall be covered with a material suitable for a high-quality first class accommodation. Color, pattern and material shall be approved by the Engineer.

Seat Strength – For all seat types and their installations, the seat shells, seat base assemblies and all respective attachments to the carbody or floor, shall be designed and constructed to comply with the requirements of 49 CFR 238.233. An analysis or test results of the seat attachment strength shall be submitted for review and the approval of the Engineer.

There shall also be fixed position (non-reclining) chairs for use at the six food-service area tables. These chairs shall have metal frames and be of suitable construction and comfort for use in a high-speed train. The backs and bottoms of these seats shall be covered with a

transportation grade woven fabric as defined in Section 11.15 Upholstery and Covering Materials. Color and pattern shall be approved by the Engineer.

3.11 Side Sliding Doors and Operating Mechanisms

The exterior side doors and associated mechanism shall comply with 49 CFR 37, 38, 223, 238 and 239.

The exterior side doors and associated mechanism shall comply with the APTA Standard currently in draft form. This section will be revised to conform with the new standard.

3.11.1 Side Sliding Doors

Sliding doors, as described below, shall be supplied at two locations on each side of the car, at the lower level (if a bi-level or double-deck car design is proposed). The doors shall be double sheathed of aluminum alloy construction, with glass windows set in a rubber glazing strips. The space between the aluminum sheets shall be filled with a glass fiber semi-rigid insulation providing noise and vibration damping as well as insulating properties. The windows shall be as described in Sections 3.8 and 11.5. The threshold shall be aluminum with integral grooves for a seal rubbing strip and for drainage. Anti-skid safety strips shall be provided.

The doors shall be designed to provide sufficient strength and rigidity to withstand a force of 200 pounds applied on an area 24 inches x 12 inches, with a maximum deflection of 0.5 inches with the long axis parallel to that of the door, 2 inches from the door edge and centered within the height of the door.

To avoid "oil canning" and warpage, the door design and construction shall take into account the differential expansion of the inner and outer skins of the doors under the extremes of the ambient and car internal temperatures.

All doors and edges shall be thoroughly sealed against air, dirt and moisture ingress when in the fully closed position. All door pockets and threshold plates shall be heated by heaters, which shall be controlled by the same type and rating ambient temperature sensor used to control the cab car heated windshields. The protective heat system shall be on its own circuit breaker.

Each side door opening shall contain two sliding panels which, when opened, shall withdraw into door pockets without scuffing against seals, insulation, or the door engine mechanism.

Each door shall be equipped with interlocking rubber bumpers on the leading edge, extending the full height of the door. When doors are closed, the two interlocking bumpers shall mate and form a weathertight joint. Seals shall be provided in the door opening to completely seal the door trailing edges. The doors shall be supported at the top by a Morton Manufacturing Company or equal roller slide arrangement, which shall offer minimum friction to the sliding motion of the doors. The doors shall be guided at the bottom in a manner that provides freedom from rattles and squeaks. Any wearing part of the door guide arrangement, including the interlocking rubber bumpers, shall be easily replaceable without removing the door.

In order to keep water from running down over passengers, gutters shall be installed over the side door openings to direct water away from the door areas.

3.11.2 Door Operators

Door operating mechanisms shall be provided to open and close the side doors and shall include positive locking of the doors when they are in the closed position. In the event of a single control system failure, the doors shall not inadvertently open while the train is in motion.

An arrangement shall be provided in the drive engine to each door which shall permit the door to travel in the closing direction without injury to a passenger caught between a pair of doors. The door operator shall be submitted to the Engineer for approval. The drive arm shall be equipped with a spring mechanism and arranged to ensure that the closing force shall not exceed 30 pounds as per APTA SS-C&S-012-02 in mid-travel. The spring mechanism shall allow the door leaf to be pushed back not less than 3.5 inches in case of entrapment between the edges of a closing door. The force required to move the door leaf back towards its door pocket shall be 20 ± 5 pounds.

A pneumatic piston-type air motor door operator or electric motor door operator shall operate each leaf of each door.

If a pneumatic piston-type air motor door operator is provided, the operating compressed air from the main reservoir system shall have a pressure regulator valve and a shut off valve readily accessible inside the car body in one of the door pockets. Moisture traps and/or filters shall be provided in the door operator compressed air system to prevent ingress of dirt or moisture in door engines. Materials used in the door operators or air system shall not be affected by either moisture or methyl hydrate which may be present in the air system.

Each operator shall also be fitted with a manual door open device, accessible when the adjacent access door panel is opened, that, when activated, shall open the corresponding door leaf and once released shall allow the door to reclose and restore the door operator to normal operating conditions.

The motion of the doors shall approximate simple, harmonic motion and shall, thereby, provide cushioning in both opening and closing. The speed of door movement shall be such that from the beginning until the end of door movement, on receipt of an “OPEN” or “CLOSE” command signal, including cushioning, the following times shall be obtained:

Opening: 2.0 seconds +/- 0.5 seconds

Closing: 2.0 seconds +/- 0.5 seconds

Adjustment shall be provided to enable these times to be maintained throughout the door operator life.

Adjustments shall be provided on door engine mounts and mechanisms to eliminate scuffing of either face of the door panels. Items, such as wiring, that are located in the door pockets shall be installed to prevent fouling of the door mechanisms. The door controls shall be trainlined to permit remote operation from control stations in each car. Door control stations shall be located adjacent to each of the side doors at the B-end on each car.

The operating mechanism shall contain obstruction-sensing feature(s). During the door closing cycle, the recycle circuit shall be effective when the door leaf is approximately 3.25 inches or less from the fully closed position. In this region, whenever a door leaf is being pushed back by

¼ inch or more, both door leaves shall immediately retract to a fully open position. An adjustable time delay feature shall be provided to hold the doors open. The adjustable range shall be between 0 and 5 seconds. If the obstruction is not removed, the doors shall continue to cycle open and close until the obstruction is removed or the time delay circuit is superseded by removal of the door close command."

3.11.3 Passenger Emergency Release

Passenger emergency operating devices shall be provided for each doorway, inside and outside of the car, in accordance with the applicable FRA regulations and APTA standards. When the device is actuated, the corresponding exterior side door leaves shall open under power if the compressed air and car electrical systems are functioning. If the systems are not functioning, continued pulling on the emergency cable shall unlock both door leaves and move each sufficiently so that the door leaves can be pushed open manually. When actuated, there shall be a minimum clear opening 30 inches wide by 74 inches high. The emergency operating devices shall be covered by a transparent, breakable cover. The inside devices shall be mounted at the appropriate heights above the handholds adjacent to the side door openings to be reached by passengers, operating crew or emergency responders (approximately 62 inches above the top of finished floor). The exterior devices shall be mounted approximately 71 inches above top of rail.

3.11.4 Employee Access

Employees shall be able to open the B-end side doors from the inside or outside of the car by means of switches located on the exterior of the car adjacent to the door and in the interior of the car at the door pockets. The switches shall be actuated by the staff key.

Panels that can be opened with a maintainer's key shall be provided in the door pockets and above the doors to permit access for maintenance and adjustment of the operating parts.

3.11.5 Audible Door Alarm and Warning Light

Audible and visual warnings that comply with the requirements of 49 CFR 37 and 38 shall be provided at each doorway and shall be activated prior to door opening and closing. Activation of the warnings shall precede the initiation of a door opening or closing sequence by approximately 4 seconds.

The warnings shall alert passengers inside and outside the car on the side of the car at which the doors are open. The design and location of the audible warning devices and visual warning devices shall be submitted to the Engineer for approval. The tone shall not be offensive, but at the same time, must call attention to door closing which is about to commence. The cycle rate shall be 0.5 to 2 cycles per second. The cycle rate shall vary in proportion to the voltage supplied to the device. The output of the audible warning shall be adjustable within a minimum range of 68 to 80 dBA. The initial output setting shall be 80 dBA. The output of the audible warning shall be adjustable.

The visual warning shall operate at a 50% duty cycle, and the cycle rate shall be approximately one cycle per second (0.5 seconds "ON"; 0.5 seconds "OFF").

LEDs shall be used for indicator and warning lights.

3.11.6 Door Position Indicating Lights

An exterior door status indicator shall be provided on each side of each car. The indicators shall be visible both forward and rearward in daylight and nighttime conditions and shall be illuminated with a red aspect under all conditions except when the door is fully closed. See Section 7.4. LEDs shall be used for this indicator light.

3.12 End Doors and Diaphragms

3.12.1 End Doors

Manually opening and automatically closing sliding end doors shall be provided except for the A-end of the Cab Car, which shall have a hinged door.

End doors shall meet the construction and strength requirements of the side doors described in Section 3.10.1. The doors shall be double sheathed, of aluminum alloy construction, fitted with windows, and shall be supported by roller in track hangers with bottom guiding as specified for the side sliding doors or approved equal. The doors shall be sealed against weather and noise. The door edge member at the latch side shall be in three pieces to facilitate latch removal or be an approved equal. Due consideration shall be given to minimizing warpage as for the side doors. The sliding end doors shall be provided with components to meet the following requirements:

1. The door shall automatically close. The closing device shall be concealed and adjustable but shall still be readily accessible for maintenance. The door is to be opened manually requiring a force no greater than 20 pounds to unlatch and move the door panel to the full open position.

   The mechanism shall contain provisions to adjust the force required to open the door. The opening force and closing speed shall be reasonably consistent through the full range of ambient temperatures given in Section 2.2.

2. A latch shall be provided to hold the door in the closed position. This latch shall be operable from either side of the door. Safety locks, operable by an approved crew key, shall be provided to preclude inadvertent opening of the end door by passengers when the car is located at the end of a train. A safety lock override is required for use in the event of an emergency.

3. A release lever shall be provided on each end door to permit opening of the door from inside the car.

4. A safety bar shall be provided at each end between the collision posts and approximately 42 inches above top of floor. When not in use, the bar shall swing downward and be secured by a spring clip on the web of the collision post.

3.12.2 Diaphragms

A non-metallic, modular, maintainable diaphragm shall be provided at each end of each car. The construction shall be such as to provide a safe, stable, weatherproof passageway between two coupled multi-level cars, and shall include diaphragm curtains with an automatic release-type handle.

To prevent undesirable noise, there shall be non-metallic wearplates on the rubbing surfaces.

The threshold plates shall be non-corrosive and have an anti-skid surface. The diaphragm assembly for each end of the coach car and the B-end of the cab car shall be B/E Aerospace 5MA1526-1, or approved equal.

The diaphragm assembly for the F-end of the cab car shall be B/E Aerospace 5MA1632-1 or approved equal.

The diaphragm shall be in full compliance with flammability and smoke emission requirements.

A retractable safety bar is to be installed in each end doorway.

Interface between diaphragm and diaphragm, at coupled connections, and between the diaphragm and the end wall of the car body, shall exclude water and air drafts.

Diaphragm size and height shall be compatible with cars currently operating in IDOT-supported or other Amtrak medium-to-long distance services in Illinois and the adjacent Midwestern states.

Articulated trainsets shall have conventional-style diaphragms on the ends of the sets which can couple to conventional rolling stock. Full-width car-to-car openings with diaphragms shall be provided between the articulated carbody sections within the articulated trainset.

3.12.3 Vestibule Curtains

A full-height, vertical curtain made of non-flammable material and suitable for this application, Adams and Westlake or equal, shall be provided, complete with an automatic-release handle.

The curtain shall be mounted at the left side of each diaphragm with a matching hook on the right side as seen looking at the diaphragm from outside the car.

The vestibule curtain installation system shall be submitted to the Engineer for approval.

3.13 Stanchions and Windscreen

The stanchions and windscreen shall be in accordance with 49 CFR 37, 38 and 238 and APTA Standards SS-C&S-006-98 and SS-C&S-016-99. Stainless-steel stanchions, including tubing, fasteners, and fittings shall be provided in the area of the side doors, stairwells, and in other areas of the car where passengers are likely to accumulate. Stanchions, of suitable strength, shall have an outside diameter of 1.25 inches and shall a 180 grit finish.

There shall be no center stanchion at the side doors. Provision shall be made for future installation of these stanchions.

Handrails that comply with applicable ADA and FRA requirements and APTA standards shall be provided on each side of the stairway from the intermediate level to the upper level, and from the intermediate level to the lower level. Details of the design and assembly shall be submitted to the Engineer for review and approval.

Suitable handholds shall be installed on either side of each side door opening to assist passengers when boarding or alighting from the car. Windscreens shall be provided at the A-end lower level side of each side door opening, extending from approximately 6 inches above

the floor to ceiling and projecting 27 inches into the car, and shall include stanchions. At locations where there is a potential for creating a dirt trap, the windscreen shall extend to the floor. Windscreens shall be of reduced width at locations where full sized windscreens will interfere with wheelchair or bicycle movement.

All installations shall be free of rattles, squeaks, sharp edges, burrs, scratches, pitting, and discoloration. For windscreen glass requirements refer to Section 11.5.1.

3.14 Thermal and Acoustical Insulation

Thermal and acoustical insulation shall be provided in order to comply with Sections 8.1 and 12 conditions. All precautions consistent with accepted industry practice shall be taken to keep carbody heating and cooling losses to a minimum and minimize transmission of noise into the car.

To reduce structurally borne sound, the floors, walls, doors, ceilings, ducts, and other sheets shall include approved fire retardant acoustic and thermal insulation. The exposed side of the insulating material shall be covered with a durable, waterproof, smooth-finished, and thermally stable material to prevent dirt from adhering or moisture from being absorbed.

The thermal insulation shall be as follows:

Floorpans: 0.75 pound density, unfaced fiberglass approximately 2 inches thick. The interior face of the sub-floor steel sheet shall be treated with anti-drumming material.

Sides, roof, ends: 2 or 3 inch thick, 0.75 pound density, reinforced kraft, foil l faced fiberglass bat. The perimeters of all fiberglass panels shall be sealed with pressure sensitive aluminum foil tape. The finished fiberglass installation shall thus have a complete vapor barrier facing the car interior. Dirt shall not adhere to the vapor barrier. Ends shall have the same materials and installation, but thickness can be 1 inch.

The insulation of the air conditioning compartment shall be primarily of an acoustical absorption design, using 3 pound density, semi-rigid, porous, neoprene coated fiberglass.

Door cavities shall be insulated with one inch thick Armaflex insulation type AP or approved equivalent to provide the required thermal and acoustical insulation requirements.

The acoustic insulation shall be as follows:

Floorpans: Spray on sound deadener of all undercar pans with minimum sound deadener to meet the sound levels. The interior face of the sub-floor steel sheet shall be treated with anti-drumming material.

Sides, roof, ends: Spray on sound deadener of all sides, roofs and ends with minimum sound deadener to meet sound levels. End thickness shall be 1 inch; sides and roofs shall be 2 or 3 inch thick.

3.15 Exterior Finish

Color scheme, lettering, signage and all graphics, tags and other lettering shall be compiled by the Contractor and submitted to the Engineer for approval.

The exterior paint scheme shall be three colors and details will be provided by IDOT or its designee. Drawings and samples with supporting data sheets shall be submitted to the Engineer for approval.

The exterior paint system shall be compliant for all air quality requirements in the IDOT service area.

The exterior front end of the cab car shall be legibly identified with the letter “F” on each side. The car number shall be legibly displayed on each side of each car. Stainless number boards, etched and backfilled with black Imron or equivalent paint shall be provided for each number board.

3.16 Stairs and Steps

The design of the boarding/alighting areas of the cars shall be suitable and safe for use at high-level or low-level platforms (see Section 2.7.1). Steps and deployable “traps” shall be provided at all doors (if necessary) to facilitate this. The distance from the top of the rail to the lower step shall be 18 inches above top of rail. The design shall minimize the retention of snow and water on the side door steps. Alternate (single-deck and/or articulated trainset) car designs will be considered. The Contractor shall submit details equivalent to those listed above for consideration of the alternative car design by the Engineer.

All steps shall have non-skid treads. The treads shall have ADA-compliant contrasting color nosings.

All stairs/steps shall be designed to meet all structural strength and safety requirements. Handrails of stainless-steel tubing shall be provided.

Sharp corners shall be avoided to minimize dirt entrapment and facilitate cleaning.

Exterior side steps shall be of expanded metal treads with steel framework and assembly shall be of sufficient strength to withstand anticipated passenger loads over the life expectancy of the car.

3.17 Toilet Room

Two, separate ADA-compliant unisex toilet rooms shall be installed in each cab car and trailer car. The required accessibility and accommodation provisions of the toilet room shall comply with Section 3.19. The dimensional layout and arrangement of the toilet room shall be submitted to the Engineer for approval. As a minimum, the following equipment shall be included in each toilet room:

1. Stainless steel hopper with seat and cover.

2. Transfer seat for wheelchair-bound passengers.

3. Vanity assembly which shall include:

a. a stainless steel wash basin.

b. a dispenser for liquid soap.

c. a tilted tempered glass mirror for wheelchair passengers.

d. a stainless steel paper towel dispenser.

e. a spring loaded faucet with a palm operated stem valve.

4. Waste container.

5. Disposable seat cover dispenser.

6. Two roll type toilet paper holder

7. Sanitary napkin waste container.

8. Flush-mounted retractable coat hook.

9. Polished stainless steel mirror for standing passengers

10. Exhaust fan and grille.

11. Fluorescent ceiling light powered by the emergency lighting circuit.

12. Three stainless steel wall mounted handholds around the toilet seat.

13. Illuminated toilet occupied status sign on the toilet room exterior wall.

14. PA speaker mounted behind a grille in the ceiling.

15. Toilet flush push button.

16. HVAC system outlet. Heating shall be provided by a floor strip. Exhaust-mode CFM shall exceed supply CFM by at least 250 CFM in order to reduce smells.

17. A waste product gravity-fed retention tank of sufficient capacity to support the needs of a 650-mile round trip (with a one-way travel time of approximately 6 hours) before requiring pumping out of the retention tank. Waste drain fittings shall be provided on both sides of the car.

18. A drain shall be included in the toilet room floor near the outside wall so that during the cleaning process, the cleaning solution shall drain to the outside of the car. The floor of the room shall be sloped so that the cleaning solution shall naturally flow to the drain.

    The drain line shall be routed under the coach so that the cleaning solution does not run or splash onto any underfloor equipment. The end of the drain line shall be treated to prevent the entry of vermin or insects, but not trap water or debris washed down the drain.

19. Ogontz drain valve with integral heater to drain the fresh water system.

20. Diaper changing table/installation.

3.18 Low Location Exit Path Marking

3.18.1 Exit Path Marking Standards

Low Location Exit Path Marking (LLEPM) shall be provided to give guidance to passengers and crew to exit the car when normal and emergency sources are not available, in accordance with APTA Standard SS-PS-004-99,.

3.18.2 Exit Path and Associated Signage

The exit path marking and signage shall be provided by high performance photoluminescent (HPPL) marking material. The material shall be as defined in APTA Standard SS-PS-004-99.

3.18.3 Exit Path

a) Marking material shall be applied on the floor as a continuous strip to ensure easy visibility to passengers and crew members negotiating travel to primary exit doors.

b) The width of each marking strip shall not be less than 1.00 inch and shall be applied with no uncovered interval exceeding 36 inches in length.

c) In all stairways, HPPL marking material shall be applied as a continuous strip applied on the partitions of both sides of the stairs.

3.18.4 Exit Doors

All primary exit doors (car end doors) and the side doors shall be clearly delineated with HPPL marking material. A minimum of 1.00 inch wide strips shall be applied to both sides of the exit doors or door frames and shall extend from the floor to a height a minimum of 12 inches above the floor.

3.18.5 Door Handles and Emergency Door Releases

Each door handle, latch or operating mechanism shall be identifiable using 1.00 inch wide outline stripping around the perimeter of the opening device when not limited by space.

3.18.6 Exit Door Sign

The primary exit doors and side doors shall be clearly marked with an HPPL “Exit” sign located on or immediately adjacent to each door not more than 18 inches above the floor measured from the floor to the top of the sign. The text and color requirements shall be in compliance with APTA Standard SS-PS-002-98 relative to exit door markings.

3.19 Miscellaneous

Car numbers, logos, signboards, signage and other graphics shall be applied to the interior and exterior of the car. Car end designations ("A" and "B") shall be included near the car numbers.

The car number sequence shall be provided by the Engineer. Drawings and samples and/or camera ready drawings with supporting data sheets for the car numbers, logos, signboards, signage and other graphics shall be reviewed and approved during the design review process..

On-board emergency equipment shall be provided in accordance with 49 CFR 239.

Four 5-pound dry chemical fire extinguishers, (2A-10BC) or equivalent, shall be furnished. Two shall be flush-mounted on the lower level in a prominent position near the stairways, and two shall be flush-mounted on the upper level in the end walls. The extinguishers shall be securely mounted on approved brackets in a manner that shall prevent vibration and rattling. Access to fire extinguishers shall be provided with maintainer's key latches for maintenance. Breakable glass or plastic windows shall be provided for in service access. Dry charge shall be as approved by the fire marshal in the area of intended use.

Each car shall be provided with a set of railway standard emergency tools permanently marked “IDOT” (or “Designee’s Initials” as provided by IDOT). These tools shall be: 1 auxiliary portable light, 1 handsaw, metal cutting, 1 axe, 1 crowbar, and 1 sledge hammer. The auxiliary portable light shall be DME Corporation Part No. P2070001214 or approved equal. The flush-mounted access door shall be fitted with a transparent plastic removable cover. Each car shall be provided with a first aid kit which shall comply with 49 CFR 239.101. The first aid kit shall be contained in a recessed cabinet with a transparent plastic window. First aid kit shall be one per car. Access to emergency tools and first aid kit cabinets shall be by maintainer's key or under emergency conditions by a pull ring attached to a zip strip.

Waste receptacles shall be provided adjacent to the side doors on both sides of the car and secured with latches operable with a crew key. Receptacle capacity shall be maximized consistent with the available space. A stainless steel waste receptacle with removable lid capable of containing a 30-gallon trash bag shall be provided on each intermediate level at the top of the stairway from lower to intermediate levels (or one receptacle in the passenger compartment vestibule wall per single-deck car).

Safety appliances shall be in accordance with current requirements of the Code of Federal Regulations, Title 49, Chapter II, FRA.

The exterior handhold arrangements of both ends of the car shall be identical. The following handholds shall be provided in accordance with 49 CFR 231.14:

1. One vertical handhold above the sill step, on each side of the car.

2. One horizontal handhold on each end sill, on each side of the coupler, at the end of the car.

Skirt panels for access to the trucks, shall be capable of being held in the open position, fastened in the closed position with the provision of safety catches under normal operating conditions.

Removable panels shall be secured with standardized quarter-turn fasteners.

A decal to identify the vehicle weight shall be posted inside A-end intermediate level electrical locker door. All decals and two (2) literature racks shall be reviewed and agreed to during design reviews.

Two (2) watercoolers for potable water shall be installed in the partition walls of each toilet room. Gravity-fed refrigerated water coolers with cup holders flush with the wall partitions shall be provided. The water coolers shall be equipped with a vacuum breaker to separate them from the non-potable water system.

3.20 Americans with Disabilities Act (ADA)

Accessibility to persons with disabilities shall be in compliance with 49 CFR 27, 37, and 38 (ADA).

There shall be space for two (2) wheelchairs on each car, or a total of eight distributed through each section of an articulated trainset (if proposed). The cars shall also be equipped with a portable bridge to negotiate passage from the car floor to the mini station platform, or vice versa. A safe, secure and rattle-free stowing area shall be provided in each car.

The portable bridge shall be readily deployed and stowed by one employee. Weight of portable bridge shall not exceed 30 lbs. Storage provisions for the bridge plate shall be included in the car design.

3.21 Bicycle Racks

Each car shall provide space and securing mechanisms for two bicycles next to the side access door, at the A-end of the lower level of the car (or nearest the vestibule if a single-deck car is being proposed). Kick plates shall be provided at the bicycle storage area to protect the walls from damage when transporting the bicycles.

3.22 Keying

The type of keys required for the cars shall be defined by the Engineer. As a minimum the keys shall consist of a staff key and a maintainer's key, The Contractor shall provide drawings identifying each key type and the location of its proposed use as identified in the Technical Specification. Three sets of keys shall be provided by the Contractor for each car.

3.23 Emergency Signage

The interior and exterior emergency signage shall be in accordance with the applicable FRA regulations and APTA Standards including, but not limited to 49 CFR 223.9 and 239, and APTA Standard SS-PS-002-98.

3.24 Food Service Area

3.24.1 Location and General Requirements

Each Business Class/Food Service car shall include an area for the storage, handling, preparation and sales of food and drinks. If a double-deck or bi-level design is used, the food service area shall be located in the upper level of business class cars between the Business Class compartment and the lounge table seating area. Alternative locations will be considered, for single-deck cars or trainsets, as well as for double-deck or bi-level car designs. The Contractor must demonstrate the benefits to IDOT or its designee of these alternate locations.

The food service area shall be sized and configured to provide at-seat service for the Business Class passengers and to provide counter service for coach class passengers. Chilled docking

space(s) shall be provided for food service carts used to provide at-seat food and beverage service to passengers.

The floor in the attendant's work area for sales and preparation of foods and beverages shall be sloped to lead to a floor drain. This shall allow for ease of cleaning, such as by hosing down the floor area, etc.

All food service equipment shall comply with UL, USPHS and NSF/FDA requirements. All equipment shall have safety restraints in accordance with NTSB guidelines.

The equipment shall provide a fully-functional food service area. All equipment proposed for use in the food service area shall be demonstrated to have been successfully used in a railroad/rail car environment for at least three years.

3.24.2 Food Service Features/Amenities

As a minimum, the following amenities shall be provided in the food service area:

- Hand wash sink
- Ice bins
- Refrigerated compartments
- Freezer compartments
- Warming ovens
- Coffee Maker
- Dry storage
- Food service cart docking station
- Display racks
- Lockable cash drawer
- Cash register
- Trash container
- Fire suppression system, including an overhead, pressurized sprinkler/fog system over the microwave and warming ovens.
- Individual wall- or cabinet-mounted 20# fire extinguishers suitable for this application.

Counters and enclosures housing food service equipment shall be constructed of stainless steel. Food service components shall be designed to minimize noise and damage from abusive use and handling. Corners, in work areas, shall have radii to prevent injury and to provide for ease of cleaning. All edges shall be "safety-edged" to prevent injury of personnel coming in contact with these edges. Sealing and construction of equipment/units shall not permit liquids

or moisture to harbor behind, over or under any of their surfaces. Each compartment shall be configured for ease of cleaning and for inspection.

Sinks and ice wells shall be integrally formed into the counter top and shall be drained to the retention tank. The sink shall be designed with an anti-splash lip and shall be equipped with manual ON faucets for hot and cold water, with auto-delayed shutoff.

Hinged doors shall be double-wall constructed. All hinged doors, when in their full open position, shall be capable of withstanding a 250-pound downward force applied to the top edge of the door, 2" from the latch end. Compartment doors shall be designed to allow complete clearance of the compartment opening when the door is opened 90 degrees. All doors shall be capable of opening 180 degrees with sufficient clearance to prevent any tendency to bind. Unitized door fronts shall be considered for all storage areas.

Latches shall have no open areas for accumulation of dirt and moisture. All latches shall be stainless steel or chrome-plated brass. Strikers shall be one piece formed or die-cast stainless steel and shall be easily removable. Latches shall be easily operated, require no lubrication and maintain full closure. Securing fasteners shall be stainless steel and shall be arranged to allow quick replacement of the latches and strikers.

Utility and non-refrigerated compartment hinges shall be heavy-duty stainless steel, flush-mounted and self-closing. Pins shall be a minimum of ¼" diameter and shall be securely welded to its mating hinge half. All hinges shall be fastened with stainless steel "ADVIL" lock bolts.

All components subject to periodic maintenance, replacement or testing shall be designed for ease of replacement. Replacement time for any major appliance shall not exceed two hours and shall not require any disassembly of the counter or enclosures.

Unless otherwise specified, all food service equipment and appliances shall operate from 120/208 Vac, with grounded neutral. Control voltage shall be 120 Vac. Twist-lock electrical receptacles and plugs shall be provided for ease of replacement of each appliance.

A circuit breaker panel for all Food Service area power shall be located convenient to the Food Service area. This panel shall contain all terminal boards, circuit breakers and other items required for the safe distribution of electrical power.

3.24.3 Refrigerator/Freezer Units

Modular, self-contained "chiller-type" refrigeration and freeze units, Traulsen or equivalent, designed for ease of replacement shall be provided. Refrigerant shall be R404A or equivalent environmentally-friendly refrigerant. Solid-state non-adjustable controls with "On Demand" defrost cycles for freezer units shall be provided.

Each chiller unit shall have a numerically-scaled indicating thermometer, accurate to +/- 3 degrees F installed in each chiller compartment. The thermometer shall read air temperature in the warmest part of the compartment. The indicator portion of the thermometer shall be easily seen and read from the outside of the chiller. Door-mounted thermometer displays shall not be used.

Refrigerator pull-down shall be to 40 degrees F or below within 30 minutes of start-up. Temperature within each compartment shall be maintained between 33 and 40 degrees F. Freezer pull-down shall be to 0 degrees F or below within 45 minutes of start-up. Temperature within each freezer compartment shall be maintained between -10 and 0 degrees F.

Condenser air shall be vented to the exterior of the car, unless car heat load calculations show the car is adequately cooled/ventilated to compensate for the refrigeration heat load. Heat shall be automatically applied in the vicinity of refrigeration condensers to facilitate cold weather start-up.

Chiller doors shall have a minimum of 2" of insulation. Latches for the chiller doors shall be heavy-duty die-cast with a polished chrome finish and shall automatically compensate for gasket wear and/or door sag. Hinges for chiller cabinet doors shall be an edge-mounted, heavy-duty design and shall be commercially-available and easily replaced.

Bell trap filter drains equipped with a 1" I.P.S. outlet shall be provided for all chiller/insulated cabinets.

3.24.4 Microwave/Reheating Ovens

Food service area equipment shall include one large-capacity, heavy-duty microwave oven manufactured by Amana, Litton or equivalent. .

A Traulsen or equivalent reheat convection oven shall be provided for reheating pre-prepared foods. Interior reheat oven temperature shall be adjustable to 400 degrees F or higher and shall be controllable within +/- 3 degrees F. The convection oven, including the door shall be insulated with a minimum of 2 inches of insulation. Oven door latches shall be heavy-duty with a polished chrome finish and shall automatically compensate for gasket wear and door sag. Latches shall be commercially available and easily replaceable.

3.24.5 Coffee Maker

All food service area installations shall include coffee makers manufactured by Brewmatic or equivalent with suitable safety restraints. The coffee maker shall be capable of brewing not less than 896 ounces per hour, when operated continuously. Each brewer shall include hot water provision for tea, etc. Loss of electrical power shall not interrupt the brewing cycle, nor shall it permit the coffee decanter to be over-filled. Coffee brewed into the decanter shall be an average 175 degrees F. A stainless steel server plate shall be provided to maintain coffee at a serving temperature of 170 degrees F, minimum.

The coffee maker water tank shall be protected against overheating and freezing. Nominal water temperature within the tank shall be 198 degrees F. A manual Tomlinson-type spigot shall be used for dispensing hot water.

Operation of the brewer shall be by pushbutton switches. All switches and indicators shall be illuminated to indicate their functions and shall include:

- On/Off
- Brew
- Warmer On/Off
- Low Water

A manual drain cock shall be provided to empty the brewer water tank. A server platen drain shall be provided to carry overflow or spillage to the primary drain. The brewer shall be removable for maintenance and cleaning without the use of tools.

3.24.6 Lighting and Ventilation Requirements

Overhead lighting, consistent with the lighting levels and general arrangement of the fixtures provided in the coach areas, shall be provided in the food service area. A reading light, adjustable by the attendant shall be provided. Spot-light type lighting, adjustable and controllable by the attendant, located during the mock-up review, shall also be provided. LED interior lighting is an option for the food service area lighting.

Two multi-speed ventilation fans, controllable by the attendant, shall be provided in the food service work area. One fan shall increase the flow of conditioned air into the area, the second fan shall be an exhaust fan venting air to the exterior of the car.

3.24.7 Safety and Security Devices

All appliances shall be secured to the car in a manner which shall prevent them from moving during operation of the train. The restraints shall be designed to permit removal of the appliance, for replacement or maintenance, without the use of tools. Appliances, such as coffee pots, containing hot liquids, shall be constructed and restrained in a manner which will prevent hot liquids from splashing during operation of the train.

Security bars with hasps for padlocks to lock refrigerated and supply cabinets shall be provided. All hardware, permanently attached to food service equipment shall be welded to the sub-structure. Welding is not permitted on the outside surface for the attachment of security bar hardware. The Contractor shall provide for the storage of removable security hardware. A system to lock the food service areas when unattended shall be provided.

3.24 Work Tables

Ten work tables shall be provided at facing seat locations in the coaches and cab cars. IDOT or its representative shall specify the locations where the work tables are to be installed. Each table installation shall be equipped with two duplex 20 Amp, 120 Vac GFI outlets.

Work tables shall be designed to meet the strength requirements of 49 CFR 238. The table profile shall allow for easy entrance and exit to the window seats. The design, location and mounting of the work tables shall be submitted to the Engineer for approval.

3.25 Luggage Compartments

Enclosed luggage compartments shall be located above each seat and running the full length of both sides of the car on all levels. The compartments shall have securable compartment covers. The capacity and configuration of the luggage compartments shall be maximized to the extent possible. Open luggage racks shall be provided to accept large pieces of luggage and garment bags.

3.26 Carbody Mock-Ups

Mock-ups shall use as many actual parts proposed for use on the cars/trainsets as possible and shall be constructed of substantial materials adequate for this purpose. Upon completion of the reviews and modifications, the Contractor shall make the mock-ups available to IDOT or its designee for training purposes. If IDOT or its designee declines to retain any of the mock-ups, they may be disposed of by the Contractor.

The Contractor shall make the mock-ups available for review preferably in Illinois, but at least within the continental United States.

Mock-ups shall include:

1. Cab Area

   The Contractor shall construct a full size mock-up of the operator's cab showing the location and arrangement of the principal elements of the cab, including all power and braking controls, as well as all panels used for trouble-shooting and communications. This shall include any cab signal displays, the windshield and side windows of the cab, adjustable operator's seat and foot support, and all doors (both into the main body of the car as well as vestibule (or other) doors to the outside. The mock-up shall use as many actual parts proposed for use on the cars/trainsets as possible and shall demonstrate the sight lines for a 5th percentile female to a 95th percentile male, the operation of any sliding or drop sash windows. Changes to the mock-up and final car design shall be made as necessary, at no cost to IDOT or its designee, to satisfy the comments of the Engineer.

2. Side Doors/Vestibule Area

   This shall include the complete side door and vestibule area, with walls, side doors, door operators, emergency door releases, bridge plate and stowage compartment (or other provision), trash receptacles, toilet room, toilet room door, equipment rooms and door or other control/communications panels as may be located in the side door/vestibule area. This mock-up shall demonstrate the operation of the side doors and the door control box. The mock-up shall utilize actual door panels, hangers, threshold, linkage, controls, switches and operator. The support structure should be an exact replica of that in the car, though it may be made of suitable, different materials. The structure should include the door header with access panels and ceiling or light fixture area, to be able to assess accessibility for maintenance. The mock-up shall include sufficient door pocket structure, access panels and exterior skin with side body indicator lights. The mock-up shall be reviewed by the Engineer and changes to the mock-up and final car design shall be made, as necessary, at no cost to IDOT or its designee, to satisfy the comments of the Engineer.

   Owing to differences in car equipment and configuration that may be responsive to this specification, it is understood that arrangement and location of equipment and facilities may vary from one car design to another. Nevertheless, it is the responsibility of the Contractor to ensure that the equipment and functions listed in the preceding paragraph are amply demonstrated in any mock-up or mock-ups as may be required.

3. E&H/Wheelchair Accommodations

The Contractor shall include the E&H/wheelchair accommodation area and two rows of conventional seats immediately adjacent to the wheelchair area to demonstrate that wheelchair and E&H access has been reasonably provided for and that any securement devices are easy to operate and do not require a crew member to assist (even though such assistance may be provided in actual service). This mock-up shall also demonstrate that safety of the passengers, crew and maintenance personnel are ensured and that maintenance, accessibility and serviceability of any of the installed equipment has been maximized. This mock-up shall also be used to verify industrial design practices being employed in the design of the cars, with respect to materials, colors, textures and finishes. The mock-up shall use as many actual parts proposed for use on the car as possible. Changes to the mock-up and final car design shall be made as necessary, at no cost to IDOT or its designee, to satisfy the comments of the Engineer.

4. Food Service Area

A full-sized mock-up of the food service (café) area, including the table seating area and the crew office shall be provided for review by IDOT or its designee. Final location and configuration of the equipment and amenities to be provided shall be determined from the mock-up. This mock-up shall demonstrate maintenance, accessibility and serviceability of any of the installed equipment has been maximized. This mock-up shall also be used to verify industrial design practices being employed in the design of the café (and adjacent areas), with respect to materials, colors, textures and finishes. Spot-type and reading lights to be provided to assist the attendant in the performance of his or her duties while working in the food service area, shall be located as part of this mock-up review process (see Section 3.23). The mock-up shall use as many actual parts proposed for use on the car as possible. Changes to the mock-up and final car design shall be made as necessary, at no cost to IDOT or its designee, to satisfy the comments of the Engineer.

SECTION 4

4 TRUCKS

4.1 General

Each car shall be equipped with two four-wheel, roller-bearing trucks suitable for normal, sustained operation at revenue service speeds up to 110 mph. Trucks shall enable the cars to meet the ride comfort requirements of Section 12.3.

The truck and its attachment to the car body shall comply with the applicable FRA regulations and rules, and applicable APTA Standards, including, but not limited to 49 CFR 238.111(a), 49 CFR 238.219, 49 CFR 238.227, and APTA Standard SS-C&S-008-98.

The truck frame and all truck parts, including brake gear, shall be capable of withstanding the maximum stress imposed by the forces acting on the frame, including, but not limited to, dynamic interaction between vehicle and track, braking, equipment operation, and any combination of these conditions.

A mechanical safety connection shall be provided between car body and truck to meet designed load transfer requirements. A positive mechanism shall also be provided such that the truck shall be raised with the car body when the body is lifted. The truck assembly shall be free from rattles and noise in service.

All truck components, with the exception of wheels, brake equipment, and brake shoes shall serve for a period of two years or 300,000 miles (whichever comes first) prior to need for replacement.

Castings for each truck shall be magnetic particle inspected per ASTM E709-80 in accordance with the manufacturer's plan. Radiographic and ultrasonic inspection may be used to supplement magnetic particle method for frame casting qualification. All casting inspections, dimensional/layout, MT, RT and UT, shall be documented, available for review upon request and retained in accordance with Contract requirements.

Welding done on truck and truck components can only be performed by certified welders. Welder certification is covered in Section 11.8. Welding in critical areas shall be magnetic particle inspected.

Wheel pairs shall be matched, not to exceed one-half tape size per axle set. Mounted wheels shall be concentric with respect to bearing centers and tread at plane of taping line within 0.015 inches T.I.R. and not to exceed 0.015 T.I.R., inches out of parallel to each other, per AAR requirements.

All equipment shall be secured to truck structure using appropriate torque values and locking methods as necessary on all attachment hardware. Fasteners used for truck mounted components shall be Grade 5 or greater as required, to meet design strength requirements for each application.

4.2 Weights and Dimensions

Trucks shall be designed to obtain the minimum weight, consistent with adequate strength, durability, reliability, performance, and low maintenance.

1. Truck wheelbase: 8'-6" (nominal).
2. Wheel diameter (new): 33".
3. Track gauge (nominal): 4'-8.5".

The completely assembled truck shall not exceed the clearance limits, required between truck and car body for all operating conditions with new or worn wheels, secondary spring deflection, deflation and maintenance.

4.3 Truck Frame

The truck frame shall be of cast or fabricated steel construction. Peak forces resulting from acceleration and braking shall be transmitted through the frame in such a way as to produce approximately equal loading on wheels.

4.4 Wheels

Wheels shall be 33 inch diameter, multiple-wear type, AAR Class *"A"*, cast or wrought in conformance to the requirements of Section 11.3.2. Wheels shall be fully machined with hub diameter and rim inside diameter held to within a 0.030 inch total indicator reading. Each wheel shall have a visual wear indicator as per AAR Recommended Practice P619-83.

Wheel profile shall be 5-1/2 inches wide and in conformance with APTA SS-M-012-99 Rev. 1, “Standard for the Manufacture of Wrought Steel Wheels for Passenger Cars and Locomotives” with 1 in 20 tread taper. The wheels shall be machined all over with 250 micro-inch finish. If the proposed design, as required in Section 9.5, includes one brake disc per axle, then one wheel per axle shall be a standard wheel and the other wheel shall be machined to accept a WABCO (or equal) 24-inch brake rotor. Particular care shall be taken with the mounting holes drilled and tapped in all wheels for brake disc attachment. These holes shall be of sufficient depth, bottom tapped, and completely free of drill cuttings or other debris to allow proper torquing of the required disc attaching bolts.

Wheels shall be dynamically balanced to provide the ride comfort requirements of Section 12.3 over the intended operating speeds of Sections 2.3 and 4.1.

4.5 Axles

The axles shall be solid and of forged steel in conformance to the specification detailed in Section 11.3.1. As a minimum the wheels, axles and journal bearings shall be mounted using the practices specified in the AAR Wheel And Axle Manual. Pressure graphs and inspection data sheets shall be provided in the Car History Book for all wheel and axle assemblies.

4.6 Journal Bearings (See also Section 11.11)

The journal bearings shall be fully enclosed, No Field Lubrication (NFL) roller-bearings, Timken Part No. HM 133444-90382 or equal including the HDL seal shown in Timken drawing E43798, 6 ½ inches x 12 inches, Type AP, Class F.

Journal bearings shall be thoroughly packed with the recommended amount of AAR approved grease, in accordance with AAR specification M-942.

Grease fittings shall not be provided.

The journal-bearing housing shall accept a journal bearing heat detector (smoke-bomb) installed by the Contractor.

4.7 Suspension

The truck-suspension system shall be designed to minimize the transmission of axle lateral, longitudinal, and vertical accelerations to the extent possible without compromising wheel load equalization or roll stability. See Sections 2.3, 2.7 and 3.1.1. Contact with lateral stops shall be minimized when traversing switches and rounding curves.

Adjustment shall be provided at the primary suspension to compensate for radial wheel wear specified in Section 2.4.

The secondary-suspension springs shall be Firestone Model 222 or approved equal. Primary rubber springs (chevrons) shall be permanently identified into two categories of spring rate tolerances. All chevron springs on an axle shall be of the same tolerance category. Vertical dampers and yaw dampers of proven design shall be provided. Anti-seize compound is to be used on mounting bolts of dampers to facilitate replacement.

Elastomeric, laminated lateral suspension and longitudinal traction pads shall be provided between the truck frame and bolster to minimize the number of possible paths to attenuate noise and vibration from the wheels to the carbody through the truck frame so that the requirements of Section 12.2.2 and 12.3 can be met. The suspension system shall demonstrate compliance to 49 CFR 238.227 during dynamic testing and 49 CFR 213.57 during static testing.

4.8 Leveling Valve System

The air suspension leveling system shall:

1. Provide for a 3-point, 3-valve system.

2. Permit consistent practical static height leveling at each leveling valve, to within ± 0.250 inches measured across the air spring seats on rising air pressure using a standard shop procedure.

3. Maintain the leveled height for a passenger load variation from AW0 to AW3 weight condition.

4. Inflate and deflate the springs at a rate not less than maximum practical passenger loading and unloading rates (4 passengers per second).

5. Provide for maximum possible car body roll stiffness.

6. Provide a load weight air pressure that is proportional to the load carried by the air springs.

7. Provide for installation of the leveling valves on the car body, close to the sidesills, for ready adjustment access on floor level track.

4.9 Tilt Mechanism

Although not required, the Contractor may propose tilt-capable and equipped cars and/or trainsets. If tilt-capability and equipment is included, the Contractor shall demonstrate at least three years successful experience with this equipment on a fleet of rail vehicles. Further, the tilt system on the fleet of vehicles shall demonstrate an availability of at least 95% minimum, and shall have achieved an MTBF consistent with IDOT or its designee's requirements.

The Contractor shall submit, as part of the proposal, specific details of the application history of the tilt equipment and system being proposed. The Contractor may offer a design which is basically unchanged from a service-proven design, but which must be varied slightly in design or manufacture to meet IDOT or its designee's requirements. The Contractor shall show, in detail, what has been changed in the equipment and why such changes will not adversely affect operation and performance. The Contractor's submittal shall include a test plan for the proposed tilt equipment, considering the particulars of the IDOT application.

The IDOT routes, in particular the Chicago-St. Louis line, will require modification to take advantage of the tilt-capability (if proposed). As part of his proposal, the Contractor shall provide a list of the required capital improvements along with order-of-magnitude costs that would allow the Chicago-St. Louis line to take advantage of the tilt capability.

SECTION 5

5 COUPLERS AND DRAFT GEAR

5.1 Coupler

The coupler shall be APTA RP-M-003 (latest revision) compliant, short shank Type H Tightlock coupler rotary operated, bottom operated with double rotary locklift operating mechanism for passenger cars. The coupler assembly shall be arranged for bottom operation by means of an operating rod located on the left-hand side of the car

5.2 Yoke

The yoke shall be quadruple shear yoke No. 46637 as supplied by National Casting or approved equal to match the type MS-489-6A draft gear.

5.3 Draft Gear

Single cushion National Castings Type MS-489-6A draft gear or approved equivalent, shall be provided.

5.4 Coupler Carrier

The coupler carrier shall be designed in accordance with 49 CFR 238.207.

The coupler shall be supported by a spring-loaded carrier fitted with an abrasion-resistant, replaceable, manganese-steel wear plate.

SECTION 6

6 CAB CAR

6.1 General

The Cab Car shall be designed and constructed in accordance with the applicable FRA regulations and rules and APTA standards.

The Cab Cars shall be identical in all respects to the Trailer cars, except as specified in this Section.

A full width cab shall be located at the F-end (front) of the cab car in accordance with 49 CFR 229.11. The cab shall be separated from the passenger compartment by a wall with a lockable, hinged door. The cab door shall be hinged to permit closing off cab compartment and the cab area. When not in use as a train control unit, the doors shall enclose the control area and free the seat on the opposite side of the control unit for passenger use. There shall be no operable controls, circuit breakers, or switches in this area

An equipment locker behind the cab shall house intercar jumper cables, dummy receptacle plugs, the radio and radio power supply, an event recorder, and any other apparatus that should be logically located there. There shall also be space in the locker for a stretcher and the Operator's personal effects.

6.2 Air Brake Equipment

Cab car mounted air brake equipment shall be Wabco schedule 26-C or equal.

A type 26B-1 brake control valve shall be mounted on the control panel, shall be within easy reach of a seated Operator, and shall incorporate a means to cut out the valve so that train braking can be controlled from the locomotive. The valve shall contain a handle which operates through the following positions:

1. Release
2. Minimum reduction
3. Full service
4. Suppression
5. Off
6. Emergency

Exhaust air from the brake valve shall be piped to the atmosphere through the floor. The brake handle shall be removable and when not in use shall be stored in a secure place on the console. Alternatively, the Contractor may propose a single handle, combined brake and power master controller for the cab cars.

Two duplex air gauges shall be located on the console, directly in front of the Operator within the Operator’s normal line-of-sight when seated. One gauge shall show the air pressures in the main reservoir (red needle) and in the equalizing reservoir (white needle). The other shall show the brake cylinder pressure (red needle) and the brake pipe pressure (white needle). Both gauges shall be internally illuminated.

An emergency brake valve, Wabco B-3B or equivalent, shall be located in the cab area and shall be accessible for operation from outside the cab wall when the full width cab is not in use. It shall be arranged so when activated, it shall cause an emergency brake application in either the cut out or cut in positions of the brake valve.

6.3 Control Equipment

The cab area shall contain an upper control console, side control console, lower side control console and a console located directly in front of the Operator. The arrangement of the operating controls shall be of a design agreed to by the Engineer and the Contractor. The controls most frequently use shall be closest to the operator and those least used furthest away. The following is a list of the operating controls to be installed in the cab:

1. Locomotive throttle controller with dynamic brake control
2. Reverser handle for direction control
3. Horn sequence control
4. Horn control
5. One electric warning bell control switch
6. Locomotive sanding control pushbutton
7. Headlight / auxiliary light switch (off; dim; bright; bright+aux)
8. Windshield heater control switch with indicator light
9. Two-windshield wiper control knobs
10. Console illumination dimming control
11. Overhead ceiling light switch
12. Integrated communications control unit (ICCU) to select VHF radio, intercom or public address functions for the handset
13. Communication handset and holder
14. Cab heater control switch
15. One alertness control system acknowledge switch and one alertness control system acknowledge foot pedal switch.
16. Air brake gauges
17. Speed indicator
18. Locomotive attendant call bell and pushbutton control switch
19. Locomotive engine run/stop control pushbutton switch
20. Locomotive fuel pump control switch
21. Locomotive generator field switch
22. Thumb lever actuated control switch (Cab Setup Switch) for enabling or locking out all locomotive controls
23. Remote locomotive load meter
24. Car number board light switch
25. Dynamic brake warning indicator
26. One green train “Doors Closed” indicator
27. Locomotive wheel slip indicator
28. Locomotive main engine fault indicator
29. Car battery charger normal indicator
30. Brake applied indicator
31. Zero speed indicator
32. Locomotive Pneumatic Control Switch (PCS) indicator light
33. Right marker light control switch with indicator
34. Left marker light control switch with indicator

35. Door interlock override sealed switch with indicator light
36. Zero speed override sealed switch with indicator light
37. TMS audio/visual alarm panel
38. Non-Operator's side of cab light switch
39. Headlight failure indicator lights
40. Auxiliary failure indicator lights
41. Locomotive engine run switch
42. Two door enable switches with indicator lights
43. HEP alarm cutout sealed switch
44. Auxiliary flash enable
45. Auxiliary flash disable

Where appropriate, pilot lights shall be incorporated into the switch controlling the device. For example, the headlight switch, marker light switch or the loco sanding push button

A panel containing all the circuit breakers for the equipment particular to the cab shall be located on the rear cab wall and shall be accessible to the Operator. The panel shall include circuit breakers for the radio communication and public address systems and for other cab control equipment. This panel shall be covered by a hinged panel with a lock. On the main circuit breaker panel at the B-end of the car, a main low voltage dc cab services circuit breaker shall be provided as the feeder breaker for this panel.

It is the Contractor's responsibility to demonstrate an understanding of and make provisions in its designs for the interface of the new rolling stock being procured via this specification with new 110 mph-capable locomotives being procured separately by IDOT or its designee. The Contractor is responsible for including appropriate interface management and coordination tasks and time in its program for the design and construction of the new rolling stock. A similar responsibility will fall to the contractor providing the new 110-mph capable locomotives.

6.4 Miscellaneous Cab Equipment

Each cab shall be equipped with the following accessories:

1. Windshield Wipers (both sides)
2. Communication handset and holder
3. Lighting

All brake gauges shall be illuminated by dimmable lights. An overhead cab light fixture shall be provided. It shall be the same as that used to illuminate the end door passageway or approved equal and shall have an independent control switch. All above lighting shall be protected by a circuit breaker.

1. Operator's Seat

   A floor mounted, high-backed Operator's seat National Seating Company Model 0849 or approved equal shall be provided in the cab.

2. Foot Rest

   A foot rest shall be provided with location and shape consistent with human engineering criteria.

3. Sun Visor
Two (2) sun visors shall be installed within the cab area. One sun visor shall be usable at the Operator windshield area. The other sun visor shall be useable at the sliding sash area. The sun visors shall be padded, fully adjustable in all directions, and shall store unobtrusively and securely when not in use. They shall not interfere with access to the controls or viewing of the gauges or indicators.

4. Coat Hooks
A folding coat hook shall be mounted on the cab inside wall. Two coat hooks shall be installed in the locker behind the cab.

5. Form Holder
Two (2) standard cab form holders and a log book holder shall be mounted on the inside rear wall.

6. Train Order Clip
A train order clip shall be mounted within easy reach of a seated Operator.

7. Paper Towel Dispenser
A paper towel dispenser shall be installed within reach of the Operator.

6.5 Additional Cab Car Equipment

6.5.1 Speed Indicator

A speed indicator system shall be installed in a position that shall be easily visible by the Operator. Speed indicator range shall be 0 – 130 mph. A speed sensing gear and magnetic pickup shall be mounted on the number three axle seen from the B-end. The magnetic pickup and mounting shall be fully adjustable for proper operation and shall be securely lockable in any adjusted position.

The speedometer shall contain a red LED track speed warning indicator which lights at 110 mph. In addition, the speedometer shall be provided with fail-safe relay contacts which open on overspeed setting of 113 mph or when the relay is de-energized (power is lost to the unit). Relay contacts shall be rated for 10 amps and protected against shorts and transients. Overspeed selection is adjustable by using a pushbutton at back of speed indicator (113 mph +/- 5 mph).

The LED's shall be easily visible by the Operator in the normal seated position.

When the actual speed is above the selected overspeed setting, the overspeed brake magnet valve shall be dumped initiating a penalty brake application.

The overspeed brake magnet valve shall be mounted on the same panel as the alertness control system magnet valve and TCS System magnet valve.

6.5.2 Cab Communications

The cab cars shall be equipped with communications equipment from which the Operator may select a voice communication link with the railroad operating authorities through the VHF radio, private conversation with a train conductor through Intercom (IC) system, an announcement

over the train Public Address (PA) system or with the "Passenger Emergency Intercom" (PEI) stations in the cars. As a minimum, the cab communications system shall include a VHF radio and radio base, an Integrated Communications Control Unit (ICCU), a VHF antenna, handset and cradle and radio PA/IC Interface unit.

6.5.2.1 VHF Radio

The VHF radio shall be an ASTRO Digital Spectra Clean Cab Radio, or approved equal. The multi-channel analog/digital mobile radio shall be capable of operating on 255 independent TX and RX frequencies including all wideband and narrowband frequencies specified by the AAR. In addition, the radio shall support DTMF signaling, PTT-ID and 12.5kHz channel spacing. The radio shall be programmed as directed by the Engineer.

The VHF radio shall be equipped with a programmable Time-Out Timer (TOT), factory preset to 60 seconds.

The radio unit shall be mounted in the equipment locker adjacent to the cab and shall be accessible for maintenance. A radio mounting base shall be provided for the radio.

The radio unit shall be designed to operate from the car 72 Vdc low voltage power supply.

6.5.2.2 Integrated Communications Control Unit (ICCU)

There shall be one ICCU control head located on the cab side console of the cab area. The control head shall be used by the Operator to provide a radio communications link with the railroad operation authority. The control head shall contain four backlighted pushbuttons "RAD", "PA", "IC" and "CALL". The "RAD" and "PA" pushbuttons shall permit selection of radio and public address. Both the "IC" and "CALL" pushbuttons shall initiate an intercom call signal that will be heard in all control cabs and at all activated door control stations. The ICCU shall be operated by either the Push-To-Talk (PTT) button and the panel's internal microphone or by the handset located adjacent to the unit. The ICCU shall be capable of programming up to 90 channels as home channels. The unit shall be complete with an integral vacuum fluorescent alphanumeric display to provide the standard FAP display used by railroads. The display shall provide the ability to program unique alpha home channel names and special messages to provide easy identification. The display shall provide LED indication showing the system activated and the mode in use

6.5.2.3 VHF Radio Antenna

The VHF radio antenna shall be omnidirectional, low profile, hard-covered style and is to be designed for transit vehicle application. The unit shall be located on the cab car roof at the A end of the car.

6.5.2.4 Handset and Holder

Handsets shall be equipped with a normally closed push-to-talk switch. The handset cord shall be equipped with an adequate strain relief fitting where it is attached to the handset. A handset holder shall be provided with each handset.

6.5.2.5 Radio PA/IC Interface Unit

A radio PA/IC interface unit shall be provided to work in conjunction with the VHF radio and the PA amplifier. The unit shall provide the Operator the ability to make public address (PA), Intercom (IC) or radio calls from the cab using the ICCU and handset.

6.5.3 Passenger Emergency Intercom

The cars/trainset shall include a passenger emergency intercom (PEI) system. The PEI system shall permit emergency communication between passengers, the Operator and other members of the traincrew between the PEI control panels and the existing intercom system.

A PEI call station panel for passenger use shall be located on each vestibule bulkhead (if double-deck or gallery-type cars are used, these shall be on each bulkhead on both levels of the car). Crew area PEIs (for traincrew plus the Operator in the cab car) shall be located out of the normal public area on the cars (in the vestibules/cabs) and equipped to respond to a call from a public area PEI.

Each call station in each car shall be equipped with the following and shall function as described below:

- A flush-mounted microphone-speaker, behind a perforated grille
- A polished stainless steel push button (1.25 inches in diameter) labeled (nominally 45 inches above the car floor) “Passenger Emergency Call” which shall activate the PEI system. The button will be slightly recessed and shall be surrounded with a 0.25-inch high, red colored circular hard anodized Teflon coated aluminum escutcheon ring.
- When the PEI is activated by pushing the button, a tone shall be generated that is broadcast at the PEI being activated as well as at the Operator’s PEI. The Operator’s/trainman’s PEI shall also have a red LED on it which activates when a call has originated from one of the PEIs in the consist. When the Operator or one of the trainmen responds to the passenger’s call, another tone of a different frequency shall be generated and broadcast on the Operator’s/trainman’s PEI, as well as the PEI at which the first call originated. When the Operator/trainman releases the handset switch, the red LED shall go out and the first tone shall sound again. If no further messages are sent from either location (call origination or call responder), the system shall time out. Time out time shall be adjustable and initially set to 10 seconds.
- An embossed stainless steel plate permanently attached adjacent to the intercom box. The plate shall have the car number in numerals and type II Braille embossed on it.

6.5.4 Train Monitoring System

The cab car equipment shall include an Event Recorder (ER), compliant with all FRA requirements for this device, which shall record train operating parameters continuously, and a Train Monitoring System (TMS) which shall monitor the Operator's vigilance. Train operating parameters, with real time date stamping, received from trainline signals or pressure transducers on the brake system shall be continuously recorded in digital form by the ER. For analysis of train operation or in the event of an accident, it shall be possible to download the recorded data to a portable computer. The ER shall be initially set and maintained at Greenwich Mean Time Standard, but it shall be resettable to local time standards through the use of download software.

The TMS shall detect the actions of the Operator. If the TMS does not receive, within a period of time determined by IDOT or its designee as per 49 CFR 238.237(b), confirmation of Operator train control activities (movement of the propulsion or brake lever, etc.), an audio and visual alarm shall be activated. The activation of the alarm shall mark the beginning of the alarm cycle. The alarm cycle shall continue until the Operator performs a system reset activity or until a penalty brake application is initiated. If the Operator does not acknowledge the alarm prior to completion of the alarm cycle, the power down sequence shall be initiated, which activates the TMS magnet valve resulting in a penalty brake application. The valid Operator activities shall be the use of the throttle, brake, horn, bell, sander, headlight, or the manual reset switch. The visual alarm of an impending penalty brake application shall be given by a train monitoring system (TMS) audio/visual alarm panel. The audio/visual alarm panel shall be mounted above the cab windshield.

The ER and TMS systems shall be microprocessor based with sufficient memory capacity to record at least 48 hours of data. The memory shall be non-volatile, crash and fire protected, and vandal resistant. Communication with the download computer shall be via an industry standard RS-232 port. The audio/visual alarm panel shall show a red indication for a system fault and a green indication for an operable system and shall have a self-test push-button switch.

The event recorder shall store data from all channels at four minute intervals. Recording of a particular channel shall also be initiated with the occurrence of the following:

1. A speed change of 1 mph or greater
2. A brake pipe pressure change of 2 psi or greater
3. Any digital input change of state

All events, along with Greenwich Mean Time to an accuracy of ± 0.5 seconds, shall be recorded. As a minimum, the following inputs for the following events shall be recorded:

1. Hand or foot reset switch
2. Self test internal
3. Horn sequence switch
4. Penalty (TMS) brake solenoid valve energized
5. Equalizing reservoir pressure switch
6. Bell pressure switch
7. Horn pressure switch
8. TMS override switch (internal)
9. Auxiliary light, right side
10. Auxiliary light, left side
11. Marker lights
12. Brake Applied
13. Door Override
14. Zero Speed Bypass
15. Headlight dim Input A
16. Headlight bright Input B
17. HEP on/off
18. Emergency brake pressure switch
19. Throttle position trainlines energized AV, BV, CV, DV
20. Reverser-Forward
21. Reverser-Reverse

22. Sanding trainline
23. Generator field
24. Doors closed indication
25. Dynamic brake setup
26. Wheel slip/slide indication
27. Radio handset Push to Talk
28. Distance
29. Speed
30. Brake pipe pressure
31. Brake Cylinder pressure
32. HEP Sealed Cut-Out Switch

In addition, the following channels associated with the Train Control System (TCS) shall be recorded:

33. ATP Bypass
34. Cab Signal
35. No Code Proceed
36. Yard Mode
37. 0 mph
38. 15 mph
39. 30 mph
40. 45 mph
41. 60 mph
42. 80 mph
43. 95 mph
44. 110 mph
45. Penalty Brake Applied
46. Motion Detect
47. Audible Alarm On
48. System Check
49. Overspeed

Future inputs to the TMS and TCS may include Positive Train Control (PTC). Definition on these inputs and other requirements of the PTC system shall be provided to the Contractor by IDOT or its designee.

See also Section 7.3.3 which specifies a possible Car/Train Control and Communications Network for management of the functions, operation and trouble-shooting of the systems on the cars/trains. The Contractor shall consider the equipment and required functions on the proposed railcars and shall propose to IDOT or its designee the most efficient means of managing and reporting on the status of these systems on these cars.

6.5.5 Horn

A forward facing multiple chime horn, Nathan P/N WH30167-13 K24 or approved equal shall be mounted on the roof on the non-cab side of the F-end of each cab car. The horn shall be controlled electrically by a pushbutton switch located on a horizontal surface of the cab control console. Pressing the button shall cause the horn to sound for as long as the button is depressed. In addition, the horn may also be actuated in a pre-defined automatic sequence by

pressing the horn sequence, another switch located adjacent to the horn pushbutton switch. The sequence shall not repeat unless the horn sequence is pressed again after the first sequence is complete. A cut out cock shall be supplied in the compressed air line to the horn and shall be located in a readily accessible location above the cab ceiling.

The sound intensity of the horn shall be in full accordance with FRA requirements.

6.5.6 Windshield Wiper

Pneumatically operated windshield wipers, with a pantograph style operating arm, shall be located above each windshield and arranged to sweep the maximum possible area of the windshield. The center of the sweeping area on a vertical plane shall be located at the center of the Operator's viewing area, assuming a 95% percentile Operator. They shall have their park position located toward the center of the car. The drive mechanism shall be accessible from inside the car.

6.5.7 Exterior Bell

An electronic bell, Transtonic Inc. Model Number 020-0082-00 or equivalent shall be provided. The bell shall be controlled electrically by a yellow switch complete with integral ON/OFF pushbuttons. The bell shall also function when the horn is sounded. Even after the horn has ceased to sound, the bell shall continue to function until shut off by an adjustable time delay relay.

6.5.8 Sanding Equipment

Cab cars shall have no sanding equipment installed.

6.5.9 Rear View Mirror

A semi-adjustable rear view mirror shall be installed at the leading edge of the sliding cab side window. The location and fixed adjustment shall permit its use by a seated Operator. A semi-adjustable rear view mirror shall be similarly installed on the opposite side of the cab.

6.5.10 Snow Plow / Pilot

A one-piece snow plow type pilot in accordance with Amtrak clearance diagram A-06-7577 revision new (except as noted in Section 2.1) shall be installed in front of the Cab Car. The configuration of the pilot shall be within the clearance diagram. The height of the bottom of the pilot above TOR shall be in accordance with 49 CFR 229.123. The height shall not be less than 3 inches with maximum uncompensated wheel wear of 0.5 inch and flat springs. The snow plow/pilot shall provide the necessary clearances to couple the F-end of the cab car to all other ends of equipment operated by IDOT as of the Contract Award date. Clearances to couple two cab ends facing each other is required. The structural integrity of the entire assembly and its attachments to the carbody structure shall be consistent with the functional requirements.

6.5.11 Cab Heating and Air Conditioning

The cab area shall contain suitable ducting for heating and air conditioning supplied by the main system in the car. Cab air conditioning and overhead heating from the main system shall be

provided by the ventilation air with the air temperature controlled by the A-end temperature control system.

Ventilation of the cab shall be provided by a duct take-off from the intermediate-level, ceiling diffuser duct. A minimum airflow of 250 cfm shall be available when the evaporator fan in the A-end overhead air-conditioning unit is operational. A louvered grille shall be installed in the cab door to exhaust the supply air. The air-flow rate and direction from the discharge outlet shall be adjustable by the Operator by means of a friction controlled damper.

The control cab compartment heating shall be supplemented by a separate cab heating system. This heating system shall be provided by:

1. Baseboard convection heating located adjacent to the Operator's seat. It shall be controlled by the A end intermediate level floor heater thermostat.
2. A forced air heater having a nominal heating capacity of 2 kW located behind the cab rear wall inside the crew locker. The lower section of the cab rear wall shall have the inlet and outlet grilles. The heater element shall be arranged in three circuits; one 0.5 kW and two 0.75 kW. All circuits shall be powered from 120 Vac. The 0.5 kW circuit shall be controlled by the "A" end floor zone thermostat and the two 0.75 kW heaters shall be controlled by a three position switch provided in the cab labeled: "OFF", "Low" and "High". The forced air heater control switch shall only be enabled when the Operator's console key switch is in the "ON" position. The blower shall be "Activated" whenever any of the heater circuits are energized. Thermal protection shall be provided for all circuits by a solid state, manually resettable thermal switch, which shall open on excessive temperature rise. In addition, a thermal fuse shall be provided for each circuit for ultimate backup protection. .

6.5.12 Cab Insulation & Sealing

The cab area shall be thermally insulated. Drafts in the cab shall be minimized by sealing all gaps, e.g., around air piping.

6.6 Train Control System

6.6.1 General Requirements

The vehicle design shall include the installation of cab control equipment. The cab control equipment shall be based on the GETS-GS Ultra Cab II (UCII) product, or Engineer approved equivalent, adapted for the new IDOT rolling stock. The cab control equipment shall be provided to the Contractor. The information concerning the signaling system that will be used by IDOT or its designee is included in Appendix A. All aspects shown in Appendix A, as contractor responsibility, shall be engineered and designed by the Contractor.

The Contractor shall coordinate with IDOT or its designee and with the signal designer representatives so that all equipment is operational, functional, meets performance and that all physical interfaces are defined and resolved satisfactorily.

6.6.2 Train Protection System Description

The wayside signaling system will provide the following functions: train detection, broken rail detection, safe train operation, route security through interlockings, and grade-crossing warnings. The Operator shall manually control acceleration, deceleration, vehicle speed, door operation, and station dwell time.

6.6.3 Train Control System Installation Requirements

The UCII shall be installed in the cab end of the cab car and shall consist of the following components;

1. Cab Signal Receiver Coil (quantity 2)
2. Logic Control Rack (LCR) (quantity 1)
3. ADU light support block complete with display and plug connector (quantity 1)
4. Mating ADU Connector (quantity 1)
5. Audible alarm (quantity 1)
6. No Code Proceed Counter (quantity 1)
7. Connectors complete with mating plug kit and accessories for LCR (quantity 4)
8. Bypass Switch (quantity 1)
9. Magnet Valve (quantity 1)
10. Resistor for holding up magnet valve when ATP is cutout (quantity 1)
11. Circuit breaker (quantity 1)
12. Pressure Switch (quantity 1)
13. Speed Sensor (quantity 2)
14. Cab Set Up Switch (quantity 1)

6.7 Positive Train Control (PTC) Equipment

Provisions shall be made in the cab car for the future installation of PTC equipment. Exact equipment sizing, power and other requirements will be provided to the Contractor by IDOT or its designee as they become available.

The Contractor shall provide two additional circuit breakers, one for a radio and one for a PTC black-box. Four-conductor shielded or CAT 5 cable shall be installed from the circuit breaker panel to the cab. Four 12 AWG stranded wires shall be installed from the circuit breaker panel to the cab. One coax cable from the radio location to an under roof location shall be installed for a future roof mounted antenna.

SECTION 7

7 ELECTRICAL POWER, LIGHTING AND COMMUNICATIONS

7.1 General

The electrical power, lighting and communications systems shall be in accordance with the applicable FRA regulations and APTA PRESS standards and recommended practices.

Power to the cars shall be by trainline cables from a 480 Vac, 3-phase, 60 Hz source. The design and configuration shall enable power to be supplied from the locomotive head end power (HEP) apparatus or from a wayside power source.

The cars shall be equipped with both locomotive and car control 27-wire trainline. All trainline wires shall run the entire length of the car and be connected from end-to-end. Spare trainline wires shall be identified in the end-of-car junction boxes.

The wire used in the electrical trainlines shall be of sufficient size to permit satisfactory operation of up to 10-car consists. The voltage drop due to the impedance of the power trainline at the extreme end of the consist of 10 cars shall not exceed 10 percent under the consist's heaviest load demands when nominal head end 480 Vac, 3-phase, 60 Hz power is being supplied to the first car.

Input to the HVAC systems, the low voltage dc auxiliary power supplies, and the 120 Vac, 60 Hz transformers for each car shall be supplied from the HEP trainline.

The low voltage dc power supply shall provide emergency lighting, communications, and the other low voltage circuit loads. (See Section 7.8)

Adequate provisions for radio interference suppression shall be incorporated in all electrical equipment. (See Section 7.8.4). All low level signal circuits (less than 5V, rms), including trainlines of the communications system, shall use shielded cable.

Electrical equipment shall be installed in suitable enclosed compartments to prevent hazard to passengers and the spread of fire. Equipment shall be segregated by voltage and otherwise logically located to simplify wiring and to facilitate in maintenance and testing procedures.

The circuit breaker panel door shall lock in the open position for safety during normal maintenance and servicing on rear of panel. The fastening method for holding the circuit breaker panel in the closed position shall be square key locks. Except in lockers, all high voltage (480 Vac) terminal boards shall be covered with protective covers where possible.

Safety covers for the electrical lockers shall be permanently installed with one side hinged. The opposite side shall have square key locks to provide safety protection for crew members from the high voltage power. Warning decals (DANGER 480 VOLTS) shall be installed on front face of panel of covers. Cut outs in these covers shall be provided for quick access to temperature adjustments, relay resets, overloads, and door cutout switches.

7.2 Head End Power Distribution

7.2.1 Intercar Connections

Provisions shall be made to distribute the head end power through all cars by means of connections between cars which permit easy coupling and uncoupling of the cars.

The HEP arrangement shall comply with current APTA Standards.

7.2.2 Intercar Jumper Receptacles

Trainline receptacles shall be mounted at both ends of the car in such a manner and location which permit, by means of intercar jumper cables, one end of one car to be connected to either end of another car or a locomotive.

The location shall be such that this car can be coupled to a typical Amtrak car or a similar multi-level commuter car, as currently operated in Illinois or the adjacent Midwestern states.

Each car shall be provided with two car control trainline jumper cables and two locomotive control trainline jumper cables.

Trainline wiring and receptacles shall be arranged to prevent simultaneous energization by HEP, wayside power or HEP from a second locomotive. .

Suitable instruction diagrams, showing the correct interconnection of all trainline jumpers, shall be provided on each end of the car.

7.2.3 HEP Trainline

The power trainlines shall run inside the two I-beams forming the car center sill and shall be supported by suitable cleats at appropriate intervals not exceeding 25 inches. In the truck area, the cables shall run inside a stainless steel cable duct inside the end sill weldment and be supported by suitable cleats at appropriate intervals not exceeding 19 inches. The cables shall emerge from the duct and enter junction boxes on either side of the draft sill. At these junction boxes, the cables to the end-of-car trainline receptacles shall be terminated on suitable power distribution bus bars.

Two parallel runs of three 646 MCM or larger cables shall form the three-phase power trainlines in order to allow power to be supplied from two independent, non-parallel generating systems. Three # 10 AWG conductors shall be terminated to the three control pins at each of the eight 480 Volt connectors on the car. One # 10 AWG conductor shall be terminated in one control pin of the 480 Volt fixed jumper cables and four 480 Volt receptacles on each car. The conductor shall run the length of the car from each 480 Volt jumper and receptacle to form the continuity interlock circuit (loop circuit) which provides the trainline complete signal to locomotive and wayside station. Two # 10 AWG conductors shall be terminated in two control pins of the four 480 Volt fixed jumper cables and four 480 Volt receptacles on each car. The conductor shall be connected to car body ground to form a car-to-car carbody ground bond.

Where individual conductors enter the trainline junction boxes at each end of the car, weatherproof, strain relief fittings shall be used for each conductor. To prevent inductive heating, the junction boxes shall be made of aluminum.

Power connectors shall be Amtrak compatible Pyle National "Trans Power" series (or approved equivalent) with two receptacles and two fixed jumpers per car end. Each receptacle shall use 4/0 AWG conductors to connect to the trainline junction box distribution bus.

The receptacles and fixed jumpers mounted on each car shall satisfy the following criteria:

1. Location: Outside, at both ends of the car, in the same position to those on Amtrak car or a similar multi-level commuter car.

2. Quantity: Two sets per each end of the car (four receptacles and four fixed jumpers total per car) symmetrically spaced for ease of installation and removal.

3. Type of Receptacles: Approved, identical, outdoor, manual, male portion with minimum of three main and three control pins each per receptacle rated at adequate voltage and current carrying capacity to provide for a 10-car train. Receptacles shall incorporate all improvements to date by the manufacturer including "monoblock" construction.

4. Type of Fixed Jumpers: Approved, identical, outdoor, manual, female portion with minimum of three main and three control pins each per receptacle rated at adequate voltage and current carrying capacity to provide for a 10-car train. The jumpers shall incorporate all improvements to date by the manufacturer including "monoblock" construction.

The physical location of the receptacles and jumpers for HEP and locomotive control trainlines shall be compatible with IDOT or its designee's locomotives. Receptacle and jumper orientation and pin numbers of HEP and locomotive control trainlines shall be compatible with Amtrak cars, similar multi-level commuter cars currently operating in Illinois or the adjacent Midwestern states and wayside power equipment. If any differences are determined, the Contractor shall describe the differences and the reasons for the differences. The control pins on each receptacle shall be utilized by the continuity interlocking circuits (looping) to ensure safe power hookup or either head end power sources or wayside power sources to the car by shop personnel. Connection to wayside power shall be made through the use of standard end of car HEP receptacles. The train control loops shall remain disabled when wayside power is connected.

7.2.4 Locomotive Control Trainline

A 27-wire trainline system shall be provided on each car for remote control of the locomotive from a control cab car or another locomotive at the opposite end of the train. The trainline wires shall run through the car body interior and terminate in 27-pin Pyle National or equivalent receptacles on both sides of the car at each end. Receptacles shall be provided at each end of the car and two jumper cable assemblies of appropriate length shall be provided with each car. The locomotive control receptacles and jumper plugs shall be colored yellow.

The locomotive control trainline wire assignments shall be coordinated with the new locomotive supplier and shall comply with the following:

- APTA RP-E-017-99, "Recommended Practice for 27-Point Control and Communication Trainlines for Locomotives and Locomotive-Hauled Equipment"

- APTA-RP-E-018-99, "Recommended Practice for 480 VAC Head End Power Jumper and Receptacle Hardware"

- APTA RP-E-019-99, "Recommended Practice for 27-Point Jumper and Receptacle Hardware for Locomotives and Locomotive-Hauled Equipment"

Refer to Appendix F.

7.2.5 Car Control Trainline

A 27-wire trainline system shall be provided to allow remote control of car functions such as door opening and closing, layover heat control, PA intercom, door safety interlocks, and buzzers. The trainline wire shall run through the car body interior from end to end and terminate on both sides of the car in Pyle National or equivalent 27-pin receptacles on the ends of the car. Trainline loop completion shall be accomplished with dummy receptacles. Receptacles shall be provided at each end of the car and two jumper cable assemblies of appropriate length shall be provided with each car. The car control receptacles and jumper cables shall be colored red. The dummy plug shall be colored black with a stainless steel handle.

The door control trainlines shall be arranged to allow for proper operation of the passenger entry door system regardless of the orientation or location of the car in the train consist. However, by the use of transition jumper cables, these cars may be operated in trains with Amtrak cars, but not necessarily with all systems functional due to the lack of equivalent control circuits on Amtrak cars and vice versa. The Contractor shall provide the details of such interconnections between car types for approval by the Engineer. Refer to Appendix G.

The Contractor shall propose a car/train control and communications network, which shall consider the equipment and requirements included in Sections 3, 4, 6, 7 and 9 of these Specifications and shall provide a reliable method for providing control, tracking functions, and the reporting and correcting of in-service defects on the new trainsets. The Contractor's proposal shall identify the benefits to IDOT or its designee of the proposed system and shall also recognize that the new railcars/trainsets may operate in consists with un-equipped cars, under which situations the car/train control and communications network may not function throughout the consist.

7.2.6 Miscellaneous

Receptacles and trainline jumper cables shall also be compatible with existing AAR standard locomotive equipment and shall employ established control circuit designations. To guard against interference from outside sources, all communications wiring shall be shielded. Trainline jumper cables shall be colored to match respective receptacles.

Trainline jumper cables shall not be interchangeable with the other than corresponding cables of the same function.

7.2.7 Induced Voltages

The Contractor shall minimize induced ac voltages in the low voltage wiring.

7.3 Door Controls and Signal System

7.3.1 Door Controls

The side door system shall include the doors on both sides of the car, the door operators (refer to Part 3 Section 3.10) and the door controls and indicators.

The door controls shall consist of, but not limited to a door control module, door control stations, passenger door open pushbuttons, crew hold open switches, staff key switches and emergency door open operators.

The Door Control Module shall house the logic boards and relays that control the side door system. The logic boards shall be programmable. LEDs shall be provided on the logic boards to monitor input and output signals to aid in troubleshooting. The Door Control Module shall also house critical relays such as zero speed, left hand door interlock, right hand door interlock, required for control of the door system. The Door Control Module shall be located in the A end intermediate locker. .

The side doors on all cars shall be equipped with local Passenger Door Open Pushbuttons located inside and outside the car for use by the passengers. The Passenger Door Open Pushbuttons shall initiate door opening only the vehicle is at zero speed and when enabled by the train crew. The exterior Passenger Door Open Pushbuttons shall be mounted approximately 71 inches above top of rail. The interior Passenger Door Open Pushbuttons shall be mounted on the handholds adjacent to the side door openings. Remote operation of door opening and door closing shall be provided by two Door Control Stations, one on each side, at the lower level B-end side doors on all cars. The cab cars shall be provided with two additional Door Control Stations in the full width operator's cab, one on each side, at the F-end intermediate level. These controls shall be trainlined and shall control the doors on each side of the train, in all the cars in a train of up to 10 cars.

Features of the Door Control Stations located at the cab of the cab car shall be as follows:

- Keyed lock to secure Door Control Station (non-cab side only).
- Setup switch with ON/OFF positions to activate/deactivate Door Control Stations.
- Red pushbutton switch to open passenger side doors on one side of the consist.
- Green pushbutton switch to close passenger side doors on one side of the consist.
- Pushbutton to enable door open circuits on one side of the consist
- Conductor's signal buzzer black pushbutton.
- The crew signal buzzer shall be mounted on the rear face of the Door Control Station faceplate.
- One red-lensed lamp complete with LED shall flash if:
    - the passenger doors on either side of the consist are enabled allowing passenger controlled opening of individual door or;

  - during the door close cycle. The light shall flash during the time it takes for all doors to close from on open position, including recycle time, if any. When all doors are fully closed and the door interlock relay is energized, the light shall extinguish.

The red light shall be identified as follows “Door System Status”.

- One green-lensed lamp complete with LED indicator on the Door Control Station shall indicate that all doors on the train are closed when illuminated. The green lamp shall be identified as “Doors Closed”.

- One amber-lensed lamp complete with LED indicator on the Door Control Station shall indicate if a Door Control Station within the train consist has been activated. Once the conductor has activated one Door Control Station within the consist, the amber lamp on that Door Control Station shall remain extinguished. The amber lamp on all other Door Control Stations shall flash, warning all other personnel that a Door Control Station within the consist has been activated. The amber lamp shall be identified as “Door Station Activated”.

- Yellow pushbutton switches to enable all local Passenger Door Open Pushbuttons on the same side of the train to allow passenger controlled opening of individual doors from either the inside or outside of the car. The two pushbuttons shall be remote mounted on the cab console at a location designated by the Engineer.

Features of the Door Control Stations located at the B-end lower level of each car shall be as follows:

- Keyed lock to secure Door Control Stations.

- Setup switch with ON/OFF positions to activate/deactivate Door Control Stations.

- Red pushbutton switch to open passenger side doors adjacent to and forward of the activated Door Control Station.

- Red pushbutton switch to open passenger side door rearward of the activated. Door Control Station.

- Blue Crew Open pushbutton switch to open one leaf to the passenger side doors adjacent to the activated Door Control Station.

- Green pushbutton switch to close passenger side doors adjacent to and forward of the activated Door Control Station.

- Green pushbutton switch to close passenger side doors rearward of the activated Door Control Station.

- Yellow pushbutton switch to enable all local Passenger Door Open Pushbuttons on the same side of the train as the activated Door Control Station to allow

passenger-controlled opening of individual doors from either the inside or outside of the car.

- Conductor's signal buzzer black pushbutton. The trainline signal buzzer shall be mounted on the rear face of the control panel.
- Separate public address and intercom system receptacles.
- White intercommunication system sonalert pushbutton.
- One green-lens lamp complete with LED indicator on the Door Control Station shall indicate that all doors on the train are closed when illuminated. The green lamp shall be identified as "Door Closed".
- At the B-end only, on both sides of each car, located on the vertical grab handle adjacent to the Door Control Station, a Crew Hold Open switch shall be provided to hold open the single door leaf nearest to the activated Door Control Station for the use by the train crew only. This Crew Hold Open switch shall be enabled only when the adjacent Door Control Station is activated. When the Crew Hold Open switch is depressed and the Door Control Station is activated the "Door Closed" indicator shall illuminate even though the door panel is open.
- One amber-lens lamp complete with LED indicator on the Door Control Station shall indicate if a Door Control Station within the train consist has been activated. Once the conductor activates a Door Control Station within the consist, the amber lamp on that Door Control Station shall remain extinguished. The amber lamp on all other Door Control Stations shall flash, warning all other personnel that a Door Control Station within the consist has been activated. The amber lamp shall be identified as "Door Station Activated".

The following operating functions shall be provided:

1. The operation of individual doors by passengers by means of green illuminated Passenger Door Open Pushbuttons inside and outside all car door openings. This function shall only be possible when the doors are enabled. An integral indicator light within the Passenger Door Open Pushbutton, when illuminated shall indicate that it has been enabled. When an individual door has been opened by a passenger, the door shall automatically close after a fixed period of time. It shall be possible to cancel the enable function by the operation of the "Doors Close" button at the Door Control Station.
2. A door position interlock circuit that includes a release relay circuit. The car door interlock relay logic shall not assume the doors are closed until the passenger release relay is de-energized.
3. Opening of the side door leaf at each side of the B-end from both the inside and the outside of the car using a staff key shall be possible. Crew key operation of doors shall only be possible if the zero speed trainline signal is present and shall open the door interlock circuit when activated. The outside crew switch shall have a hinged, spring-loaded, weatherproof cover.

4. If an emergency pull ring is activated either inside or outside of the car, the corresponding side doors shall open under power. Should power not be available, then the operation of the device shall unlock the door operating mechanism enabling the doors to be pushed open manually. The device shall not allow the doors to be re-closed under power until it has been manually reset. It shall be possible to activate this device by pulling a red ring located behind breakable covers both inside and outside the car. See Section 3.10.2.

5. Activation of a Door Control Station with the door control switch set to the “On” position shall “short circuit” the “Door Open” trainline for the opposite side of the train to prevent simultaneous actuation of Door Control Stations on both sides of the train.

6. With a key inserted and the door control switch on the Door Control Station set to the “On” position, the door open trainlines on the selected side of the train shall be short circuited until a “Doors Open” switches on the same Door Control Station is actuated.

7. Suitable safeguards shall be integrated with the door controls to prevent the doors from opening while the train is in motion (zero speed system - #8 below) and to prevent the train from moving if any side door on the train is open (door interlock system - #9 below).

8. Unless the zero speed system is activated or bypassed, it shall not be possible to open any side door from any Door Control Station, any staff switch, or Passenger Door Open Pushbutton, except the crew door at an activated Door Control Station by the of the Crew Door Open pushbutton. The zero speed system shall be activated when zero speed is detected on the locomotive and the trainline is energized at 66 ± 14□ Vdc . Should the train move at a speed above the threshold of the zero speed detector on the locomotive, the zero speed trainline shall be de-energized. A "Zero Speed Bypass" switch and indicator shall be provided in each cab car and locomotive for use by the operator in the event of a zero speed system malfunction.

9. Unless the door interlock system is activated or bypassed, it shall not be possible to move the train under power. The door interlock system shall only be activated when all side doors on each car in the train are closed (or individual doors bypassed by its cutout switch) energizing each car interlock system and, in turn, energizing the 74 Vdc door interlock trainline to the locomotive. Visual indication as to the status of each door interlock shall be provided by door interlock indicator lights mounted on the ceiling at each side door location. When a door interlock switch is OPEN, the associated door interlock indicator light shall illuminate. A "Door Interlock Bypass" switch and indicator shall be provided in each cab car or locomotive for use by the operator in the event of a door interlock system malfunction which cannot be corrected by use of the individual cutout switches.

10. Suitable cutout switches for each door leaf to isolate the doors and controls from the trainlines. The cutout switches shall bypass the door leaf position detection switches so as to cause the car door interlock relay to indicate a doors closed

condition. The switches shall be located in the door pockets near the door operator and shall be clearly labeled as to their function and switch positions.

11. Suitable door leaf position interlock switches on each door leaf which shall detect when each door is fully closed. The switch shall close when the door edges, as the doors are simultaneously closing, are within 0 inches (plus 0 inches, minus 1/8 inch) of each other measured at the height of the switch actuator. The switch shall open when the doors are less than 1-1/4 inches apart as the door leaves are moving in the opening direction. When only one door leaf is active, the switch shall open when the active door leaf has moved less than 5/8 inch, moving in the opening direction, with respect to the centerline of the doorway. The switch shall be actuated by the door leaf or an attachment to it and not by any part of the actuating mechanism. All switches shall be connected in series and all switches shall be closed or bypassed by the cutout switch in order to energize the car door interlock relay.

12. If pneumatic door operators are provided, the door operators shall be so arranged that the door leaves open when the air solenoid valves are electrically energized. Each door operator shall have a two position air shutoff valve. Valve position: “Open” shall be normal with “Closed” as a vented off position to isolate the operator from the air supply and vent air from the operator. This shall allow the door to be manually moved to and locked in the closed position as an emergency in service measure.

13. All door control relays, including the zero speed and the door interlock relays, shall be mounted on one common panel and all wiring shall be brought to terminal blocks with screw terminals that will accept ring tongue lugs. All relays shall be fully enclosed in dust tight enclosures with screw or Faston terminals.

14. The locomotive traction (Gen. Field) shall be interlocked with the door circuit so that traction cannot be achieved unless continuity within the door interlock system is reached (doors are closed or failed door system is bypassed).

15. Provisions shall be made for opening the single door leaf nearest each Door Control Station (crew door) regardless of the status of the zero speed trainline and door interlock loop circuit.

    Control of crew doors shall be accomplished by using the Crew Open pushbutton located on each Door Control Station and the Crew Hold Open switch located on the vertical grab handle adjacent to each Door Control Station.

    Activation of the Crew Open pushbutton shall cause the door to open and remain in that position until closed by a trainline ”Door Close” signal or by loss of the zero speed signal, if the adjacent Door Control Station is not activated. The grab handle mounted Crew Hold Open switch, when depressed, shall delay the closing of the crew door even when all train doors have been commanded to close by the trainline signals.

7.3.2 Signal System

A suitable trainlined electric buzzer, intercommunication signal system shall be available between all Door Control Stations and an appropriately equipped locomotive or cab car when any Door Control Station is activated. When any Door Control Station is activated and the signal buzzer pushbutton is depressed, the signal shall be audible at all Door Control Stations throughout the train. The electric buzzer signal system shall have a distinctively different tone from the private communication signal buzzer utilized between any car and locomotive. It shall operate from the low voltage dc system.

The signal system shall comply with applicable radio interference regulations. (See Section 7.7.4).

7.4 Interior Lighting

The interior lighting shall be in accordance with the applicable FRA regulations and rules, and APTA standards including, but not limited to, 49 CFR 229, 238 and 239 and APTA Standard SS-E-013-99.

Main interior lighting shall be provided by two longitudinal rows of fluorescent fixtures located throughout the car, and by four fluorescent fixtures in each door vestibule suitably mounted to minimize shock. All fluorescent lamps shall be Cool White in color. Alternatively, LED interior lighting may be proposed, if shown to be cost-effective and if it can be demonstrated that this does not materially affect the in-car environment (additional heat generated, additional EMI, etc.). If LEDs are proposed, these shall be high intensity white (equivalent to a 40W A19 lamp) with a clear prismatic lens in line with the LED.

Main interior lighting shall be powered from the 120 Vac power system. Where the interior lights are also emergency lights, they shall be powered by the low voltage dc power system. At each passenger door and vestibule area, two of the fluorescent (or LED) light fixtures shall be emergency lights. All lighting fixture lenses are to be made of polycarbonate material or approved equal, in full accordance with the requirements of the Flammability and Smoke Emission Guidelines. All fluorescent fixtures shall be equipped with suitable shock hazard protection to minimize the risk of personal injury during service and maintenance activities.

The lighting shall be as uniform as practical throughout the car. The average intensity of illumination with nominal voltage available at the fluorescent lamps shall satisfy the following criteria:

Location	Method of Measurement	Intensity
Passenger Seats	At an elevation of 33 inches above the floor and on the upper surface of a transverse 45° plane	30 foot-candles (All seats except those in the vestibule which shall be 10 foot-candles)
Passenger Aisles	At the floor	5 foot-candles
Entrances and Exits	At the floor within 20 inches from the door, inside the car	5 foot-candles

Location	Method of Measurement	Intensity
Vestibules and Stairways	Equal to or exceeding AAR requirements as measured at the floor according to Section 5 of the AAR Electrical Manual	5 foot-candles

7.4.1 Fluorescent Lamp Ballasts

The fluorescent lighting fixtures shall contain electronic dc inverter or electronic 120 Vac ballast mounted on or near the lighting fluorescent fixtures. Power for the inverter ballast units shall be from the auxiliary power system. The over-temperature setting for the ballast shall be less than the temperature rating for the other components of the light fixture. Each ballast shall operate one or two T-8 fluorescent lamps unless otherwise approved by the Engineer. Miniature fluorescent lamps may be used in other fixtures used to illuminate the stairways from intermediate to upper levels or in other applications as approved by the Engineer. The frequency of the inverter ballast output shall be not less than 18 kHz and each ballast shall be protected against application of reverse polarity. Power protection circuit breaker shall be provided on the main circuit breaker panel.

7.4.2 Emergency Lighting

The emergency lighting system shall perform in accordance with the requirements of 49 CFR 238.115, 239.101 and APTA Standard SS-E-013-99. The emergency lighting system shall provide sufficient illumination for a period of at least one and a half hours (90 minutes) in the aisles, stairways, doorways and steps to permit safe evacuation of the car.

The Contractor shall provide an analysis that estimates the number and location of the fixtures required to be a part of the emergency lighting system and the lighting levels these fixtures will provide under emergency conditions. The emergency lighting system shall include fixtures on the upper, lower and intermediate levels (depending on the car/trainset configuration being proposed). Other interior emergency lighting shall be provided in areas as follows:

1. Aisles.
2. End doorways.
3. Stairways.
4. Vestibule areas (two fluorescent lights in each area).
5. Toilet rooms (one fluorescent lamp).

The Contractor may also propose LED lighting as an alternative to the fluorescent fixtures (so long as the rest of the car interior lighting is done by LEDs). In this alternative, the Contractor shall propose the specific LED fixtures that shall constitute the car emergency lighting circuit and shall demonstrate that the same lighting levels are achieved in this alternative.

7.4.3 Service Lights

Service lights, powered from the 120 Vac power system and controlled as indicated, shall be installed in the following locations for maintenance personnel:

1. Two service lights located near each roof mounted HVAC unit controlled by an ON-OFF switch.

2. One service light located near each fresh air fan controlled by an ON-OFF switch.

3. One service light located in the crew locker controlled by a limit switch activated by opening the crew locker door (cab car only). All service lights shall be covered with an aluminum or steel light guard.

4. One service light in the toilet room utility compartment controlled by a limit switch activated by opening the door to the compartment.

One service light located in the crew locker controlled by a limit switch activated by opening the crew locker door (cab car only).

Service lighting may also be by LEDs (so long as the rest of the car interior lighting is done by LEDs). In this alternative, the Contractor shall propose the specific LED fixtures that shall constitute the car emergency lighting circuit and shall demonstrate that the same lighting levels are achieved in this alternative.

7.5 Exterior Lights

The exterior lights shall comply with the applicable sections of 49 CFR 221 and 49 CFR 229. High intensity LED lighting shall be used where appropriate.

7.5.1 Status Light

A single side status light fixture shall be provided on each side of each car. The design and location of the fixtures shall assure visibility of the fixture and aspects in sunlight and darkness by employees at track level or in control cabs.

The status light fixture shall consist of an assembly of three LED lamps mounted in a single housing. The indicator colors shall be as follows:

1. Red Color: DOOR OPEN
   (Displayed only on car(s) with any door open).

2. Amber color: BRAKES APPLIED
   (Activated when the brake cylinder pressure is greater than 10-psi).

3. White Color: EMERGENCY BRAKE APPLIED
   (Displayed on any car where the passenger/conductor emergency brake actuator has been activated and/or the door control station is activated).

Access to the fixture for easy lamp replacement and cleaning shall be by a convenient, removable panel accessible from the car interior. Lenses and housings shall be watertight.

The status lights shall be powered by the 72 Vdc system.

7.5.2 End Door Area and Stairways

Lamps, designed for railway service, shall be located externally (one over each end door of the coach car and one over the B-end end door of the cab car) in such a manner as to illuminate the intercar passageways. The lamps shall be housed in suitable watertight housings.

The stairway to the upper level shall have lights to provide illumination of the steps. Lamps shall be LED type. The end door way and stairway lighting shall be powered by the 72 Vdc system.

7.5.3 Rear Warning (Tail) Lights

The A- and B-ends of the coach cars and the cab cars shall be equipped with two High Intensity LED rear warning (tail) lights. The warning light and luminosity shall comply with FRA requirements..

The rear warning light receptacle shall be powered by the 72 Vdc system.

7.5.4 Marker Lights (Cab Car Only)

A weatherproof marker light assembly shall be installed on each side of the F-end of the cab car. The marker lights shall be LED type meeting FRA luminosity requirements. Red and white marker lamps shall be provided on each side of the car. A selector switch shall be provided in the cab and an indicator in the cab shall show that the marker lights are illuminated.

The marker lights shall be powered by the 72 Vdc system.

7.5.5 Headlights (Cab Car Only)

Headlights shall comply with requirements of 49 CFR 229.125. A headlight assembly with two PAR200 lamps shall be mounted above the end door at the cab end of the cab car. The aiming of the lamps shall be adjustable and shall be initially set to illuminate a person standing upright in the middle of straight section of track 800 feet in front of the car on a dark, clear night. Headlight lamps shall be installed to facilitate bulb replacement from the exterior of the car.

The headlights shall be powered by the 72 Vdc system.

7.5.6 Auxiliary Lights (Cab Car Only)

Auxiliary lights shall comply with requirements of 49 CFR 229.125. Auxiliary light fixtures, complete with 350 PAR56SP lamps, shall be located at the lower right and left sides on the F-end of the cab car. The auxiliary lights shall be aimed so the beams cross at a point 400 feet from the car at 50 $\pm$2 inches above top of rail.

The auxiliary lights shall be powered by the 120 Vac system through an AC/DC converter and shall operate continuously when energized. The auxiliary lights shall be activated through the Headlight/Auxiliary switch located in the control cab. If the headlight/auxiliary switch is on, it shall be possible to cause the auxiliary lights to flash alternatively either by manual control or if either the horn or bell is actuated. It shall also be possible to manually deactivate the flashing auxiliary lights.

7.5.7 Car Number Lights (Cab Only)

A car number light assembly shall be installed above the cab side and non-cab side windows at the cab end of the cab car. The light assembly shall illuminate the cab car road number, upon activation of the car number light switch located in the cab. Each light assembly shall be illuminated by two T-12 fluorescent lamps powered by separate inverter ballasts. IDOT or its designee will provide the road number.

7.6 Communications System

All cars shall be equipped with a trainlined Public Address and Intercom system (PA/IC) system. The PA/IC system shall operate from the low voltage dc car supply and be individually fused in the battery switch box or protected with circuit breakers located in the electrical locker. PA/IC circuits connected to intercar audio and remote control lines shall be protected from component failure due to accidental shorting or grounding of the lines. The PA/IC equipment described shall make use of the car control trainline, wiring, and jumper cables described in Part 3 Section 7.3.

The cab and coach cars shall be equipped with communications equipment from which crew personnel may make an announcement over the train Public Address (PA) system or engage in private conversation with other crew personnel or the Operator through the Intercom (IC) system. As a minimum, the communications equipment common to both cab and coach cars shall include a PA/IC amplifier, handset and holder, communication stations, interior and exterior speakers.

7.6.1 PA/IC Amplifier

The PA/IC amplifier shall be mounted in the auxiliary equipment space at the A end of a bi-level car or in the communications equipment locker if a single-deck car or other design is proposed. The PA/IC unit shall be on a quick release AAR type radio base so that it can be readily removed from the front of the assembly.

The unit shall have an audio adjustable output of 40 Watts rms. The unit shall be designed to operate from the 72Vdc low voltage power supply and shall be complete with transient filtering. The unit shall incorporate at a minimum, the following indicators and controls on the front panel:

1. Handset Level- sets volume to handset earpiece.
2. Trainline Level- sets audio level to trainline
3. Speaker Level- sets audio level on trainline
4. Power Supply Indicators- displays input/output voltage
5. BarGraph- indicates audio output level
6. On-Off LED- indicates when switch is on and car battery is present
7. Handle- for ease of removal or transport.

7.6.2 Handset and Holder

Handsets shall be equipped with a normally closed push-to-talk switch. The handset cord shall be equipped with an adequate strain relief fitting where it is attached to the handset. A handset holder shall be provided with each handset.

7.6.3 Interior and Exterior Speakers

Each vehicle shall be equipped with a minimum of eighteen (the quantity specified is for a bi-level or double-deck car; for any other car configuration, the Contractor shall provide sufficient speakers to achieve equal performance) interior speakers located throughout the car such as to provide a uniform audio level throughout each passenger compartment. The interior speakers shall be arranged for replacement from the front and sufficient length shall be provided in the wiring for this purpose. Each vehicle shall also be equipped with four weather resistant exterior speakers installed on the exterior of the car sides near each set of doors to enable the broadcasting of messages to passengers on the platform from the public address system from within the car.

7.6.4 One-way Communication (Public Address)

The Public Address (PA) system shall be designed to allow the crew to make paging announcements for distribution through the interior speakers. For a crew member to initiate a PA announcement, a handset shall be plugged into the PA receptacle at one of the Door Control Stations. Once the handset has been plugged in, the audio from the handset shall be placed on the PA audio trainlines once the push-to-talk switch is depressed. PA announcements shall be simultaneously broadcast over the interior and exterior speakers when the door control station is energized and the doors are opened. Exterior speakers shall also be activated when the 'Door Enable' feature of the door system has been activated.

There shall be no feedback between car speakers and the control station handset when the Public Address system is in use.

7.6.5 Two-way Intercommunications (Intercom)

The Intercom (IC) system shall be designed to allow the crew to communicate with other personnel on the train including the Operator. See also Section 6.5.3 on the Passenger Emergency Intercom system. The Contractor shall prepare a study to use the communications subsystem as a possible means by which to accomplish the communications needs outlined in this section. Use of the PEI for crew communications purposes shall consider anticipated volume of calls by passengers vs. those between train crew members, in order to ensure that the combined usage does not preclude emergency communications by one user group or the other.

For IC communication between crew members within the train consist, a handset shall be plugged into the IC receptacle at one of the Door Control Stations. Once a handset has been plugged in, the audio from the handset shall be placed on the IC audio train lines. To signal other crew members that an IC call has been requested, the crew member shall depress the IC CALL pushbutton located above the IC receptacle. Once the pushbutton has been depressed the audible tones at each Door Control Station throughout the train consist shall activate for as long as the pushbutton is depressed. Handset to handset communication shall be initiated once a crew member at another Door Control Station plugs his handset into the IC receptacle.

7.6.6 Global Positioning System (GPS)

Each car shall include a Global Positioning System (GPS) receiver to provide train/car location, position, speed and a standard time reference upon receipt of a valid GPS signal. The GPS receiver shall be energized when the Generator Field switch in the cab car or locomotive cab of

a coupled consist is activated. The GPS receiver shall remain active for at least one hour after the Generator Field switch in the cab car or locomotive cab of a coupled consist has been deactivated.

It shall be possible for any networked device on a train to subscribe to the information broadcast by the active transceiver. Time of day and date shall be displayed on the operator's in-cab display and on the variable message signs in the passenger compartments of the consist. All train networked devices with time of day clocks shall be automatically synchronized to the GPS train time network variable on initial power-up of the consist.

The GPS transceiver shall enable/disable IDOT-provided enhancements (WiFi, etc.) when the car or cars are being used on a non-IDOT route (at present, IDOT-supported routes include Chicago-Carbondale, Chicago-Quincy, and Chicago-St. Louis; the list may change and IDOT or its representative will provide the updated list to the Contractor).

7.6.7 Automated Announcement System

The cab cars and coaches provided under this procurement shall be equipped with an automated announcement system, which provides for automatic announcement of what the next station shall be and repeats this announcement on approach to the station. The triggering of the announcements (both initial and approach-repeat) shall be by interface with the GPS equipment on the cars.

In addition to the initial station approach and repeat announcements, the system shall provide for automatic broadcast of safety-related announcements, including locations of emergency exit windows, familiarity with emergency communications media on the cars, etc. Other message requirements shall be determined by IDOT or its designee during the design phase of the project.

The automated announcement system shall be simple to use, and readily adaptable to use on different IDOT-supported services on a day-to-day basis.

7.6.8 Closed-Circuit Television (CCTV)

A video surveillance system shall be installed on each car. The system shall use NTSC video signals. The system shall be powered from the car's low voltage power supply/system. The video system shall be activated whenever the Generator Field switch in either a cab car or in the locomotive cab of a coupled consist is activated. The system shall continue to record for a period of time (to be established and agreed during the design phase) after the Generator Field switch in either a cab car or the locomotive cab of a coupled consist has been deactivated.

The video system shall use digital technology to provide the highest quality color images possible. The entire system, including all the elements and the installation shall be approved by the Engineer.

Color cameras shall be provided in the passenger compartment of the cars to provide coverage of each side door, the partition doors and the passenger compartment center. The number of cameras required shall be determined by the contractor, which shall demonstrate to IDOT or its representative that the proposed quantity and deployment of cameras provides for the observation of the entire passenger compartment. In addition, cameras shall provide a view of

the operator's control stand in the cab cars, as well as a forward view from the cab car along the track, when that car is leading a train.

Cameras in the passenger compartment shall be as small as practical while retaining the image quality necessary to make a positive identification of persons at least 12 feet away. There shall be covers over the cameras to protect them from vandalism, including spray paint and hammer impacts. The cameras shall be plug-connected to permit quick changing of units. The cameras shall be rigidly mounted to prevent car vibration or shock up to 5g in any direction from moving the camera.

The camera recording the forward view from the train operator's position shall be mounted in the upper left corner of the windshield and aligned to provide a straight view ahead. The lens shall be shielded to eliminate reflections from the inside of the windshield. The camera shall show station platforms, switches/signals and other right-of-way details in sufficient clarity to allow it to be used as part of an incident retrieval process.

Camera mounting, adjustment and wiring shall be inaccessible when the camera is installed. All fastenings used in the camera installation, which are accessible from the interior of the cab, shall be tamperproof.

7.7 Auxiliary Power

The auxiliary power shall comply with the applicable parts of 49 CFR 238 and 49 CFR 239. The auxiliary power shall be included in Section 2.8 of this Specification as part of the EMC plan.

Low voltage dc and ac power systems shall be provided. Suitable system protection shall be included on the main circuit breaker panel for individual circuits on each system as well as input and output power protection of the low voltage power supply and battery charger. Input power to the solid state power supply and battery charger, and to the power transformers of the 120 Vac power system, shall be supplied by the car's main power service.

The 480 Vac car end connections shall be used for wayside connection to hotel power when a consist is laying over in a station/yard or other servicing facility.

7.7.1 Low Voltage dc Power System

7.7.1.1 Requirements

Each car shall be provided with a nominal 72 Vdc ungrounded Low Voltage Power Supply/Battery Charger (LVPS/BC) power system. The system shall consist of an onboard solid state power supply and battery charger connected in parallel with a storage battery.

The input to the LVPS/BC shall nominally be 3-phase 480 Volts, 60 Hertz power source from an ungrounded delta connected power system supplied by the locomotive. The LVPS/BC shall operate with input voltage variations of ± 50 Volts and frequency variations of ±3 Hertz continuously. The input power factor should exceed 0.9 at the rated load. Output voltage ripple shall not exceed 2.0 V peak-to-peak (0.7 VRMS) under all operating conditions. Over and under voltage and reverse polarity protection shall be provided.

The design of the LVPS/BC system shall be modular, permitting the replacement of sections within the car. Modules performing the same functions shall be interchangeable. Input and

output connections shall be made by easily accessible MIL-C-5015 quarter-turn bayonet type connectors. Means shall be provided to prevent cab and coach car units to be installed in the wrong car type if they are not interchangeable.

The unit shall be solid state, microprocessor based, with transient and surge protection circuitry necessary to produce reliable performance in a rail transit environment. It shall have provision for a PTE connection to enable fault data logging.

The LVPS/BC unit shall include a separate output for the purpose of driving an external battery charge failure Indicator (BCF). The circuit shall be arranged so that the indicator light is illuminated if conditions are normal and not illuminated if failure conditions occur. One indicator shall be located above the intermediate level B end circuit breaker locker in both cab and coach cars. An additional indicator shall be located within the control cab compartment.

The low voltage dc power system shall meet the requirements of 49CFR238.115 (4) and APTA Standard SS-E-013-99.

7.7.1.2 Low Voltage Power Supply

The Low Voltage Power Supply (LVPS) section of the unit shall supply regulated 72 Vdc power to all operating loads. The output voltage regulation shall be ± 3% for input voltage variations of ± 50 Volts and frequency variations of ± 3 Hertz, for any load up to continuous rated current. Above this load, the voltage shall decrease to provide current limiting to the rated current for a short circuit condition. On restoration of normal loading, the voltage shall automatically return to its regulated value.

The following low voltage circuit loads shall be normally connected to the LVPS:

1. Communications system
2. Emergency lighting
3. Door controls
4. Temperature controls
5. Wheel slip
6. Other controls/loads as may be required.

The rated capacity of the LVPS shall be no less than 125% of the maximum car load.

Isolation from ground on both positive and negative sides shall be provided. Ground fault detection shall be included and shall be adjustable from 5 to 10 ma. The unit shall operate correctly with either output terminal grounded.

The LVPS shall include a contactor that will connect the batteries to the car loads in the event of HEP or LVPS failure. The changeover shall be automatic and be properly coordinated so as not to cause any cycling of loads. The contactor shall also protect the batteries from complete discharge, by disconnecting the car load when the battery voltage level drops within an adjusted range between 46 and 50 Vdc.

7.7.1.3 Battery Charger

The battery charger shall be capable of supplying regulated dc power to charge a 48 cell nickel cadmium storage battery specified below. No external loads shall be connected across the battery during charging. The charger shall start-up automatically in case of dead battery.

The charger control circuits shall be so designed that any probable failure of the control shall not cause the output voltage to increase above the no load output voltage in order to prevent damage to the battery from overcharging.

The charger shall provide a constant, dual rate, temperature compensated, voltage and current limited mode of control. The battery charger shall control the charge of the battery as per the battery supplier charging algorithm. Charging voltage shall range from 1.3 to 1.7 Volts per cell. A control signal shall be provided to allow the use of a momentary contact, external test switch to force the charger into the high rate mode regardless of the state of the battery. The charger shall not be damaged by reverse polarity connection of the battery.

The battery shall be capable of being isolated from the car loads by a two pole manual cutout switch and circuit breaker. These components shall be located in a suitable box adjacent to the battery with provision to prevent gas interaction between the battery box and the switch box. It shall not be possible for the low voltage dc system to be energized through the battery charger when the battery is isolated.

The charger control system shall also include a high temperature alarm and inhibit system. A temperature sensor mounted on a battery cell within each battery compartment shall shutdown the battery charger for a battery high temperature condition of 149° F ± 4 °F. The battery charger function shall remain shut down until the battery temperature is below the sensor set point and the reset button on the battery status monitor is pressed. The LVPS portion of the system shall continue to operate normally. The indication of over-temperature shall not be cancelled by opening of the charger input or output power circuit breakers or by opening of the main battery switch.

7.7.1.4 Remote Status Display Module

A remote solid state Status Monitor Display unit shall be mounted in the intermediate level B end circuit breaker locker for a bi-level car and electrical locker of a single level car. The unit shall use LED indicators for alarms and digital LCD displays for voltage and current. The Status Monitor shall communicate to the LVPS/BC via a serial link. The monitor shall indicate the following as a minimum:

1. LVPS output current and voltage
2. Battery Charger current and Voltage
3. 480 Vac On
4. DC ground Fault
5. LVPS and Battery Charger current limit
6. Battery Over-temperature
7. Boost/Float Charge
8. Open Battery Circuit
9. Defective or Discharged Batteries
10. LVPS failed
11. LVPS maintenance required

12. LVPS/BC overheating
13. Wrong LVPS/BC installed
14. Switches for alarm test and reset

7.7.1.5 Batteries and Battery Compartment

A 48-cell, nominal 64 Vdc, fiber nickel-cadmium battery shall be provided. There shall be separate batteries for cab and coach cars. The battery shall be sized with 25% reserve capacity to enable all the low voltage dc circuits to operate normally for a period of at least two hours in accordance with IEEE Std. 1568. 49 CFR238.115 and APTA-SS-E-013-99 requires the back-up power system to be sized to supply emergency loads for a period of at least 90 minutes without the solid state battery charger being on to charge the battery providing the battery is fully charged at the start of the cycle. The battery supplier shall recommend a charging algorithm that shall enable the batteries to meet the above requirements. Operation (Ref. Part 3 Section 7.4) of the side doors on one side of the car at five minute intervals shall be considered as normal operation over this period. After two hours, the battery voltage at the loads shall not have fallen below 52 Vdc.

The battery and enclosure shall be designed in accordance with 49CFR238.225 (b), and APTA Recommended Practice RP-E-007-98.

The battery shall be mounted in one or two weatherproof ventilated enclosures with the battery raised to generally clear the bottom. The enclosure covers shall be designed to be removable without using tools. The battery shall be mounted on a roll-out tray accessible from the exterior of the car. Proper ventilation shall be provided to prevent accumulation of gases.

7.7.2 120 Vac Power Systems

Each car shall also be provided with a 120 Vac, single phase, 60 Hz electrical system. All 120 Vac electrical outlets shall be protected by a GFI circuit either local to or remotely mounted to the receptacle. The system shall consist of two onboard, single phase power transformers providing power to:

1. UL listed duplex, twist-lock convenience electrical outlets located in the interior of the car. Six (6) receptacle outlets shall be located throughout the car. One switched incandescent light fixture and a convenience outlet shall be provided in the area of each HVAC unit.

2. UL listed, standard duplex convenience electrical outlets (for laptop computers and other personal-use devices) shall be provided at every passenger seat in the interior of car. These outlets shall be on a separate circuit breaker. These outlets are not intended to be used for vacuum cleaners or similar equipment, therefore signs indicating that these outlets are for laptop computers or other personal communications devices only shall be installed.

3. Fresh air fans.

4. Car interior lighting.

5. Service lights.

7.7.3 Spare Trainlines

Three spare trainline wires shall be connected from end to end of each car in the car control trainline connectors. Three (3) spare trainlines, in addition to the 27-wire car control trainlines, shall be connected from end to end of each car receptacles and shall be terminated on terminal boards in the end of car junction boxes.

Trainline wire sizes shall be 10 AWG.

7.7.4 Radio Interference

The Contractor shall ensure that the communications equipment including, but not limited to, the train radio, hand-held radios, the PA, and the intercommunications systems are free from onboard as well as externally caused interference. The Contractor shall submit a communications system design plan that shall describe the communications system trainlining equipment and interference mitigation measures within 90 days following award of contract.

The application of control components such as filtering, shielding, and bonding shall conform to sound engineering practices and, wherever possible, shall be an integral part of the car electrical system.

Interference sources, such as the electric buzzer intercommunication signal system or other trainline signals, etc., shall be adequately suppressed.

7.8 Wiring Diagrams

The Contractor shall provide schematic and wiring diagrams. These diagrams shall separately show the high voltage and the low voltage systems, the door control circuits, lighting circuits, climate control circuits, communication circuits, and trainline wire assignments. These schematics shall be coordinated to include identification of wiring of subassemblies and shall be included in the maintenance and repair manuals. The schematics shall be revised to include modifications, repairs and reworks performed throughout the execution of this Contract.

7.9 Destination Signs

Each car shall be equipped with a destination sign by each side door on each car. This sign shall be capable of displaying simple graphics (the “Amtrak-Illinois” logo) or a one-to-four digit train number when operating in an IDOT-supported service (Chicago-Carbondale, Chicago-Quincy and Chicago-St. Louis). Entry of the selected display or message to appear on the destination signs shall be made at the Trainman’s Display Keyboard (TDK) located near the circuit breaker panel.

7.10 Future WiFi

Cabling shall be provided in the cars for a future WiFi system. This feature shall be active only on IDOT-supported routes (Chicago-Carbondale, Chicago-Quincy and Chicago-St. Louis – other routes may be implemented in the interim; IDOT or its representative shall provide the updated information to the Contractor). Cable shall be Cat 5 Ethernet complete with a minimum of 4 twisted pairs.

One cable shall be installed from the A end locker to the B end locker.

Another cable shall be installed from the B end locker to the B end circuit breaker locker with enough length stowed so that the cable can be routed to the exterior of the car in the future.

Disabling/enabling of the WiFi and other features (destination signs, etc.) may be done by GPS command, by recognition of the entry of a non-IDOT train number on the TDK, or by insertion/removal of a system enabling device. The Contractor shall specify the arrangement to be used to control these features, and demonstrate that the proposed arrangement has been used successfully in a railroad environment for at least three years. Installation of wayside equipment (access points, etc.) is not a part of this procurement. If the Contractor's proposed design incorporates the system enabling device, sufficient devices shall be provided to equip all trainsets and to provide 10% to 15% agreed level of spare equipment.

7.11 Visual Message Signs

Each interior partition shall have a visual variable message electronic sign installed. These signs shall be ADA-compliant. The sign reading area shall be nominally 8 inches high by 28 inches long and be suitable for display of two lines of characters. The sign enclosure shall be no more than 3 inches deep with the length and height to suit the enclosed equipment. The sign mounting shall be designed with no visible fasteners, but shall permit the sign to be removed for cleaning or replacement. The sign shall be plug-connected, with the connector suitable for use in the railroad/transit environment. The signs shall be powered form their own separate circuit breaker form the 64 Vdc trainlines.

The sign characters shall be formed by LEDs with nominal 1/8-inch diameter lenses designed to offer a viewing angle of 120-degrees. The LEDs shall be spaced nominally 0.16 inches center-to-center. The LEDs shall be capable of providing a multi-colored display. Sign characters shall scroll and the scrolling speed shall be adjustable and shall be a part of the message data base.

The signs shall be capable of repeatedly displaying the messages. The number of repetitions shall be adjustable and shall be part of the message data base.

Each pre-recorded message given for each station and each special message shall be displayed. When a manual PA announcement is given, the signs shall display the time and date. When no message is being displayed the signs shall display the time and date.

Entry of the train or work-piece number into the Trainman's Display Keyboard (TDK) shall provide all equipped cars in the train with the group of intermediate and terminal station names to be announced, along with other announcements to be made in the course of the trip. As noted in Section 7.3.3, the Contractor shall consider the inclusion of car/train control and communications network, of which the TDK shall be a part. Alternatively, the Contractor may propose another similar device for data entry, status reporting and monitoring/control.

SECTION 8

8 HEATING, VENTILATION AND AIR CONDITIONING

8.1 General

The HVAC system shall provide a comfortable temperature controlled environment of the passenger areas considering:

1. AW2 Passenger load per individual, coupled car. Contractor shall demonstrate compliance with this requirement for alternative car/trainset configurations.
2. Frequency of door openings associated with passenger loading and unloading.
3. Design ambient conditions (See Section 2.2).
4. Solar load.
5. Internal electrical load.
6. Carbody thermal losses.
7. Fresh air load.
8. Heat losses due to train motion.

A microprocessor based, integrated heating, ventilation, and air conditioning (HVAC) system shall be provided. The system shall be designed to maintain the specified interior passenger area temperature and humidity and to also assure adequate interior ventilation. ASHRAE Standard 55-1992 "Thermal Environmental Conditions for Human Occupancy" shall be used as a guide in determining system capacities. The Contractor shall prepare a detailed heating and cooling load analysis along with recommended heating, cooling, and ventilation capacities for all car types.

The proposed HVAC equipment and controls shall be identical for all car types. Control software may differ between business class/food service cars and the cab/coach cars.

In no case shall the heating capacity be less than 40 kW (not including the forced air control cab heater) or the refrigeration capacity be less than 237,000 Btu/Hr. The HVAC unit manufacturer shall conduct qualification testing to verify that the units provide the design heating and cooling capacity.

The HVAC system shall be powered primarily from the 480 Vac, 3 phase, 60 Hz supply. The fresh air blowers shall be powered by the 120 Vac, single phase, 60 Hz power supply. The temperature controls shall operate from the low voltage dc power supply. To minimize the effects of motor inrush currents on the head end power system, the controls shall incorporate a method to provided random starting of the refrigerant compressor motors. The random start up timing shall be set at agreed intervals on each car and from car to car.

The HVAC system shall be controlled by a solid state temperature control using a sufficient number of temperature sensors to properly regulate heating and cooling in response to temperature changes inside and outside the car. Temperature sensors in the car body shall be

located to accurately reflect temperature changes without being unduly influenced by external heat sources or solar radiation. Except in the area of the side doors and vestibule, the HVAC system shall maintain a temperature variation within the following;

1. At any given time, among all points in the same horizontal plane 36 inches above the floor from one end of the car to the other the temperature variation shall not exceed ±2ºF.

2. At any given time, between any point 48 inches above the floor to a corresponding point 6 inches above the floor in a vertical plane the temperature variation shall not exceed ±3ºF.

HVAC system circuit breakers and temperature control adjustment devices shall be accessible only to the operating crew. Circuit breakers, controls, and relays shall be inaccessible to the passengers.

8.2 Air Conditioning

The cars shall be cooled using electromechanical equipment that has been proven in rail service. Two self contained HVAC units shall be provided to meet the requirements of this Section. The HVAC units shall be installed above the ceiling at each end of the car.

The air conditioning system shall be designed and adequately sized to maintain a 75º ±2ºF interior car temperature measured at the return air grille at the normal ambient conditions specified in Section 2.2. Interior relative humidity shall not exceed 60%. For ambient temperatures greater than 100ºF, the air conditioning system shall be capable of maintaining a 25ºF below the ambient temperature up to 125ºF. Application and integration of the system is to be in accordance with the recommendation of the air conditioning manufacturer who shall also specify air flow requirements.

Each HVAC unit shall be totally self-contained and shall consist of a compressor/condenser section and an evaporator section with electric heating units.

For major repairs, the HVAC units shall be removable through suitable roof hatches. Routine service operations shall be largely performed through hinged access panels accessible from the inside of the car. Access to the condenser fan shall be through the discharge outlet in the roof. Refrigerant solenoid control valves shall be located near the receiver tank for ease of service access.

The HVAC unit shall be mounted above drip pans. The drip pans shall catch the moisture (condensate) removed by the evaporator and shall also reduce objectionable noise that might be transmitted to the passenger area. The drip pans shall be designed and constructed to minimize sloshing of the condensate, eliminate water dripping on passengers, and maintain carbody pressurization. Insulation shall be provided to minimize heat loss and noise and to prevent condensation on the ceiling interior. The drained condensate shall be directed to the roadbed through the carbody structure without leakage and shall not be discharged on car structure, wheels, brakes, or electrical equipment. The drip pans shall incorporate access hatches to permit servicing from the inside of the car. Access to the drip pans shall require the removal of a minimum number of ceiling panels. The ceiling panels providing access to the drip pans shall be held by square-key latches. The hatches in the drip pans shall be sealed against

air and water penetration and shall be insulated to prevent heat loss. All fasteners securing the drip pans shall be of stainless steel or other non-corrosive material.

To prevent the penetration of snow, dirt, or water, a condenser air outlet cover shall be provided on the roof. The cover shall be designed to lock in either the “covered” or “open” position.

The refrigeration system shall include, as a minimum, the following components and features:

1. An environmentally friendly (non-ozone depleting) refrigerant recommended by the HVAC sub contractor.

2. Two scroll type refrigerant compressors to provide 50% and 100% capacity control.

3. Compressor shutdown control shall be by means of a pump down cycle sensing suction line pressure.

4. Refrigerant compressor crankcase heaters.

5. Condenser fan and motor assemblies.

6. Condenser coil assemblies with 0.008 inch thick copper fins on 0.38 inch diameter copper tubing at a spacing of 8 fins per inch.

7. Receivers (if required by design) of welded steel pressure vessel construction. The receiver shall have two floating ball sight glasses.

8. Suction accumulator (if required by design).

9. Replaceable cartridge type filter driers, discharge line check valves, and moisture and liquid indicators.

10. Liquid line solenoid valves (2 per unit).

11. Thermal expansion valves (2 per unit).

12. Evaporator coil assemblies with two horizontally split sections for modulated and full cooling. The assembly shall have copper fins on the copper tubing. Spacing, diameter of the tubing and thickness of the fins shall be specified by the HVAC supplier and be suitable for the IDOT system environment.

13. High, low, and modulation pressure switches.

For cab compartment air conditioning refer to Section 6.5.10 of this Specification.

8.3 Heating

The cars shall be electrically heated. The system shall compensate for carbody losses and fresh air heating loads.

The heating system shall be designed and adequately sized to maintain a $70^{o} \pm 2^{o}F$ interior temperature throughout the car measured at the return air grille at the normal ambient

conditions specified in Section 2.2. Overhead heat shall be divided into three stages. The size of each stage shall be chosen and controlled so that cycling of the heating contactors is minimized.

The overhead heaters shall be protected against overheating caused by the loss of sufficient air over the heater elements..

The side wall heater shall be enclosed by a perforated sloping top, 304-4 stainless steel heater grilles with perforated holes. The grille shall be designed to provide a smooth transition with the side wall. The grilles shall be designed to prevent debris from entering the heating space and contacting the heater elements. The grilles shall be fitted with interior baffles to assist the convection air flow. The temperature of any portion of the grilles that could come in contact with passengers shall not exceed 140°F at nominal supply voltage and an interior air temperature of 70°F.

Antifreeze protection (activated at an outside temperature of 45°F) shall be provided for the door thresholds, water tank(s), and water drain valves. In addition, a convection heater for the door track shall be provided at the floor level of each door pocket.

Layover heat shall be supplied by the sidewall heat or overhead heat or a combination of both and shall maintain a minimum interior temperature of 45° ±5°F. During layover heating, the evaporator fans shall operate and the fresh air fan motors shall be shut off.

The heating system shall include, as a minimum, the following components and features:

1. Three stages of forced air electrical overhead heat.
2. Heater over temperature protection devices.
3. Sidewall heaters.

For cab compartment heating refer to Section 6.5.10

8.4 Ventilation

The design of the ventilation system, including fresh air and recirculating air intakes, ducts, and diffusers, shall provide controlled movement of conditioned air to all occupied areas of the car. The ventilation system shall be arranged so that in the event of failure of one of the air conditioning units, air from the other unit shall be distributed throughout the car.

The ventilation system shall be designed and constructed to comply with the requirements of 49 CFR 238.103. The Contractor shall demonstrate compliance through design, analysis and testing. The ventilation system shall be designed and integrated into the vehicle to ensure that it does not contribute to a fire in unoccupied spaces.

Conditioned air shall be delivered to the passenger areas through adjustable linear diffusers which may be integral with the main interior lighting fixtures. The total air flow from the two evaporator blower fans shall be 5500 cfm (±5%). Fresh air shall be induced upstream to the air filters by fresh air fans located at each end of the car. The fresh air fan motors shall be two-speed, shall be powered from the 120 Vac supply, and shall be easily accessible through hinged ceiling panel. The fresh air flow per passenger, at nominal passenger load conditions,

shall be within the guidelines of the ASHRAE Applications Handbook. The total normal fresh air flow shall not be less than 1000 cfm with the reduced fresh air flow at approximately one-half of the normal when the ambient is below 20ºF. The fresh air blowers shall be shut down whenever the side doors are open or the car is in the layover heat mode.

To prevent toilets odors from entering the passenger areas, each toilet room shall be provided with a 120 Vac exhaust fan that shall discharge not less than 60 cfm of air to the car exterior. Conditioned air shall be introduced into the toilet room through a sight-tight grille in the toilet room door or through a minimum one inch space between the toilet room door and the floor, or through a supply air grille.

The ventilation system shall provide a minimum carbody pressurization of 0.1 inch H_2O at full fresh air flow with all exterior doors and windows closed and the toilet room exhaust fan running.

Toilet room exhaust shall, at all operating speeds, maintain a negative pressure at all times as compared to the rest of the car interior.

Air filters shall be provided in the return air duct to filter the return and fresh air mixture. The filter element shall be a 2 inch thick Farr 30/30 pleated-type filter or approved equal. Access to the filter shall be through the return air grille which shall be hinged along one side.

The ventilation system shall include, as a minimum, the following components and features:

1. Evaporator blower and motor assemblies.
2. Fresh air fan and motor assemblies.
3. Air flow detection switches.
4. Mixed air filters.

8.5 Controls

Heating and cooling control shall be by a solid state controller using electronic sensors for temperature data. The output of the solid state controller shall drive electromechanical relays and contactors which shall, in turn, control electrical power to the heater elements, motors, and various control devices. The changeover between heating and cooling shall be automatic and, except for the first stage of overhead heat (reheat), shall preclude the simultaneous operation of heating and air conditioning. A solid state or microprocessor based temperature controller providing software control and modification of temperature set points by IDOT authorized staff, as well as the control and modification of various functions such as reheat, is desired. Other proven solid state controller designs will be considered providing the design allows for field modification of the temperature set points and other functions by IDOT authorized staff.

As a minimum, the following temperature sensors shall be required:

1. Return air sensor at each HVAC unit return air grille.
2. Duct air sensor at each HVAC unit downstream of the evaporator motor.
3. Floor heat sensors at floor level in each of four sidewall heating control zones.

4. Ambient temperature sensors located in a position that accurately reflects outside temperatures.

An automatic operating “Summer/Winter” control shall, in the “Winter” position, lockout the air conditioning. The control shall be set by the exterior car ambient temperature sensor. Both heating and air conditioning layover control shall be provided. The layover selection shall be integrated with the "Summer/Winter" switch. In the “Winter” mode, layover heating shall maintain a carbody interior temperature of 45º ±5ºF. In “Summer” mode, layover cooling shall maintain a carbody interior temperature of 75º ±2ºF. The air conditioning system in layover “Summer” mode shall function as usual except that there shall be no fresh air induction. In layover “Winter” mode, the air conditioning system shall be disabled.

The layover mode shall be automatically enable whenever the brake pipe pressure falls below 50 psi or when the locomotive or cab car brake controller is placed in the emergency position. The enabling of layover shall be trainlined.

Each HVAC control panel shall include an indicator and monitor display which shall show the control logic state. Indications shall be by means of suitably labeled LED's which shall display all calls for heating or cooling from the zones controlled from that panel. Overload indicators and resets shall be available for use by the train crew without exposing the crew to hazardous voltages.

The HVAC system control set points shall be as shown below:

- Return Air Temperature HVAC System Mode.
- Below 70ºF Heating.
- 70ºF to 72ºF Ventilation.
- 72ºF to 73ºF Partial Cooling with Reheat.
- 74ºF Full Cooling with Reheat.
- Above 75ºF Full Cooling.

During all modes, the interior relative humidity shall not exceed 60%.

The control system shall include, as a minimum, the following components and features:

1. Temperature control panel.
2. Temperature sensors.
3. Motor starters.
4. Motor protective devices.
5. Heat contactors.

The Carbuilder shall submit a temperature control schedule and a detailed description of operation for approval by the Engineer.

SECTION 9

9 BRAKE EQUIPMENT

9.1 Brake Performance

The full-service brake rate of one train with the equivalent of four 154,000 lb, multi-level cars, plus one 285,000 lb, fully fueled, ready-to-run, locomotive with an assumed full service brake rate of 1.5 mphps over the entire operation speed range (0 mph to 110 mph) under all load conditions shall be 2.0 mphps, ±10 percent. The maximum instantaneous rate during a stop shall not exceed 3.2 mphps.

Higher braking rates shall be possible by adjustment. It shall be possible to set the car full-service braking rate down to 1.5 mphps.

During an emergency brake application, the brake cylinder pressures shall be 20 percent higher than full-service pressures. The emergency brake rates shall be higher than the full-service brake rates by proportionately the same amount, up to the limit of wheel-to-rail adhesion.

The braking efforts by the disc shall be maximized to the safe limit of the thermal capability of the discs.

9.1.1 Brake Control

Brake-cylinder pressure shall be modulated by a load-weigh system in proportion to the car weight on the air springs. In the event that load-weigh-sensing pressure is lost, the brake rate shall not be less than 95% of the empty car weight brake rate.

The brake system shall be the WABCO 26-C brake equipment or equal. All parts necessary to complete the efficient operation of this equipment shall be supplied, installed, and tested in accordance with AAR requirements.

The brake valve portions associated with the 26-C brake system shall, to the greatest possible extent, be interconnected by, and mounted on, a manifold assembly. The manifold assembly shall be installed in a location from which it is accessible from the interior of the car, for the purpose of changing out the individual valve portions, or the entire manifold assembly. The number of valve portions that are required to be installed under the car shall be limited to the absolute minimum that is consistent with the proper function of the air brake system in all required modes. Sound attenuation shall be provided to prevent transmission of audible noises to the passenger compartment.

Design and construction of laminated manifolds shall be of a type that has proven service history.

9.2 Reservoirs

Reservoirs shall be rigidly attached to the car body, preferably on the same side and as close as practical to the control valve and relay valve. Auxiliary reservoirs shall be sloped toward one end where a 1/2-inch N.P.T. drain plug shall be installed.

Main reservoirs shall be pressure tested in accordance with FRA and AAR requirements. Certificates of acceptable pressure testing shall be traceable to each main reservoir's serial number and shall be included in the Car History Book.

9.3 Passenger Emergency Valves

Two Passenger Emergency valves shall be located in positions adjacent to, but diagonally opposite side doorways in accordance with APTA Standard SS-M-007-98. An additional valve shall be located in the cab area and shall be accessible for operation from outside the cab wall when the full width cab is not in use. The valves when actuated shall cause an emergency brake application to the train and cause the emergency brake indicators on the side of the car to light. Access shall be readily available to reset valve by authorized IDOT staff.

9.4 Truck Brakes

The brake system on each truck shall consist of:

- A tread-brake actuator and shoe acting on each wheel for a total of four tread-brake assemblies per truck, and
- Disc-brake actuators with friction pads acting on a disc(s) mounted on each axle. One or two disc-brake assemblies per axle may be used. The Contractor shall provide supporting calculations proving that the proposed disc-brake configuration provides adequate braking for the intended operating conditions.

The composite disc/shoe system satisfying the requirements of Section 9.1 shall have braking capability appropriately apportioned between discs and shoes.

Wheel- tread brake units shall be equipped with composition-type brake shoes, size, and type as specified by the brake system subcontractor.

9.5 Air Piping

All piping shall be assembled with as few fittings as is practical and in accordance with AAR Standards. (See Section 11.10.1). The welding of the air brake system piping shall follow AAR Recommended Practice S-402, latest revision. The line between the 26-C Brake Control Unit and the combined volume/selector reservoir shall be steel or copper protected as noted in Section 11.10.1.1 of this Specification. The main reservoir train line shall be level or sloped from the center of the car into two small drain reservoirs equipped with manual drain valves, located at either end of the lower underframe. All branch lines shall be taken at the centerline or higher from the Main Reservoir and Brake Pipe lines. From each tank the line shall rise to the end level. Each drain valve shall be operable by an extension lever from trackside, on the same side of the car as the brake control equipment. In normal operation, the valve shall be closed (off) when the lever is pushed in. A test-gauge fitting shall be supplied at the D-7 operating unit. In order to maintain air-brake-system air pressure in the event of an air spring failure, suitable by-pass valve(s) shall be installed. Brake cylinder shut-off, vented valves, painted yellow, shall isolate each truck, and shall be accessible from track side. Approved hoses shall be utilized only in locations where flexibility is required. Length of hoses shall be minimized. Pinless gladhands shall be supplied.

Each drain valve shall have a guard to prevent damage from track debris.

Hoses shall be installed on each end and aligned so that coupled cars will traverse the trackage both on the main line and in the yards. The Contractor shall provide tooling to ensure the locations are consistent from car-to-car so that coupling, car-to-car, will keep the correct hose location in all cases.

Elastomeric hose supports or approved equivalent shall be applied to the end-of-car hoses to prevent coupled or uncoupled hose ends from dropping below 2-3/4 inches above top of rail. These supports shall not interfere with proper operation of the hoses on coupled or uncoupled cars in the yards or on the mainline.

Valves and piping shall be stored prior to assembly to the car with temporary covers on all exposed openings. Immediately prior to installation of any brake system valves and accessories, the piping system shall be blown free of grit, scale, or any foreign material, while mechanically excited, and subsequently dried. See Sections 11.1.7 and 11.10.1. Hoses and piping shall be protected such that any moisture will not freeze in them, even when the outside temperature is as low as -34 degrees F.

9.6 Hand Brake

A hand brake shall be provided at the B-end of the car. The hand brake shall be Peacock Model 840 with a 21-inch-long handle or approved equal. The handbrake chain shall conform to the latest AAR Specifications.

The arrangement of the hand brake and mechanism shall result in safe, efficient performance, and be accessible for maintenance.

The hand brake shall be installed so as not to present a hazard to passengers and shall be located so that a crewman has ample clearance and freedom to safely and effectively apply the hand brake.

The hand brake with associated rigging shall apply the brakes on one tread brake unit on each axle of the adjacent truck.

Hand-brake-cable slack adjustment to be the pin-and-clevis style or approved equal.

In accordance with requirements of APTA Standard SS-M-006-98 for a manually operated mechanical parking brake, with a force of 74 pounds applied 3 inches from the end of the handle, the brake shall be able to hold a car at AW1 load on a 5.0 percent grade. In addition, with an applied force of 125 pounds on the handle, the brake shall be able to hold a car at AW3 load on a 3.5 percent grade.

9.7 Wheel Slide System

A wheel-slide protective system, WABCO type E-7 or approved equal, shall be provided.

The microprocessor-controlled, wheel-slide control system shall detect random, back-to-back, and synchronous wheel slides at all four axles, by means of inductive speed sensors at axle-mounted toothed wheels. Slide correction shall be made on a per truck basis, by a dump valve located as close as possible to the air piping connection to the truck. Wheel-slide protection shall be effective from any car speed down to 5 mph.

The operation of the dump valves shall be energized-to-dump and energize-to-lap and de-energize-to-apply. The detection and control system shall be powered from the low- voltage dc power system. The system shall operate over the full-demand range of service braking and during emergency braking. The slide control system shall be activated during application of service braking or emergency braking (as detected by a drop of brake pipe pressure below 50 psi).

One of the wheel slide sensors on each cab car, coach and business class/food service car shall be used for an odometer for registering accumulated mileage, regardless of direction of travel. This system shall receive the distance information from a magnetic pickup-tooth gear counter arrangement.

The odometer system shall be isolated from the wheel slide system. The odometer shall have its own wheel speed sensor (interchangeable with, but not a part of the wheel slide circuit) and circuit breaker. An average diameter of 33 inches shall be used for the wheel size.

The display for odometer mileage shall be located at a readily readable position in the electric locker and shall display six digits, the lowest being ten miles, displayed as “1”.

9.7.1 Fail Safe

The slide system shall be fail-safe, such that the normal system failure mode shall render the slide system ineffective and shall not prevent the application of brakes at any rate less than desired. Separate fail-safe timing and override of friction brake release on each truck shall also be provided. The operation of the dump valves shall be energized-to-dump or energize-to-lap. The detection and control system shall be powered from the low-voltage dc power system.

The system shall operate over the full-demand range-of-service braking and during emergency braking. During a service or emergency braking (as detected by a drop of brake pipe pressure below 50 psi), the dump valves shall be de-energized (and remain de-energized until the car has come to a complete stop) if an unsuccessful slide correction lasting longer than 5 seconds is detected.

9.7.2 Wheel Size Variation

The wheel-slide correction system shall function properly with differences up to 2 inches in diameter among the wheels of a vehicle (but not on the same axle). The equipment shall be self-calibrating, requiring no manual adjustment to compensate for wheel diameter variations.

9.7.3 Speed Pickups

The axle-speed sensors shall be of approved, rugged design for direct application to the bearing-housing sensor brackets. The sensors shall be fitted with waterproof, quick-disconnect connectors and shall be supplied with the necessary armored truck cabling. For each of the four, wheel slide axle-speed sensors installed on cab and trailer cars, the cabling shall include a car body mounted junction box near the associated axle. On the cab car, an additional axle-speed sensor is required for the cab speedometer and shall be installed opposite the wheel slide axle-speed sensor on the third axle from the B-end. The junction box for this axle, then, shall accommodate an additional cable and appropriate connector. Waterproof, quick-disconnect fitting shall be applied to each junction box and each end of each cable. A split-ring gear shall be installed to allow removal without pressing off the wheel assembly.

9.7.4 Self Test

To expedite servicing and maintenance of the car on a daily basis, the wheel slide unit shall be equipped with a self-test feature for internal/external fault diagnosis. The unit shall provide indication if it declares itself defective for any reason, or it shall be equipped with a test- position control switch to manually provide a quick check of the system components.

The wheel-slide system and installation shall be reviewed for acceptance by the Engineer.

SECTION 10

10 WATER AND WASTE SYSTEM

10.1 General

Each cab and trailer car shall have a water supply and waste system. With the exception of the undercar water fill lines, and the toilet retention tank, all of the components associated with this system shall be located in a utility compartment behind the toilet compartment rear wall and shall be accessible through a hinged door. Illumination of the utility compartment shall be provided by a wall mounted service light.

The water system capacity shall be determined by the Contractor. Onboard water shall be used for hand washing and toilet flushing if required. Onboard potable water shall be used for drinking and for food service. Contamination of food service and the drinking water system shall be prevented by a FDA approved backflow preventer or by FDA mandated air gaps on the outlet.

Raising of water shall be by compressed air. A suitable pressure reducing valve shall be connected to the main reservoir and shall provide an output pressure of 10 to 15 psig which shall be used to pressurize the water and toilet flush system.

Grey water shall be discharged directly to the water retention tank.

Toilet waste shall be gravity drained to a retention tank mounted directly below the toilet hopper.

10.2 Water Tank

Water storage shall be provided by one stainless steel tank mounted in the B-end vestibule area next to the partition bulkhead. The water storage tank shall comply with the latest edition of the ASME "Unfired Pressure Vessel Code". The tank shall be insulated and provided with an antifreeze heater.

10.3 Premixed Conditioning Solution Tank

Premixed conditioning solution storage tank shall be provided by one stainless steel tank mounted in the B end vestibule area next to the partition bulkhead. The premixed conditioning solution storage tank shall comply with the latest edition of the ASME “Unfired Pressure Vessel Code”.

10.4 Water Fill Arrangement

A wayside water fill nozzle with an overflow outlet shall be installed on the left hand side (cab side) of the car. The water filling system shall permit the wayside water supply pressure to overcome the car water raising pressure. A completely filled system shall be indicated by a steady flow of water from a separate water flow outlet located under the car.

10.5 Premixed Conditioning Solution Fill Arrangement

A wayside premixed solution fill nozzle with an overflow outlet shall be installed on the left hand side (cab side) of the car. The premixed solution filling system shall permit the wayside premixed solution supply pressure to overcome the car premixed solution raising pressure. A

completely filled system shall be indicated by a flow of premixed solution from a separate flow outlet located near the fill nozzle. The wayside premixed solution system shall have a cutout valve, so as to isolate when not in use.

10.6 Piping

A properly sized network of copper lines shall be installed to connect the water tank to the water filling equipment, and wash basin, and to provide a means for draining the system to the roadbed. Shut off valves with identification tags shall be provided at major equipment locations. A main drain valve shall be provided under the floor, accessible from below the car. An automatic thermostatic drain valve shall be installed. The drain valve shall automatically empty the water system when the utility compartment interior temperature falls below 34^{o}F. Piping shall be installed in a manner that shall prevent the formation of air or water pockets when the system is drained.

A properly sized network of stainless steel lines shall be installed to connect the premixed conditioning solution storage tank to the toilet hopper. The use of flexible tubing shall be minimized. All piping shall be protected such that it shall not freeze even when the outside air temperature is -34 degrees F. The contractor shall provide test data that demonstrates the installed system meets this requirement.

10.7 Waste System

Waste sanitation shall be provided by a flushing arrangement. When the toilet is flushed, a measured amount of premixed conditioning solution consisting of a mixture of biocide, glycol anti-freeze and water shall be introduced into the toilet hopper by a flush ring mounted in the toilet hopper. Toilet flushing shall be initiated by a pushbutton located on the wall of the toilet room. The premixed conditioning solution storage tank shall have a minimum capacity of 39 US gallons. The waste retention tank shall have a minimum capacity of 55 US gallons. The tank shall be protected against freezing by the introduction of premixed conditioning solution with anti-freeze properties each time the toilet is flushed. The use of automatic drain valves is strictly prohibited. A waste tank drain receptacle with a shut off valve and dust cap shall be mounted on the left hand side (cab side) of the car. The waste retention tank shall be fitted with an internal water washing arrangement that shall use the yard water supply for tank cleaning.

SECTION 11

11 MATERIALS AND WORKMANSHIP

11.1 General

This Section is applicable to all parts of the car whether provided by the Contractor or by the Contractor's Subcontractors. Accordingly, all the requirements of this Section apply to the design and construction of equipment furnished by the Contractor and its Subcontractors.

All materials and workmanship shall be in accordance with highest industry practices in all respects and shall be consistent with the intended application and end use of the manufactured parts.

11.1.1 Standards

At the time of Contract award, all materials and manufacturing techniques shall meet the latest revision of the appropriate APTA, AAR, ANSI, AISI, and ASTM Specifications and Standards and state and FRA regulations, unless otherwise specified and approved.

11.1.2 Commercial Materials

Any commercial materials which are not covered by a specification shall be clearly identified on the drawings by the commercial trade name or number, the name and address of the manufacturer, and a description of the material composition.

11.1.3 Substitution

Substitution of materials other than those specified, require prior review and acceptance by the Engineer.

11.1.4 Joining Surfaces

All joining surfaces shall be clean and free from dirt, grease, scale, and other contaminants prior to attachment or joining.

11.1.5 Operating Environment

All materials to be used in the construction of these cars shall be chosen such that they shall economically and safely achieve their function for the design life of the car in the environment outlined in Section 2.2.

11.1.6 Interior Cleaning

Fabrics and other non-metallic materials used for interior appointments shall not be affected by industrial compounds recommended and used for cleaning such materials. Where any commonly used cleaner or lubricant shall be detrimental to any material, it shall be noted on the component drawing and in the service-support manuals.

11.1.7 Cleaning During Car Construction

During car construction, adequate care shall be taken to prevent drill cuttings or other swarf from accumulating in areas which after subsequent assemblies become inaccessible. A progressive program shall be employed to prevent and remove such accumulations. Where drilling or other work has to be performed after installation of air brake equipment and piping or electrical equipment and wiring, adequate precautions, including covering of such equipment if necessary, shall be taken to prevent possible future problems. Before delivery of each car, a final clean up shall be made to assure all debris is removed from the car interior. Areas of particular concern, but not limited to these areas are:

1. All electrical junction boxes, conduits and other wire runs, lockers, panels, heaters, exposed-terminal blocks where retained metallic debris is critical.

2. Air-conditioning drip pans including water drains.

3. Door pockets where later car movement could cause door problems due to debris in door tracks.

4. Ceiling panels where subsequent movement can dislodge debris which could fall onto electrical equipment.

5. All air brake components and associated piping, tubing, fittings, and hardware. These items shall be cleaned, capped, and left capped until connected. The systems shall then be purged and cleaned.

11.1.8 Fire Safety

All materials inside the cars shall be selected to minimize combustion and propagation of fire. All combustible material used in the construction of the car shall satisfy the flammability, smoke emission, and toxicity requirements of this Specification, 49 CFR 238.103, and NFPA 130, latest version. In case of conflict, the most restrictive requirement shall prevail. The Contractor shall comply with all provisions of 49 CFR 238.103 (c), Fire Safety Analysis for Procuring New Passenger Equipment, and APTA RP-PS-005-00, “Fire Safety Analysis of Existing Passenger Rail Equipment”.

The Contractor shall provide certificates of Compliance for all combustible materials in the form of test reports and certificates issued by independent testing laboratories.

Demonstration of compliance may consist of reports and/or certificates issued for previous applications of the same materials in the same environment, if applicable. 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 in 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 Date. For low risk materials, test data from these reports that are dated between 5 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 designated as high or low risk shall by agreement between the Contractor and the Engineer.

A matrix showing the type of materials, where used, flammability and smoke emission test identity, test facility, test requirements, test results, and nature and quantity of the products of combustion shall be reviewed during design review stage.

The Contractor shall be responsible for complete conformance with these standards for itself and its subcontractors and suppliers. IDOT or its representative may, at its discretion, require that the current batch of material being provided for this contract be retested for conformance with these standards.

11.1.9 Toxicity

The Contractor shall establish a review and analysis program for approval to minimize the use of materials and products recognized to release toxic products of combustion. Those materials and products generally recognized to release toxic products of combustion shall be identified by the Contractor and submitted to the Engineer for review within 180 days of Contract Award Date. Any such materials and products approved for use in the construction of these vehicles shall be addressed in the Fire Safety Hazards Analysis.

All materials tested for flammability and smoke emission shall be tested for toxicity using Boeing Specification Support Standard BSS-7239 and/or Bombardier standard SMP 800-C.

11.1.10 Finishing Materials

Finishing materials shall be applied to commercially-acceptable tolerances with respect to flatness, finish, and fitting of joints, as applicable. Materials shall be integrally-colored, of uniform color throughout the car, and fabricated to extend durability and provide consistency of appearance throughout car life.

11.2 Structural and Sheet Metals

The materials used shall be in accordance with APTA Standard SS-C&S-034-99.

11.2.1 Aluminum

General: 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."*

Alloys to be used for the car body structure are as follows, or approved equal:

1. Other Extrusions: AA6061-T6 and AA6351-T6.
2. Exterior sheeting: AA5086-H32 and AA5454-H32.
3. Roof sheeting: AA3003 H34.
4. Body Posts, Roof Bows, Horizontal Rails, and second floor crossings: AA6061-T6 and AA 6351-T6.

Design Stresses: All aluminum structural members shall be designed in accordance with the requirements of the Aluminum Association's (AA), **"**Specification for Aluminum Structures" and

"Engineering Data for Aluminum Structures." Proper allowance shall be made for the effects of fatigue, and for column and plate stability effects.

Fabrication and Fastening: The forming of aluminum parts, their joining by bolting, riveting, and welding and the protection of contact surfaces shall conform to the requirements of the Aluminum Company of America's Technical Report No. 524, **"**Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles," except as otherwise specified herein.

Fabrication techniques shall be such that the strength and corrosion resistance of the aluminum shall not be impaired nor the surface finish permanently marred or discolored during construction.

11.2.2 Stainless Steel

General: Stainless steel shall conform to the mechanical properties indicated in the AISI Standards for the specified alloy. All materials, workmanship, and identification markings shall conform to the requirements of the AISI committee on Stainless Steel Procedures. Stainless steel used in the interior shall be AISI 300 series or approved equal. If used, structural stainless steel components assembled by fusion or resistance welding shall be of AISI-type 201L, 301L, 301LN, or SUS301L (with Nitrogen) and shall conform to the requirements of ASTM A666 except that the carbon content shall not exceed 0.03 percent and type 301LN and SUS 301L (with Nitrogen) shall not exceed 0.25 percent nitrogen. Other stainless steels conforming to ASTM A666 or A240 are acceptable for non-welded applications.

Alloys to be used for the car body structure are as follows, or approved equal:

1. Center under-pans: Stainless Steel Type 304 or approved equal.

Finishing Methods: Surface finishes shall be uniform and of such texture that the original finish shall be maintained through repeated brush washings.

Buffing and polishing of stainless steel, where required, shall be done without the use of any composition-containing iron or iron oxide.

11.2.3 Steel

General: Steel used in the underframe and other parts of the car body structure (including equipment compartments) shall be a high strength, low-alloy steel, with smooth surfaces in accordance with industry standards. Application shall be as follows.

1. End underframe, centersills, crossbearers, collision posts, side sill and side plates and anti-telescoping beams: ASTM A-588, ASTM A-710 or approved equal.

2. End sub-floor steel sheets: ASTM A-606 or approved equal.

Design Stresses: Structures of low-alloy, high-tensile steel shall be designed so that the sum of the stresses to which any part is subject (except in the case of collision) shall not exceed the corresponding allowable stress values which have been selected by the Contractor.

In selecting the allowable stresses, the Contractor shall have made appropriate allowance for the effects of column, flange, and web stability, locate discontinuities and other stress concentrations, strength reduction at welded regions, fatigue loadings, etc.

Sources for selected stresses shall be cited or, static and fatigue test results may be submitted, as justification for selected values.

All steel hardware e.g. bolts, screws, washers, shall be protected from corrosion by zinc plating of adequate thickness. Where commercial grade hardware is used, plating grade, thickness, and material shall be reviewed. If necessary, such hardware shall be re-plated before use. The measures to be taken to prevent the risk of galvanic corrosion from bimetallic contact shall be in accordance with the requirements of Section 11.13.

11.3 Steel Other Than Body Structure and Sheeting

11.3.1 Axles

Axles shall be forged steel conforming to SAE/AISI 4140, normalized, oil-quenched, and tempered to give Brinell 220-270, minimum ultimate tensile strength of 100,000 psi, elongation of 20 percent in 2 inches minimum, reduction of area at 50 percent minimum, yield strength of 80 Ksi minimum. Axles shall comply with APTA RP-M-001-98, “Recommended Practice for Passenger Car Axle Design.”

11.3.2 Wheels

The wheels shall be heat treated, multiple-wear type, 33 inch diameter, Class ‘A’ curved plate, hub stamped in accordance with AAR Specification M-107-84 latest revision, including AAR Circular Letter C-9201 and APTA SS-M-012-99.

11.3.3 Steel Castings

Steel castings shall comply, shall be tested, inspected and accepted in accordance with procedures of the applicable AAR standards.

The quality of steel castings shall be checked in accordance with the requirements of AAR M-201. Any radiographic testing shall be per ASTM E94 using reference radiographs to ASTM E446 or E186, as may be applicable. The radiographic sensitivity shall be at least 2 percent (2-2T). Acceptance levels for the radiographic testing shall be submitted to the Engineer for review and approval. The surface quality of the steel castings shall be evaluated in accordance with ASTM A802-95 to acceptance level IV. All weld repairs shall meet the requirements of ASTM A488. When castings are found to be unacceptable, they shall be repaired in the original factory of manufacture prior to shipment or by another repair process approved by the Engineer.

All steel castings used in the truck structure shall be made of electric furnace, heat-treated, AAR M-201, Grade B.

11.4 Rubber and Elastomers

11.4.1 General

All rubber shall be so compounded and cured that it shall perform satisfactorily in car operation at any temperature between − 40 deg. F and 160 deg. F and shall last for a period not less than 3 years or 300,000 miles, whichever comes first, prior to the need for replacement.

11.4.2 Tests

Unless otherwise specifically stated herein, all tests shall be conducted according to the latest revision of ASTM test procedures for rubber goods.

11.4.3 Window and Door Sealing

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

11.4.4 Truck Parts

Rubber-truck springs shall be compounded, designed, and cured as to meet the load and other requirements of these Specifications.

The rubber shall be resistant to oil, grease, and acid. If used, air springs shall be molded, natural rubber.

11.4.5 Elastomers

All elastomers other than rubber shall be neoprene or equal, or better suited alternative materials, as approved by the Engineer. Equal or alternative materials shall conform to applicable ASTM requirements.

11.5 Glazing

11.5.1 General

Glazing used shall meet the following material criteria:

1. Windshield glazing shall be a single-glaze, certified FRA Type I clear laminated safety glass, meeting all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The glazing shall incorporate an anti-spall shield on the interior side. The glazing shall be clear tint. The glazing shall be 0.560 inch thick. The glazing's maximum solar energy transmittance shall not exceed 70%.

2. Cab End Door Window glazing shall be a single-glaze, certified FRA Type I clear laminated safety glass, meeting all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The glazing shall be clear tint. The glazing shall be 0.560 inch thick. The glazing maximum solar energy transmittance shall not exceed 90%.

3. Non-cab End Door Window glazing shall be a single-glaze, certified FRA Type II clear laminated safety glass, meeting all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The glazing shall be clear tint. The glazing shall be 0.375 inch thick. The glazing's maximum solar energy transmittance shall not exceed 90%.

4. Side Door Window glazing shall be a single-glaze, certified FRA Type II clear laminated safety glass, meeting all the applicable requirements of ANSI Z-26 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The glazing

shall be clear tint. The glazing shall be 0.375 inch thick. The glazing's maximum solar energy transmittance shall not exceed 90%.

5. Cab Car Control Station Sliding Window assemblies shall be double-glazed. The outer pane shall be 0.250-inch thick, clear laminated safety glass. The inner pane shall be 0.250-inch thick, clear laminated safety glass. The double-glazed assembly shall have a 0.250-inch dead air space separating the inner and outer panes. The double-glazed assembly shall be certified FRA Type II and meet all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The double-glazed assembly shall be clear tint. The double-glazed assembly's maximum solar energy transmittance shall not exceed 85%.

6. Side (Non-Emergency) Window assemblies shall be double-glazed. The outer pane shall be 0.250-inch thick, -tinted tempered safety glass unless specified otherwise by the Engineer. The inner pane shall be 0.375-inch thick, clear tempered safety glass. The double-glazed assembly shall have a 0.375-inch dead air space separating the inner and outer panes. The double-glazed assembly shall be certified FRA Type II and meet all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The double-glazed assembly shall be gray tint unless specified otherwise by the Engineer. The double-glazed assembly's visible light transmission shall be 24%. The double-glazed assembly's maximum solar energy transmittance shall not exceed 50%.

7. Side Emergency Window assemblies shall be double-glazed. The outer pane shall be 0.250-inch thick, gray-tinted tempered safety glass unless specified otherwise by the Engineer. The inner pane shall be 0.375-inch thick, clear laminated safety glass. The double-glazed assembly shall have a 0.375-inch dead air space separating the inner and outer panes. The double-glazed assembly shall be certified FRA Type II and meet all the applicable requirements of ANSI Z-26.1 and U.S. Code of Federal Regulations, 49 CFR 223, including Appendix A. The double-glazed assembly shall be gray tint unless specified otherwise by the Engineer. The double-glazed assembly's visible light transmission shall be 24%. The double-glazed assembly's maximum solar energy transmittance shall not exceed 50%.

8. Non-Cab Intermediate Level Windscreen glazing shall be a single-glaze, 0.380-inch thick tempered safety glass. The glazing shall be gray tint. The light transmission shall be 24% to 28%. The exposed surface shall have SAE J673 #1 edge finish.

9. Cab Intermediate Level Windscreen glazing shall be a single-glaze, 0.380-inch thick tempered safety glass. The cab partition wall glazing shall be clear tint. The other intermediate windscreen glazing shall be gray tint and light transmission shall be 24% to 28%. The exposed surface shall have SAE J673 #1 edge finish.

10. Cab and Non-Cab Lower Level Windscreen glazing shall be a single-glaze, 0.380-inch thick tempered safety glass. The glazing shall be clear tint. The exposed surface shall have SAE J673 #1 edge finish.

11.5.2 Flatness

When an individual glass light is laid on a truly flat surface, the glass shall not indicate a bow of more than 0.03 inches per lineal foot in any direction.

11.5.3 Overlap

The overlap of one sheet of laminated glass with respect to the other at an edge shall not exceed 1/32 inch. Corners and burrs shall be ground smooth and all edges shall be sealed.

11.5.4 Bonding

The bond between the sheets of laminated safety sheet glass and the membrane shall be of such quality that when the glass is broken by shock, by twisting, or by direct impact, there shall be no material separation between laminations. No sheets of laminated glass containing unbonded areas shall be accepted.

11.5.5 Dimensional Tolerance

The overall dimensions of individual lights as supplied shall be held within 1/16 of the dimension ordered. The thickness of individual lights shall have a tolerance of +0.020 inches.

11.5.6 Color

When examined over a white background, there shall be no appreciable color variation in the individual lights of laminated safety glass.

11.5.7 Haze

Lights of laminated safety glass shall be so nearly free from haze that the laminated glass shall approximate the same clarity as a light of non-laminated plate glass of the same thickness, when tested in accordance with Section 11.5.10.

11.5.8 Specks and Scratches

Occasional specks of foreign material or scratches are permissible outside of the central three-quarters of a light provided such specks do not exceed 0.020 inches in the greatest dimension and scratches do not exceed three inches in length. IDOT or its representative reserves the right to determine which lights are to be rejected.

11.5.9 Distortion

Laminated safety glass shall produce no apparent distortion on a straight line at 45^{o} to the plane of the glass.

11.5.10 Testing

All questions regarding the quality of the glass shall be settled by the test methods described in ANSI's most recent revision of American Standard Z26.1, "Safety Code of Glass for Glazing Motor Vehicles Operating on Land Highways".

11.6 Wire and Cable

11.6.1 General

All car wire and cable shall be insulated, cross-linked polyolefin materials or equal as approved by the Engineer. Wire insulation shall meet the requirements of APTA Standard SS-E-001-98 and NFPA 130-2006.

All wire, cable, terminal blocks, relays, resistors, and all other electrical items shall be clearly marked for identification. Identification and marking shall be approved by the Engineer.

11.6.2 Conductor Sizes

Selection of wire size shall be based on the required current carrying capacity, voltage drop, physical strength, temperature, and flexibility requirements in accordance with applicable APTA, AAR, ICEA, ASTM, NEC or MIL Standards and Specifications and Section F of the *AAR Manual of Standards and Recommended Practices.*

Wire for control and auxiliary circuits shall not be smaller than 14 wire AWG except that 16 AWG wire may be permitted for wiring to pass through connectors, or where used in lighting, door, vendor supplied door and temperature control panels and communications circuits.

Design wire ampacity shall comply with NEC Table 310-18, 110C Column. When more than three conductors are applied in a raceway or cable, the ampacities shall be derated, as described in Note 8 of Table 310-16.

Minimum wire sizes shall be as follows:

1. Wire pulled through conduits or wire way: 16 AWG.
2. Wire on electronic units, cards, and card racks: 22 AWG.

The Engineer may approve smaller wire sizes for selected applications upon submission of appropriate applicable data for justification.

11.7 Wiring

11.7.1 General

Wire insulation shall be rated for 600 Vac/1000 Vdc and the thickness shall be as listed in column B of Table 3-1 of ICEA Publication S-66-524 (NEMA WC7). Insulation shall be colored (gray or similar). Wires smaller than 8 AWG shall be indelibly marked, for proper circuit identification, by means of hot stamping on the wire surface throughout the length of the wire. Each designation shall be no more than 3 inches from the last designation on the 24 inches of wire nearest termination and 36 inches apart on the rest of the wire run. Wires larger than 8 AWG and multi-conductor cables shall be marked at each end with circuit designations which are identical to those shown on circuit schematics. Heat shrink tubing of proper size shall be printed with the wire designations shall be installed on the ends of the wire in an easily visible position as close to the termination as practical.

Damaged wiring shall be replaced and wire splices are prohibited.

Wiring shall be in accordance with accepted industry practices and applicable North American Standards, including those of APTA, AAR, ANSI, ASTM, IEEE, and NEC. The Contractor shall provide a listing of applicable standards and proof of compliance. If standards other than North American standards are referenced, the Contractor shall provide proof that the non-North American standard is equivalent to the appropriate North American standard, and that all requirements are met. Deviations from approved standards shall be only on a case by case basis and specifically approved by the Engineer.

Where possible, wiring which operates at 480 Vac or 120 Vac shall not be placed in the same conduits, junction boxes, or ducts with wires operating at low voltage dc. When a given piece of electrical apparatus needs to be connected 480 Vac or 120 Vac and low voltage dc, all wiring to the apparatus shall be insulated for the higher voltage.

11.7.2 Terminals

Where possible, plug and receptacle connectors shall be used to make connections to electrical devices that may need replacement. Wire connections shall otherwise be made using crimped lugs terminated on stud-type or screwed terminal strips or approved equal.

Terminal strips, described above, shall be used for all wiring connections, except the pigtail connections to fluorescent lamp sockets in fixtures.

Terminals for wire and cable shall be of the crimp or compression type. Terminals shall be applied in accordance with the manufacturer's recommended tools and procedures. Approved terminals include AMP Incorporate PIDG ring tongue and .250 inch series Faston or approved equal.

The use of fast-on terminations shall be approved by the Engineer.

All terminal studs shall be plainly and permanently marked so that the circuits may be easily identified. Wiring shall be routed so as to minimize obscuring of terminal markings.

Service loops allowing a minimum of three re-terminations shall be provided in the wiring to terminal strips. Conductors shall be protected by suitable means such as insulation grip to minimize breakage of the conductor at or near the terminal.

11.7.3 Undercar Wiring

Undercar wiring shall be run in galvanized steel EMT conduit or liquid tight flexible conduit. In lieu of using a conduit or wire raceway, the trainline power cable may be cleated in place at frequent intervals using cable cleats made from wood or neoprene material. The clamping arrangement shall prevent excessive squeezing of the cables. Strain relief bushings shall be used at locations leaving and entering conduit, wire raceways, or equipment enclosures. However, cleated wiring shall not interfere with access to undercar equipment. Care shall be taken to prevent inductive heating caused by individual phases passing through magnetic components such as steel enclosures.

11.7.4 Conduits, Junction Boxes, and Fittings

All externally mounted junction boxes, terminal boxes, pull boxes, or fittings, etc. shall be fully weatherproof. All conduits and cables entering these boxes shall enter via weatherproof fittings. Where there is a possibility of water or condensation accumulating in a box, drain holes with split pins installed shall be provided.

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.

Conduits shall be made from steel with compression fittings or equal. Wire raceways shall be made from corrosion resistant sheet steel with weatherproof junctions. Conduits used in the car interior may be a thin wall aluminum.

The bend radii of all conduit shall be as large as possible to facilitate wire pull through. Conduit bends shall be by machine without producing wrinkles on the inner surface of the bend. Conduit fittings at boxes or bulkheads shall have retained plastic inserts to protect wiring from damage due to abrasion on sharp edges. Where wires exit from conduits at locations other than above, the end of the conduit may be flared to prevent wire damage. Conduit fills shall not exceed those allowed by the National Electrical Code, NFPA Publication No. 70-1981.

Suitable drip loops shall be provided in the conductors at the equipment compartments to further minimize the possibility of the entry of water. Where such conductors pass through a car structural or other member, a means shall be used to prevent damage to the conductors due to chafing.

Within the car body in areas not subject to inadvertent contact by damaging objects, nonmetallic tubing or plastic cable ties may be used in lieu of metallic conduit or wire ways if approved by the Engineer.

Covers for undercar fittings, etc., shall be gasketed using approved materials. If threaded fasteners are used to retain covers, they shall be made from stainless steel. The use of tapped holes with threaded fasteners is to be avoided wherever possible. Anchor nuts or retained tapping plates are the preferred hardware. Interiors of boxes shall be suitably protected by non conducting white paint against condensation and corrosion. When more than one supplier is used, all fittings which require covers and area of the same size shall be supplied by the same manufacturer.

It shall be possible to replace terminal blocks without requiring access to the back of the mounting surface.

All terminal blocks shall be permanently identified including those on subcontractor supplied equipment except for terminal blocks that are integral to the light fixtures. Identification shall be as per pertinent schematic wiring drawings.

For maintenance purposes, access to junction boxes, panels, and other wiring areas shall be as easy and simple as possible. Except for under car mounted junction boxes and distribution boxes located in the auxiliary equipment compartments, covers shall be retained using

approved quick removal fasteners or latches. Tapped holes shall not be used unless specifically approved by the Engineer.

11.7.5 Grounding

Except where noted, all electrical circuits shall be completely insulated from carbody.

The carbody 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. Studs or bolts with welded grounding plates shall be used for all ground connections. Hardware used for other purposes such as equipment mounting shall not be used for ground connections.

The 120 Vac, 60 Hz, single phase service shall be separately and firmly grounded to the carbody structure and have a green indicating color band applied at the terminations.

All apparatus operating at 480 Vac and not directly grounded to the carbody through its mounting shall have grounding straps. This particularly applies to resilient mounted motors.

11.8 Welding

11.8.1 Responsibility

The Contractor shall be responsible for the quality of the welding and brazing done including that done by subcontractors. All welders employed in the making of welds on structures or products built under these Specifications shall have been tested 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. Welders shall be certified in accordance with AWS or CSA standards, to perform the work in the contract. The Contractor shall identify products and equipment where non AWS or CSA certified welders are used in their manufacture. For any such products and equipment using non AWS or CSA certified welders, the Contractor shall submit descriptions of their intended use and details of the Contractor's proposed approval procedure.

11.8.2 Cleaning

Before welding of any sort is started, 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. Any corrosion protection removed for welding shall be replaced after welding is completed.

11.8.3 Welding

Welding procedures shall comply with the latest issues at contract signing of AWS D15.1*"Railroad Welding Specification", "Specifications Covering Use of Aluminum in Rapid Transit and Other Passenger-Carrying Railway or Railroad Vehicles",* Aluminum Company of America; of AWS D1.1 "*Structural Welding Code – Steel"* and with AWS D1.2*"Structural Welding Code - Aluminum"* or CSA-W47.1, *"Certification for Fusion Welding of Steel Structures"*, CSA-W47.2, *"Certification of Companies for Fusion Welding of Aluminum"* and CSA-W59, *"Welded Steel Construction (Metal Arc Welding)".*

Structural welding of stainless steel by the fusion-arc process shall be governed by AWS D1.6-99. Prequalified welding procedures are not permitted. The Contractor shall select fusion-welded fatigue allowable stress values for review and approval before construction. These fatigue allowable stresses shall not exceed the lesser of fatigue limits specified in AWS D1.1-98, Chapter 2, or 50 percent of the joint strength level calculated from ASME strength allowable in ASME Section VIII Tables UHA-23 and UW 12.

11.8.4 Riveting

The car body design may be of riveted construction. Riveting procedures shall be based on principles and practices acceptable in the rail transit industry. Solid rivets shall be installed in accordance with Contractor's Manufacturing Process Specifications.

Hot-driven steel rivets shall not be used. Holes for aluminum rivets shall be drilled and countersunk in accordance with accepted industry practices.

Huck rivets and other commercially available rivets systems may be used in accordance with the manufacturer's recommendations.

11.9 Paint and Painting

11.9.1 Equipment Compartment and Locker Paints

The inside of all control equipment compartments, except for the A end and B end intermediate level lockers, and electrical locker enclosures shall receive at least one coat of white non conducting paint. .

11.9.2 Trucks

The Contractor shall apply one coat of metal primer on all exposed surfaces of trucks, excepting the wheels, axles, brake rotors, brake shoes, brake linings, and exposed elastomers, hoses, cables, and wiring.

Before shipment of the truck to the car builder’s site, the Contractor shall clean off all accumulated dust, dirt, or other foreign matter by means appropriate to the purpose and shall then spray and air dry a final coat of truck paint of a type that shall not conceal cracks that may develop in service. Color and material shall be agreed.

11.9.3 Battery Enclosure

All metal battery enclosures shall be given one coat of an alkaline-resistant paint.

11.9.4 Lettering and Numbering

Lettering, numbering, and logos shall be permanent and suitable for the location and application. Breakers, switches, and gauges shall be properly and clearly identified. All electrical items such as terminal blocks, relays, and resistors shall be clearly and permanently identified as per applicable wiring drawings.

11.10 Piping and Tubing

11.10.1 Air Brake Piping

11.10.1.1 Materials

Car body air piping shall conform to the *AAR Manual of Standards and Recommended Practices* on brakes and brake equipment. Procedures for cleaning air brake piping before welding, after welding, and before valves are installed, shall conform to the AAR Section E *"Specification for the Welding of Air Brake Pipe and Fittings for Railroad Cars",* pages 128 through 131. Copper tubing shall be used in all locations and shall be SAE J528 or ASTM B75; the fittings shall be of an approved type. All copper tubing located under the car shall be protected with *"Armaflex"* or approved equal. The use of flexible hose shall be minimized and shall be as approved by the Engineer.

11.10.1.2 Joints and Fittings

Sweat-type fittings of wrought copper or cast brass shall be used except that compression fittings shall be used at removable equipment.

11.10.1.3 Routing and Clamping

All piping shall be installed in a manner allowing for efficient maintenance using the least possible number of fittings. It shall be so routed as to preclude or minimize moisture accumulation and to minimize damage from outside sources. Condensate traps shall be installed as necessary. Sufficient clamps shall be installed to ensure against vibration and rattling.

11.10.2 Refrigerant Piping

Except for tubing used in the construction of heat exchangers, refrigerant and condensate drain piping shall be copper tubing conforming to ASTM B88 Type “K”.

Where forming of the piping is not possible or practical, wrought copper sweat type fittings conforming to ANSI Standard B16.22 shall be used for joining tubing sections. All tubing ends shall be de-burred prior to joining.

Refrigeration circuit tubing shall be joined using brazing alloy BAg-7 or BAg-2 conforming to Federal Specification QQ-B-650-B. Condensate tubing may be joined using soft solder. To prevent oxidation on the interior of the piping, all brazing shall be done with the affected section of piping flooded with nitrogen. After brazing, the joint exterior shall be wiped and any flux residue cleaned from the tubing and fittings. Refrigerant piping shall be thoroughly cleaned prior to being charged with refrigerant.

Piping subject to condensation shall be insulated with an approved refrigerant piping insulation.

11.10.3 Water Piping

Piping shall be seamless copper tubing in accordance with SAE J528b or ASTM B75 and sized for the service intended.

Fittings shall be sweat type wrought copper or cast brass in accordance with ANSI Standards B16.22 and B16.18 or "Swage-lok" compression type.

Piping shall be joined using silver solder conforming to AWS BAg-2 for cast brass fittings and to AWS BCup-3 brazing filler metal for wrought copper fittings. The use of solder with lead content is strictly forbidden. The exterior of brazed joints shall be wiped clean after brazing. Flux shall be cleaned from the piping interior of brazed joints.

The piping shall be routed and sloped to allow for proper drainage. The low points of the system shall be equipped with automatic thermostatic drain valves that shall discharge all water when the local ambient falls below approximately 40^{o}F.

After installation, the complete water system shall be sanitized.

11.11 Bearing Life

Bearing life shall be in conformance with the requirements in AAR Specification M934-82 or with *"B-10"* life, whichever requirement is for longer life. Minimum *"B-10"* life shall be 500,000 miles of operation.

The *"B-10"* life of a bearing means that no more than 10 percent of the bearings shall have failed solely because of spalling due to fatigue during that period and that 90 percent of the bearings shall continue in service beyond the period.

11.12 Plymetal and Plywood

All floor panels shall be in compliance with U.S. Product Standard PS 1-95.

11.12.1 Plymetal

The panels utilized in the construction of the cars shall be structurally-laminated of stainless steel or similar material on both sides of the plywood. Dry shear strength shall not be less than 250 psi. The bonding process shall be done in a platen press under uniform pressure to assure continuous structural bond throughout. Facing shall be 0.016-inch thick, 28 gauge, type 304 stainless steel with No. 2 standard finish or approved equal.

11.12.2 Plywood

All plywood panels shall be marine type plywood and shall be manufactured in accordance with the requirements of Grade-Structural I of the National Bureau of Standards Voluntary Product Standard (American Plywood Association) PS 1-95. Each panel shall be formed from one piece; scarf and finger jointed panels are not permitted. All panels shall be sealed and waterproofed with an epoxy based system on all edges and cutouts, as soon as possible after fabrication. All exposed edges of the panels, joints between panels, fastener heads, and opening of panels used in areas accessible to moisture shall be sealed with a watertight, fireproof sealant as approved by the Engineer. All panels, as ultimately used in the car, shall be in accordance with the requirements of the flammability and smoke emission specifications.

11.13 Corrosion Prevention

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

Areas exposed to dirt shall be designed to minimize retention of dirt and moisture, and sections that may retain moisture or dirt shall be provided with adequate drainage and ventilation and shall be accessible for cleaning. Under-pans or covers, suitably sealed, may be used where applicable to protect underframe sections.

Joints and crevices shall be sealed with a sealant which is resistant to the environment, shall not absorb moisture and shall remain resilient and maintain its sealing properties for the life of the vehicle.

Metal surfaces shall be treated with surface preparation and primer materials specific for the metal with due consideration for the severity of exposure to which the surface is subjected.

The joining of dissimilar metals or metal and wood shall be minimized and where unavoidable particular care shall be taken to prevent galvanic corrosion in the case of dissimilar metals or, in the case of wood and metal, concentration cell or chemical corrosion.

Where possible, bolts and rivets shall be at a similar electrochemical-solution potential to the metals being joined, or shall be isolated from them by means of plastic or other non-metallic coatings.

The Contractor shall submit 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.

11.14 Plastics and Fiberglass

11.14.1 Thermoplastics

The interior finish of the car shall incorporate formed-thermoplastic or fiberglass components, such as window masks. This material shall be in compliance with the Flammability and Smoke Emission Standards, and shall not show stress cracks on any molded surfaces for the life of the car.

Thermoformed plastic material shall be color impregnated and shall have anti-static characteristics if such characteristics are not naturally present in this material. All applications shall be in full compliance with the requirements of this Specification.

11.14.2 Fiberglass-Reinforced Parts

11.14.2.1 General

FRP shall be manufactured by an open molding or matched die molding process. The production techniques shall ensure that the glass fiber reinforcement is uniformly distributed throughout the final product in such a manner as to avoid resin-rich or resin-starved sections. Finished gelcoated surfaces shall have a minimum gloss value of 85 when measured with a 60^{o} glossometer and shall exhibit no print through of the reinforcements or have any orange peel.

FRP parts shall have a greater thickness at attachment points and edges. Exposed sharp edges shall not be allowed on any parts.

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.

11.14.2.2 Construction

1. Resin

   The resin shall be selected to meet the physical properties of this Specification and molding process requirements.

2. Reinforcement

   The fiberglass reinforcement shall be as required to meet the physical properties of this Specification and the molding process requirements. The proposed glass content shall be confirmed through testing to ASTM D 2584.

3. Gel Coat

   The gel coat shall be resistant to scuffing, fire, weather, and cleaning agents

4. Additives

   Additives, fillers, monomers, catalysts, activators, pigments, fire retardants, and smoke inhibitors shall be added to the resin mixes to obtain finished products with the required physical, flammability, and smoke emissions characteristics of this Specification.

11.14.2.3 Strength Requirements

Independent laboratory test reports shall be provided confirming that the production reinforced plastic material complies with the requirements of the following standards. Test specimens shall be conditioned in accordance with ASTM D 618.

Mechanical Property	ASTM Test	Performance
Tensile Strength- except end cap	D 638	10,000 lbf/in^2
Tensile Strength- end cap	D 638	4200 lbf/in^2
Compressive Strength- except end cap	D 695	18,000 lbf/in^2
Compressive Strength- end cap	D 695	5,000 lbf/in^2

Mechanical Property	ASTM Test	Performance
Flexural Strength-except end cap	D 790	15,000 lbf/in^2
Flexural Strength-end cap	D 790	3,000 lbf/in^2
Impact Strength-except end cap	D 256	8 foot pounds per inch of notch
Impact Strength-end cap	D 256	5 foot pounds per inch of notch
Hardness-including end cap	—	45 Barcol

11.14.3 Melamine

Melamine on or in panels shall be color-impregnated, Melamine shall resist abuse and vandalism, and resist scratching and marking. All applications shall have characteristics equivalent to those of material supplied by Arborite Division, Domtar Construction Materials Ltd. Balanced applications of melamine shall be used to prevent warpage, drumming, or poor adhesion. Gloss finishes shall not be used. The unexposed balance sheet shall not be subject to the same finish or quality requirements as the side exposed to the passengers.

11.15 Upholstery and Covering Materials

11.15.1 Seat Cushion

Seat cushion material shall be in accordance with the requirements of the Flammability and Smoke Emission Guidelines. The cushion shall be of uniform composition, having a porous surface and open cells to provide breathability. The flame resistant properties of the cushion material shall not change when exposed to liquids, nor when its consistency changes under normal use. Cushion foam shall be molded in one piece or may be assembled by laminating pieces together, to achieve the required contour. If adhesives are used in the foam lamination process, this shall not change the flame resistant properties of the assembly.

Seat back flexible foam shall meet the following physical property criteria when tested without upholstery material:

1. Tensile Strength: 8.0 lbf/psi minimum when tested to ASTM D3574-95 Test E.
2. Elongation: 150 percent minimum when tested according to ASTM D3574-95 Test E.
3. Compression Set at 50 percent constant deflection: 10 percent maximum when tested according to ASTM D3574-95 Test D.
4. Thickness Loss: 5 percent maximum.

5. Tear Strength: 30 percent minimum when tested according to ASTM D3574-95 Test H.

Seat bottom flexible foam shall meet the following physical criteria when tested without upholstery material:

1. Tensile Strength: 12.0 lbf/psi minimum when tested to ASTM D3574-95 Test E.
2. Elongation: 150 percent minimum when tested according to ASTM D3574-95 Test E.
3. Compression Set at 50 percent constant deflection: 10 percent maximum when tested according to ASTM D3574-95 Test D.
4. Thickness Loss: 5 percent maximum.
5. Tear Strength: 2.5 lbf/psi minimum when tested according to ASTM D3574-95 Test H.

11.15.2 Woven Fabrics

Fabric used for seat upholstery shall be made of an approved flame resistant polyester. The maximum fabric shrinkage shall be 2 percent in either the warp or fill direction.

Seat upholstery material shall be subjected to the physical tests of textile products required by the latest revision of the following ASTM methods, and the results shall not be less than the following values:

Test No.	Description	Criteria (Polyester)
D-3776	Fabric Weight	12 oz/sq yd without back coating
D-3775	Fabric Count	Warp: (ends) 75 epi Fill: (picks) 40 to 72 ppi
D-3597, Section 7.1	Breaking Strength	Warp: 200 lbs. Fill: 200 lbs.
D-3597, Section 7.2	Tear Strength (Tongue)	Warp: 20 lbs. Fill: 14 lbs.
D-3597, Section 7.3	Yarn Slippage	Warp: 75 lbs. Fill: 75 lbs.

Test No.	Description	Criteria (Polyester)
D-3597, Sections 7.6, 7.7, 7.9, 7.10	Color Fastness To:	Water: Class 4 min. Solvent: Class 4 min. Crocking: Class 4 min., wet or dry Light: Grade 4 min. for 80 standard hours
D-4966-89 12kpa	Martindale Abrasion Test	20,000 cycles – no breaks

11.15.3 Fabric Backed Vinyl

Vinyl used for seat upholstery shall be made of woven, transportation grade fabric-backed vinyl, Uniroyal Phoenix or approved equal. The material shall be in full accordance with the requirements of the Flammability and Smoke Emission Guidelines.

Fabric-backed vinyl used for seat upholstery shall be subjected to the physical tests of textile products required by the Federal Test Method Standard No. 191, latest revision, and the results shall not be less than the following values:

Test No.	Description	Criteria
5100	Tensile Strength	Warp: 55 lbs. Fill: 155 lbs.
5110	Seam Strength	85 lbs.
5134	Tear Strength (Tongue)	Warp: 10 lbs. Fill: 12 lbs.
5136	Tear Strength (Trapezoid)	Warp: 7 lbs. Fill: 10 lbs.
5660	Colorfastness – 200 hrs.	No change
5970	Adhesion of Coating	10 lbs.

11.15.4 Floor Covering

Floor covering material shall be in full accordance with Flammability and Smoke Emission requirements and consistent with the use and its application. The material shall be non-slip, non-staining, non-discoloring and 100 % non-oil extended. No whitening (limestone) shall be used in the compound.

At room temperature, the material shall bend around a 3/4 inch diameter mandrel without breaking, cracking, crazing or showing any change in color. The material shall meet the requirements of ASTM F 1344, in addition to other requirements described in this Specification.

SECTION 12

12 PASSENGER COMFORT

12.1 General

The Contractor shall ensure that the vehicle is designed and built so that the noise, ride quality, and vibration criteria outlined in this Specification are met, including the requirements of Section 12.2.2 relative to acceptable environments for passengers and crew.

12.2 Audible Noise

12.2.1 Auxiliary Equipment

The Contractor shall devote particular attention to the design of the car and its auxiliary equipment to obtain quiet operation and shall ensure that the noise and vibration criteria specified herein are not exceeded. Particular attention shall be given to the design of all equipment to ensure minimum generation of noise and vibration, and to the attenuation of airborne and solid-borne noise and vibration along the path from source to passenger. Vibration isolators, enclosures or baffles, seals, acoustical absorption, mass, bracing, car body panels with adequate sound transmission loss, or panels with adequate sound transition or other appropriate methods, shall be incorporated into the car design to adequately attenuate noise and vibration generated by wheels and rails, wind, motors, rotating equipment, and all other car elements and equipment to ensure that the limitations on interior noise and vibration are not exceeded.

Noise levels from equipment not specifically mentioned herein shall be controlled by the Contractor to ensure that the interior noise and vibration limits for the complete car are satisfied.

All equipment shall be designed to minimize rattling and audible resonance at all speeds up to 10 percent above maximum normal running speed by the use of gaskets, vibration dampers, resilient mounts, bracing, or similar methods in order to achieve the noise requirements of Section 12.2.2.

12.2.2 Noise Criteria

Noise criteria specified shall apply to measurements taken in an empty car (AW0):

1. Noise produced by operation of cars at 110 mph on FRA Class 6 track, composed of premium rail and concrete ties without special track work or level crossings, and with wheel tread and railhead in new condition, shall not exceed the following sound pressure levels when measured inside the car at all locations that are 4 feet above the floor surface and at least 2 feet from car body surfaces.

    a. Upper level: 63 to 70 dBA.

    b. Lower level: 70 to 75 dBA. [This noise criterion shall also apply to a single-deck car under these same conditions.]

    c. Door vestibules: 73 to 76 dBA. [This noise criterion shall also apply to a single-deck car under these same conditions.]

d. Intermediate-end compartments: 71 to 74 dBA.

2. Noise produced by the individual operation of equipment, operating under normal conditions, such as air-circulating fans, door operators, fluorescent lamps, and air conditioning shall not exceed 70 dBA when the noise is measured inside the car at all locations at least 1.0 foot from any car body surface, except at doors, where the measurement shall be taken 2 feet from the surface.

3. Noise produced by the simultaneous operation of all equipment, operating under normal conditions, shall not exceed 70 dBA, when the noise is measured inside the car at all locations at least 1 foot from any car body surface.

4. Noise produced by the operation of all side doors on one side of the car, with all auxiliary systems operating simultaneously under normal conditions, shall not exceed 78 dBA on the "Fast" scale when measured inside the car at least 2 feet from the door surface of the door and 5 feet-3 inches above the floor.

5. Exterior noise produced by auxiliary equipment shall not exceed 77 dBA at 15 feet from track centerline at a height of 5 feet-6 inches above top of rail.

12.2.3 Applicable Documents

For the purposes of general information and interpretation, agreed portions of the following documents (or their equivalents) are to be used: USASI - SI.4 - 1983 - *General Purpose Sound Level Meters,* ISO - 1231 - Part VII - *Quantities and Units of Acoustics.*

12.3 Ride Quality

The ride quality shall not be less than the following values when the car is traveling at normal operating speeds at AW0 car weight on FRA Class 6 track:

1. Lateral: ISO Reduced Comfort Boundary, 2 hours, total journey
2. Vertical: ISO Reduced Comfort Boundary, 2 hours, total journey
3. Reference: International Standard 2361 *"Guide for the Evaluation of Human Exposure to Whole-Body Vibration, 2nd edition, 1978-01-15."*

Method of Evaluation: Ride quality shall be determined, using a Hewlett Packard 3561a Dynamic Signal Analyzer or equivalent, from playback of unweighted signal outputs from vertical and lateral accelerators located at the longitudinal center line of a bi-Level car at the leading intermediate level above the truck center line; and at both ends of the upper and lower level, at the nearest passenger seat from the trucks. For a single-deck car, the measurements shall be taken at both ends of the passenger compartment at the passenger seat nearest to the trucks. The signal analysis shall be used to provide an accumulated ride quality over the entire journey including acceleration and braking, but excluding station stops.

SECTION 13

13 QUALITY ASSURANCE

13.1 Scope

This Section specifies minimum requirements for Quality Control/Quality Assurance activities to ensure that materials and services conform to all Contract requirements.

13.2 Application

The requirements of this Section apply:

1. To the extent specified in the Contract.
2. To the Contractor.
3. To the Subcontractors in possession of and performing work on the material to be used for this Contract.

13.3 Responsibility

13.3.1 Responsibilities of Those Performing the Work

To establish, conduct, control and document in accordance with the requirements of this Section, all inspection, verification, testing and other activities needed to demonstrate that materials and services conform with Contract and referenced specification requirements including, as applicable, the technical literature associated with Contractor's and Subcontractor's products and components.

13.3.2 Quality Assurance Representative's Responsibilities

To survey and verify the quality of the Work in the Contractor’s Manufacturing Facility and in the Final Assembly Plant (if different) until the Work is completed and accepted, including but not limited to the following:

1. Verification of inspection and testing methods.
2. Establishment of discrete, quality verification points in the manufacturing process.
3. Verification of "first-off" (First Article Inspection) or pre-production samples.
4. Verification of quality characteristics of subcontracted items which cannot be inspected at the Contractor's facility.
5. Verification of Contractor's compliance with Contract requirements relating to quality operation/administration.
6. Verification of Receiving Inspection Non-Conforming Material and Material Review Board procedures and conformance to procedures.
7. Verification of equipment and tool certifications.

8. Verification of jigs and fixtures.

9. Verification of welder certification and NDE testing certification.

10. Witnessing of in-line testing of systems and set-up procedures.

11. Final inspection and system witness of functional testing.

12. Preparation of Release for Shipment Documents and Open Items List (if appropriate).

13.3.3 Quality Assurance During Commissioning & Warranty

The Engineer may appoint an additional inspector(s) to ensure all cars are commissioned in a correct and expedient manner. Retrofits and warranty work shall also be subject to the Engineer's inspection and approval by the Engineer or the Quality Assurance Representative.

13.4 Definitions

Certain words and phrases used in this Section such as Quality Assurance Representative, Evaluation, Contractor, Objective Evidence, etc., have specific meanings. Those are defined in Section 1.

13.5 Applicable Documents

The quality assurance requirements of all state, Federal, industry and regulatory specifications that apply to the Work are included under this Section. It is the Contractor's responsibility to ensure that the completed vehicle(s) comply with all applicable specifications for their intended rail transportation service operation.

CSA Z299 may be submitted as an alternate. Proof of equivalency to U.S. standards is required. Written approval by the Engineer is necessary for alternate references.

13.6 Requirements

13.6.1 Quality Program

The Contractor shall establish and follow a documented Quality Program for all operations involving verification of conformance to quality and contractual standards and specifications. The Quality Program shall outline the Contractor's practices. The Contractor's Quality Program shall be submitted to the Engineer for approval.

13.6.2 Quality Organization

The Contractor, before proceeding with the work, shall appoint a representative authorized to resolve quality matters and shall notify the QA Representative of the appointment in writing.

Inspectors shall be other than those who performed the work and shall not report directly to immediate supervisors responsible for producing the work being inspected.

13.6.3 Inspection Equipment Calibration

The Contractor shall provide objective evidence to the QA Representative that suitable inspection devices are available at any time for inspecting the material and meet the following requirements:

1. Are in a known state of calibration.
2. Can provide valid measurements.
3. Are being re-calibrated in accordance with governing requirements.

13.6.4 Inspection Records

The Contractor shall:

1. Keep records of all inspections as objective evidence that Contract requirements are met for one year after the contract is completed or as specified in the Contract and shall notify the Engineer when records are being disposed.
2. Positively identify in these records the material, specific inspections performed, and results obtained.
3. If measurements are not possible, include in the records the number of conforming items, the number rejected, and nature of the defects.
4. Make copies of these records available to the Engineer for review.
5. Prepare forms for the release of material as required by the Contract.
6. Maintain stamps, tags, routing cards, move tickets, tote box cards, or other devices that positively indicate the inspection status of items.
7. Establish and maintain a system for tags or stamped impressions that indicate final inspection of items.
8. Show the identity of the Contractor and the inspector on inspection stamps.

13.6.5 Interpretation of Technical Data

The Contractor shall direct all questions about the meaning of intent of Specifications, drawings, and related Contract requirements to the Engineer.

13.6.6 Control of Nonconforming Material

The Contractor shall:

1. Positively identify nonconforming material.
2. Provide holding areas or methods for segregating nonconforming material.
3. Prevent unauthorized use, shipment, or mixing with conforming material.

4. Document methods for repairing or reworking nonconforming material.

5. Maintain adequate records clearly identifying the material, the nature, and extent of nonconformance and its disposition.

13.7 Verification of Quality Assurance

13.7.1 Accommodation, Facilities and Assistance

The Contractor shall provide the QA Representative with the following assistance at no cost to IDOT or its representative:

1. Suitable working accommodation on the premises of the party performing the work, including private office accommodations, furniture, and telephones for two persons. In addition, a telephone connection for a computer and a printer/fax machine and access to a copier machine shall also be provided.

2. Reasonable use of inspection and test equipment.

3. Assistance needed to document, move, and release material.

4. Access to all applicable work areas and to subcontractors, at all applicable times.

5. Addition of the IDOT QAR to the distribution list for all approved documents (drawings, procedures, Non-Conformance Reports, MRB resolutions, etc.) supplied to the Contractor's Quality Department for this project.

13.7.2 Initial Evaluation

The QA Representative may initially evaluate the inspection facilities and procedures to ensure they meet the requirements of the Contract and this Section.

13.7.3 Continuing Evaluation and Verification

The QA Representative may frequently survey and verify by surveillance the control of inspection.

Verification by the Quality Assurance Representative shall not relieve the Contractor of his responsibility to provide acceptable material nor shall it preclude subsequent rejection.

13.7.4 Corrective Action

The IDOT QA Representative will transmit all surveillance and hold point inspection comments as well as test witnessing comments to the Contractor's Quality Representative for the project. The Contractor's QA Representative shall arrange to promptly correct the conditions. Disputed comments shall be referred to the respective IDOT and Contractor Project Managers for resolution.

13.8 Preparation for Delivery

The Contractor shall inspect preservation, packaging, packing, and marking to ensure they conform with Contract requirements. A check-off list shall be developed by the Contractor

listing all items associated with the delivery. It shall be checked off and presented to the IDOT representative prior to Release for Shipment.

13.9 Quality Assurance during Commissioning and Warranty

The Engineer may appoint additional inspector(s) to ensure all cars are commissioned in a correct and expedient manner. Retrofits and warranty work shall also be subject to inspection and approval by the Engineer (or the Quality Assurance Representative)

13.10 Alternative Inspection Methods and Equipment

Test methods and equipment may be used other than those specified in the Contract if they provide, as a minimum, equivalent evidence that the material is in conformance with the Contract requirements. Prior to using alternate methods or equipment described, they shall be in a written proposal and demonstrated to the QA Representative that they effectively substantiate product quality. Where there is a dispute the methods and equipment specified in the Contract shall prevail.

SECTION 14

14 TESTING

14.1 General

The proposed car shall be a service proven, fully developed design. Compliance with the technical requirements of these Specifications shall have been demonstrated by qualification (type) tests and recorded in official test report documents. The results of all tests shall be submitted to the Engineer for acceptance. Test reports for previously performed qualification tests may be submitted by the Contractor in lieu of conducting the qualification tests described in this Section for those items that are identical to the items addressed in the test reports. Where the item applied to these cars differs from the item addressed in the test report for the previously conducted qualification test, the Contractor may propose to demonstrate compliance to the Contract requirements through analysis, design presentation and supplemental testing in lieu of conducting the qualification tests described in this Section.

Test reports for previously performed qualification tests shall be approved by the Engineer. Within 180 days of NTP, the Contractor shall submit a Master Test and Inspection Plan for demonstrating compliance with the requirements of this Specification and 49 CFR 38 for review and approval by the Engineer. The plan shall address static and dynamic tests to be conducted at the component, system and vehicle levels. In addition to these tests and others identified in the Contract, the plan shall include roll angle and wheel loading tests and/or analysis (refer to 49 CFR 213) and center of gravity determination test and/or analysis.

The Contractor shall, prior to commencement of any tests, reach agreement with the Engineer on specifications for the tests including procedures, reference standards or codes, detailed instrumentation specification, and proposed format of the test report. Before commencing tests, the Contractor shall provide the Engineer with the agreed versions of the above material.

Evidence of timely calibration of the instruments traceable to the standards set by the National Institute of Standards and Technology (NIST) shall be available to the Engineer. The Contractor shall state, prior to commencement of any test, where and when the tests will be performed. This information shall be provided in sufficient time to permit the Engineer to attend the tests in accordance with the General Conditions of the Contract.

Written reports of all tests performed on the cars and their components shall be submitted to the Engineer for review and acceptance. In the event tests indicate that equipment does not meet the requirements of these Specifications, the corrective action and subsequent retest shall be at no cost to the Engineer. Testing shall be repeated until the test shows that the requirements of these Specifications have been met. All tests, except as otherwise agreed to, shall be performed at the plants of the Contractor or the subcontractors.

Tests described in this section are, except as noted above, the responsibility of the Contractor and are considered by the Engineer to be the minimum requirements. Prequalification, by tests of previous multi-level vehicles and by service proven history, shall not relieve the Contractor of the responsibility for the integrity of the design and quality of the delivered cars.

The Contractor shall submit a Test Plan that itemizes all testing to be performed on the cars. Tests are categorized as:

- Qualification Tests

  Tests in this category shall demonstrate design compliance and performance capability relative to these Specifications. These tests shall be performed on the number of cars, devices, and assemblies specified for that particular test.

- Shop and Acceptance Tests

  Tests in this category are to prove that assembly and installation has been properly done. These tests are performed on every car, device, or assembly specified. Shop tests are performed at the Contractor's Assembly Plant and Acceptance Tests at both the Contractor's plant and on the IDOT (or designee) system.

14.2 Structural Qualification Tests

14.2.1 Carbody Structural Qualification Test

The car body structure shall be tested in accordance with APTA PRESS and AAR requirements to prove compliance of the structure with these Specifications. These tests may be waived for an existing, tested and certified car design that is structurally similar to the cars described in these Specifications. Structural equivalence of this existing, tested and certified car design can also be demonstrated by a Finite Element Analysis, subject to the approval of the Engineer. The structural test procedure and a report shall be submitted at the time agreed to by the Engineer.

14.2.2 Truck Structural Qualification Test

The first production truck shall be subjected to vertical, transverse, and brake load tests. These tests may be waived for an existing, tested and certified truck design that is similar to the trucks described in these Specifications. The test procedure and a report shall be submitted at the time agreed to by the Engineer.

14.3 Vehicle Dynamic Qualification Test

Vehicle dynamic qualification tests shall be performed on the cars on track provided by IDOT or its designee. The locomotive and the train crew shall also be provided by IDOT or its designee. The Contractor shall provide a list of dynamic qualification tests for review and approval by the Engineer. Test technicians and test equipment shall be provided by the Contractor.

At least 90 days prior to commencing tests, the Contractor shall submit procedures for each dynamic qualification test to be conducted for review and approval by the Engineer.

At the discretion of the Engineer individual dynamic vehicle tests may be waived if such tests have been performed on identical cars or identical equipment on previous contract or contracts.

14.4 Vehicle Static Qualification Test

Vehicle static qualification tests shall be performed by the Contractor. The Contractor shall provide a list of static qualification tests for review and approval by the Engineer. Test technicians and test equipment shall be provided by the Contractor.

At least 90 days prior to commencing tests, the Contractor shall submit procedures for each static qualification test to be conducted for review and approval by the Engineer.

At the discretion of the Engineer, individual static qualification tests may be waived if such tests have been performed on identical cars or identical equipment on previous contracts.

14.5 Vehicle Shop Test

14.5.1 Carbody Watertightness Test

Each assembled car, with all windows and doors installed, shall be subjected to a water spray test to verify carbody water tightness. Exterior apparatus that may affect water tightness of the car body shall be installed at the time of testing.

Water shall be sprayed on the roof and sides from nozzles located approximately 48 inches from the car side. The nozzles shall be Spraying Systems No.1/2 GG3OW (or approved equal) positioned in an equilateral triangular spray pattern. The volume of water shall be not less than 5 USGPM per nozzle with a water pressure of 40 psi at the nozzles. Particular care is to be taken to concentrate the spray in the area of carbody joints, seals, doors, windows, and air intakes.

All car body ends shall be sprayed with water from nozzles located in planes parallel to and approximately 24 inches away from the end sheets of the car. The nozzles shall be Spraying Systems 1/8 GG2 (or equal) positioned 17 inches apart in an equilateral triangular pattern and shall produce an overlapping spray pattern. The volume of water shall be not less than 0.5 USGPM per nozzle with a water pressure of 80 psi at the nozzles.

Pre-assembly water tests may be utilized for testing of specific car body sections to demonstrate the water tightness integrity of riveting, etc., on sides or roofs.

Spraying shall commence for 10 minutes prior to inspection and shall run continuously during the inspection.

All leaks found during the tests shall be corrected and the car retested to the satisfaction of the Engineer.

14.5.2 Air Brake Test

The Contractor shall perform testing on the air brake equipment on all cars to ensure compliance with these Specifications, the manufacturer's test codes, applicable FRA requirements, and APTA Standard SS-M-005-98.

All air piping, including hoses and couplings, shall be charged to not less than 125 percent of working pressure and all pipe joints or fittings shall be tested with a soap solution. All air leaks shall be corrected before an APTA single car test is performed. Every car shall be tested with a standard APTA single car testing device using the code of tests covering its use. The testing shall include an approved brake pipe restriction test.

14.5.3 Side Door Test

The side doors and their operating equipment shall be checked and adjusted on all cars to ensure attainment of the specified speed of operation, smooth and proper functioning of

controls, obstruction detecting, signals, interlocks, and seals. Prior to shipment, each completed door installation shall be cycled from closed to open to closed once every 20 seconds for a minimum period of six consecutive hours.

This test shall be monitored and failures recorded. In the event of a failure, the complete test shall be repeated after corrective action has been taken by the Contractor or its subcontractor.

14.5.4 Carbody and Equipment Dimensional Tests

Dimensional measurements shall be made on each car with the car on level, tangent track and all air suspension bellows, if applicable, at normal height. The results shall meet the requirements of Section 2.4.

14.5.5 HVAC Test

With the air conditioning system operating, a refrigerant leakage test shall be conducted on all joints in the refrigerant system. Any leaks shall be corrected and the leakage test repeated.

The HVAC system shall be adjusted and tested to meet the requirements of these Specifications, including a hot room test. If the proposed car has already been tested in a similar configuration, the system shall be functionally tested and diffusers adjusted to comply with Section 8.4 and the compressor crankcase heater checked for correct functioning. The car body static pressure shall also be measured. Corrective action shall be taken if the measured value is less than 0.1 inches of water gauge.

The refrigeration and freezer units in the food service area shall be adjusted and tested to meet the requirements of these specifications.

14.5.6 Water Piping Test

On all cars, the completed water piping system shall be pressure tested by charging the system to 1.5 times its working pressure. During a thirty minute test period there shall be no indication of a loss of pressure in the system.

14.5.7 Electrical Wiring Test

The Contractor shall verify the integrity of the car wiring on all cars by checking for circuit continuity and proper polarity in accordance with APTA-SS-E-001-98. After assembly and installation of all equipment, the tests listed below shall be performed.

If any manufacturing or assembly, other than that required to correct problems discovered during testing, is carried out after testing is completed, the Engineer shall have the authority to require that the appropriate tests be repeated.

14.5.8 Carbody Wiring Insulation Test

To ensure that the insulation of all wire and cable installed by the Contractor has not been damaged before or during installation, both insulation resistance and dielectric strength testing shall be done on all completed cars.

14.5.8.1 Ground Resistance Test

The insulation resistance to ground of each voltage supply system shall be measured and recorded. The following minimum values shall apply:

Nominal Circuit Voltage	Resistance to Ground
72 Vdc	3 Megohms
120 Vac rms	4 Megohms
480 Vac rms	5 Megohms

A 500 volt megger shall be used to measure the 72 Vdc system and a 1000 volt megger shall be used to measure the 120 Vac and the 480 Vac systems. All solid state components shall be removed or isolated to prevent damage. The batteries shall also be disconnected. Perform the ground insulation test by disconnecting all ground wires, connecting all the circuits of a given voltage together, and testing each nominal voltage system separately. During the testing of a given supply, all other supply circuits shall be grounded. If any readings fall below the above values, the defective wiring or components shall be replaced or the readings raised to an acceptable level by other means. A copy of the recorded insulation ground resistance readings, together with an outline of the method used, shall be included in the Car History Book.

When the insulation ground test is successfully passed, dielectric strength test shall be performed as outlined below.

14.5.8.2 Dielectric Strength Test

A high potential ac insulation to ground test shall be performed in accordance with APTA SS-E-001-98 on all circuits and apparatus. The initial test shall be done at 3080 Vac for 480 Vac circuits, 1144 Vac for 72 Vdc and 1240 Vac for 120 Vac circuits, with the voltage applied for one minute without any insulation breakdown. Any wire, cable, or equipment that does not meet the requirements of the test shall be removed and replaced. After the replacement of any defective parts, materials, or equipment, the affected circuits shall be retested. Retesting shall be done with the above test voltage levels reduced by 15%. Shields shall not be subject to hi-pot tests.

14.5.8.3 Subcontractor Apparatus Insulation Test

To ensure that the insulation in the individual items of Subcontractor vendor apparatus is adequate, components furnished by Subcontractors that are assembled and wired into package units at the point of manufacture, the Subcontractor shall perform insulation integrity testing. A certified test report for tests of insulation made on components being furnished for this Contract shall be included in the Car History Book. Requirements for these certified tests shall be mutually agreed upon between the Contractor and the Engineer.

14.5.9 Installation Test

The purpose of these tests is to ensure that the individual items of equipment have been correctly connected after assembly to the car.

On each car, examine all wiring circuits to ensure correct connections after assembly, tightness of electrical connections and installation of all equipment in accordance with relative wiring diagrams.

14.5.10 Trainline Wiring Test

The purpose of this test is to ensure the train line wiring does not have any high resistance connections.

All equipment connected to trainline wiring shall be complete before this test is conducted and shall remain connected throughout this test. The battery switch shall be in the OFF position and all control positions on the cars shall be in the OFF position.

The voltage required to pass a direct current of 2 amperes through each control trainline circuit shall be measured and shall not exceed 1.25 Volts per car measured from the trainline receptacle at one end of the car to the receptacle at the other end of the car. The voltage required to pass a current of 2 amperes through each communications trainline shall not exceed 2.25 Volts.

14.5.11 Low voltage Supply and Battery Charger Test

The low voltage supply and battery charger shall be tested for correct operation. Input and output voltages shall be checked, and operation of all equipment connected to the LVPS. Passenger and staff convenience outlets and all protection devices and circuits shall be verified.

14.5.12 Lighting Test

All Internal and external lighting shall be tested for correct operation on all cars. Cab car instrument lighting shall also be verified.

14.5.13 Communications Test

The communications system shall be tested on all cars. All control panels, and handsets shall be verified for correct operation. Volume of loudspeakers shall be adjusted, and destination sign operation and controls shall be verified,

14.5.14 Pre-Delivery Functional Tests

Prior to delivery from the Contractor's facility, the Contractor shall confirm that the car is completely operational and ready for service. Certain specified routine tests and final inspection shall be performed to ensure that the car is complete.

Functional tests shall include but not be limited to: the air brake system; side door operation and control; HVAC system; lighting system; communication system; trainlines; power phasing; low voltage dc supply; and, battery charging. In addition, on cab cars, the auxiliary equipment, appliances and controls shall be similarly tested. It shall be possible to functionally test all equipment on a single car basis.

14.6 Post Delivery Vehicle Tests and Commissioning

Upon delivery, and prior to final acceptance, the Contractor shall confirm that the car is completely operational and ready for service. Certain specified routine tests and final

inspections shall be performed to ensure that no damage or defects have occurred during the period between car completion and car delivery.

Functional tests shall include but not be limited to the air brake system, side door operation and control, HVAC system, lighting system, communication system, trainlines, power phasing, low voltage dc supply, and battery charging. In addition, on cab control cars, the auxiliary equipment, appliances and controls shall be similarly tested. The Vehicle Commissioning Tests shall meet 49CFR659 requirements for safety certification.

It shall be possible to functionally test all equipment on a single car basis.

The test and commissioning procedure shall be submitted to the Engineer for review and acceptance at least one month before the scheduled delivery of the first car.

SECTION 15

15 DESIGN DOCUMENTATION AND TRAINING PROGRAM

15.1 Scope

15.1.1 Purpose

This Section defines the procedures by which the Engineer shall obtain assurance that operational requirements have received early consideration so that the specified performance can be both obtained and sustained economically.

To this end, this Section requires that suitable management organization(s) and systems exist to ensure that appropriate and comprehensive documentation is developed, maintained and delivered. The documentation shall be legible, fully updated with appropriate signatures or stamps, dated and factual, demonstrating, verifying and certifying that the cars are built to the standards specified.

In addition, this Section also addresses the requirements for supporting activities and Training Programs.

15.1.2 Definitions

Certain words and phrases used in this Section such as Contractor, Engineer, etc., have specific meanings. These are defined in Section 1.2.

15.2 Deliverable Documentation

The deliverable documentation shall include top level assembly drawings, parts lists, test plans, test reports, circuit diagrams, materials certificates of compliance and engineering analyses.

Lower-level drawings may be required to fully explain or if referred to on top-level drawings.

Detail production engineering and assembly drawings are not necessary.

The Contractor shall supply to IDOT or its representative within 60 days after delivery of the last cars and completion of all modifications, the final as-built drawings. The drawings shall consist of two sets of whiteline, reproducible drawings and shall conform to all requirements as specified in Section 2.27 of IDOT's "Standard Agreement Provisions for Consultant Services." Deliverable documentation shall be in the English language. Units of measurements shall be in US units.

No standard, specification, material, process, or component may be specified in the design unless it, or an acceptable equivalent, is available on the North American continent or prior approval has been given by the Engineer for its use.

The deliverable documentation shall be in the form of:

1. 8 1/2" x 11" US standard letter size bond paper for all correspondence and narrative submittals.

2. 22" x 34", 11" x 17", or 8 1/2" x 11" size sheet shall be used for drawings. Larger sizes may be utilized upon approval by the Engineer.

3. The Contractor shall also furnish all drawings, schematics and device tables in two (2) electronic formats. One (1) set shall be provided as AutoCAD electronic files on CD-ROM; two (2) CD-ROM copies shall be provided. The other set of documents shall be provided on CD-ROM as read-only files in an Adobe Acrobat PDF format; two (2) CD-ROM copies shall be provided.

The documentation to be delivered shall include, as a minimum, the following:

1. Management Plan,
2. Quality Plan,
3. System Safety Plan,
4. Production Schedule updated on a monthly basis,
5. Five copies of each drawing submitted plus a reproducible set,
6. Specification Review Conferences Minutes,
7. Conformed (as-built) Specification,
8. Progress Photographs,
9. Car History Books,
10. Clearance Outline, Static and Dynamic,
11. Wire Running Lists (Refer to Section 7.9),
12. Integrated Schematics Manual (Refer to Section 7.9),
13. Contractor's List of Recommended Spare Parts,
14. Test Reports and Certificates of Compliance,
15. Operator’s Manuals as defined in Section 15.3,
16. Running Maintenance Manuals as defined in Section 15.3,
17. Heavy Repair Manuals as defined in Section 15.3,
18. Illustrated Parts Catalog as defined in Section 15.3,
19. Camera Ready Copy (1) of all Manuals and Training Materials as defined in Section 15.3.

These documents shall be provided in hard-copy and reproducible format (as required above) and shall also be provided as electronic files on CD-ROM as read-only files in an Adobe Acrobat PDF format. Two (2) CD-ROM copies shall be provided. One set of documents will be provided in MS-Word/Excel format (as appropriate to the particular document), which will allow IDOT or its designee to modify the documents in a controlled manner.

15.2.1 Design Review Requirements

Design review meetings shall be held bi-monthly, or as required, with the Engineer to allow monitoring of progress and any other relative information communication. This does not preclude intermediate communications as is required.

The Contractor shall submit quarterly progress reports recording the activities for the period.

15.2.2 Engineering Changes

The Contractor shall submit to the Engineer, revised documentation for review prior to introducing any change in the approved configuration. The Contractor shall introduce a system

which shall identify the ongoing design configuration and shall document the configuration of each vehicle delivered.

15.2.3 Management Plan

To demonstrate an organized and systematic approach to the design task, the Contractor shall submit a plan which shall show how the proposed program shall be structured and function. It is not the intention of these Specifications to require creation of unique and special procedures when existing procedures are satisfactory.

15.2.4 Design Evaluation

The Contractor shall organize Design Review meetings for each of the major sub-systems and their integration on the car. The objective of these meetings is to present details on the design and equipping of the cars and to achieve agreement (with IDOT or its designee) on design issues. The Contractor shall maintain a list of open items, with responsibility and due date for resolution noted on for each item. The action item list shall be maintained throughout the duration of the project and updated monthly.

The following meetings shall be organized by the Contractor:

- Conceptual Design Review

  Meetings shall take place 30 to 60 days after NTP and the Contractor shall present system concepts and the general arrangement drawings at these sessions. The Contractor shall include these design review sessions on the project schedule submittals, and shall also provide a minimum of 15 days notice to IDOT or its designee prior to holding these sessions.

- Preliminary Design Review

  The Contractor shall hold meetings at which the majority of the design work has been completed. The Contractor shall demonstrate with drawings, analyses, reports, etc. that the design meets the requirements of the specification. The Contractor shall include these design review sessions on the project schedule submittals, and shall also provide a minimum of 30 days notice to IDOT or its designee prior to the conduct of these sessions.

- Final Design Review.

  The Contractor shall hold meetings where only changes to the designs that have occurred/been necessitated since the Preliminary Design Review are discussed and agreed upon. After this meeting the design is “frozen” and all further changes shall be via the Change Control process.

When specific quantitative or qualitative requirements are called for in the other Sections of these Specifications, the Contractor shall show, either by analysis of existing relevant data or by test, that the design shall match the requirement.

Such analysis and testing shall take into account the effects of shelf life, environmental conditions during transport, and handling during assembly and shall, where applicable, include all associated subsystems down to the lowest tier.

If the Contractor elects to use analytical methods, it shall be the responsibility of the Contractor to adduce evidence which shall substantiate the data and methods used.

Failure to meet the requirements above shall require testing to evaluate the design in question against specific requirements. The Contractor shall submit to the Engineer, for review and approval, an appropriate test plan. After approval, notice shall be given so the Engineer or a representative can be present if so desired, and the test shall be conducted. In any case, a test report shall be prepared and a copy made available to the Engineer.

Failures encountered during testing shall be analyzed for cause, and appropriate corrective action taken, including retesting at the discretion of the Engineer.

15.3 Manuals and Catalogs

15.3.1 Types and Quantities

The Contractor shall furnish manuals for use by vehicle operators and maintenance personnel in accordance with the requirements of this Specification. Manuals to be supplied as part of this Contract are as follows:

1. Operating Instructions Manual — 50 copies
2. Maintenance Procedures Manual — 10 copies
3. Illustrated Parts Catalogs — 10 copies
4. Training Manuals — 10 copies
5. Integrated Electrical Schematics — 10 copies
6. Electrical Wiring Diagrams and Device Tables — 10 copies
7. Air and Water Piping Diagram Manual — 10 copies

The Contractor shall also provide a copy of all manuals and catalogs identified above on electronic media, in a format that can be edited by IDOT or its designee.

Within 12 months after NTP, or prior to the FAIs, whichever comes first, the Contractor shall submit to IDOT or its designee, for approval, Tables of Contents and sample formats for each type of manual and for the Illustrated Parts Catalog.

Delivery of the draft copies of the manuals and catalogs shall occur after the FAIs, but prior to delivery of the first production vehicle. IDOT or its designee's review time for these drafts shall be 30 days.

Delivery of the final copies of the manuals and catalogs shall occur before delivery of the first production vehicle. The final edition of all manuals, incorporating all changes deemed

necessary, shall be completed and delivered 60 days after receipt of all comments requested from IDOT or its designee.

15.3.2 Operating Instructions Manual

The Operating Instructions Manual (OIM) shall contain all information needed for the proper operation of the vehicle. It shall include general vehicle familiarization material, such as:

1. Location, function and operation of controls, gauges, indicators and switches;

2. Discussion of the trucks, couplers, lights, environmental control, and other features of the vehicle which the operator may not be in a position to control or adjust but of which the operator should have some basic knowledge;

3. Emergency equipment and procedures;

4. Troubleshooting and Operator corrective actions.

The manual shall be logically organized with systems and elements considered in descending order of importance. Care shall be taken that all statements and illustrations are clear, positive, and accurate, with no possibility of incorrect implications or assumptions.

15.3.3 Maintenance Procedures Manual

The Maintenance Procedures Manual (MPM) shall enable the maintenance staff to have with them, in convenient form, all information needed for preventive maintenance inspections, on-vehicle running maintenance and adjustment, and on-line trouble diagnosis of each system including such data as troubleshooting guides, equipment specifications and schematics for the vehicles and each of its systems. It shall also include, in a separate section, all information needed for periodic inspection and servicing requirements, including lubrication, inspection and adjustment of all apparatus. The MPM shall contain a detailed analysis of each component of the vehicle so that the maintenance staff can effectively service, inspect, maintain, adjust, troubleshoot, repair, replace, and overhaul vehicle and components. The MPM shall include instructions for using portable test units (PTUs) for maintenance, adjustment, test, and troubleshooting functions.

15.3.4 Illustrated Parts Catalogs

The Illustrated Parts Catalogs (IPC) shall enumerate and describe every component with its related parts for the vehicles, PTUs and special tools. One column shall include the Original Equipment Manufacturer's (OEM) part number, if it is not originally manufactured or supplied by the Contractor. The IPC shall include a column for the customer part number.

Drawings showing cutaway and exploded views of subassemblies and components shall be used to permit identification of all parts. Parts common to different components (for example, bolts and nuts) shall bear the same Contractor's and OEM number in all components. Each part or component shall be identified as being part of the next higher assembly.

15.3.5 Training Manuals

Training manuals shall contain sufficient material to aid the Contractor in performing the requirements of Section 15.6.

15.3.6 Integrated Schematic Manuals and Diagram Manuals

The Integrated Schematic Manuals (ISM) shall enable the maintenance staff to have with them, in convenient schematic form, information needed for on-line trouble diagnosis of electrical or pneumatic systems.

15.3.7 Manual Formats

All publications shall be in loose leaf form and use 20 pound offset paper. They shall be in four general categories and sized as follow:

1. Operating Instructions Manual — Pocket Size
2. Maintenance Procedures, Integrated Schematic Manuals and Wiring and Piping Manuals — Standard Size
3. Parts Catalog — Standard Size
4. Training Manuals — Standard Size

Pocket size manuals shall be 4-1/4 in wide, 8-1/2 in high, and not more than 1-1/4 in thick. They shall be bound using plastic binding combs (Cerlox type) along the 4-1/4 in dimension and the pages therein shall be as large as can be accommodated without damage. The front and back cover shall be plasticized and sized to protect the pages inside.

Standard size manuals shall be reproduced on pages that are 8-1/2 x 11 in. three-hole punched The binder cover shall be 10 in. to 10-1/2 in. wide (depending on ring size) and 11-1/2 in. to 12 in. high. The binders shall not exceed 3 in. overall thickness. Folded pages will be permitted (11 x 17 in., "Z" - folded) where the information to be conveyed cannot be presented clearly on single pages. Manuals for 8-1/2 x 11 in. pages may be divided into multiple volumes if the required material cannot be accommodated within the maximum binder thickness. A Table of Contents shall be provided in each volume.

All covers shall be approximately 1/16 in thick, resistant to oil, moisture, and wear, to a high degree commensurate with their intended uses. Standard size loose-leaf three-ring type binders shall be used. Diagrams and illustrations shall not be loose or in pockets. All printed material shall be clearly reproducible by standard dry copying machines.

All documents or drawings which include information in a language other than English shall include an English translation adjacent to the non-English passage. All dimensions given in metric units shall also state the English unit equivalents parenthetically next to the metric dimensions.

15.4 Diagnostic Test Equipment

15.4.1 General

The Contractor shall provide all equipment specified in this Section for comprehensive in-service testing of vehicles. All of the test equipment identified in Sections 15.4.2 and 15.4.3 shall be delivered at the same time as the acceptance of the first vehicle. Standard test instruments used in the bench testers should be the "ruggedized" or a "field" version of the particular item. All Portable Test Units (PTUs) shall be delivered as specified in this document.

15.4.2 Maintenance Facility Bench Test Devices

One set of bench test devices shall be supplied by the Contractor for the purpose of testing, troubleshooting, and calibrating all electrical, electronic, mechanical, electro-mechanical, pneumatic, and hydraulic components of each vehicle subsystem.

Test units shall be for use in maintenance and repair facilities. The Contractor shall ensure compatibility of all test units with IDOT or its designee's maintenance facilities. A list of proposed bench test devices shall be provided in the proposal.

15.4.3 Portable Test Units

Three portable test units (PTUs) shall be supplied for the on-board systems listed below to aid the maintenance staff in maintaining, troubleshooting, and calibration of the vehicle equipment.

1. Train Control System,
2. Propulsion System,
3. Friction Brake System,
4. Auxiliary Power Supply and Battery,
5. HVAC System,
6. Doors,
7. Train Communication System.

Each PTU shall be supplied with an instructional manual that describes how to use the tester along with expected results and how to troubleshoot and repair the tester.

PTUs shall be notebook computers configured to interface with the on-board systems listed above and loaded with all necessary software to provide the functionality required by this Section. Three identical units shall be supplied, including all necessary interface cables.

PTUs shall be able 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 all of the signals, responses and outputs produced by a system by means of instruments such as meters, oscilloscopes, or gages. Connection of the PTU to the equipment shall be through test plugs conveniently located inside the vehicle so that the maintenance technician is able to observe the functioning of the system while it is being tested.

15.4.4 Special Tools

The Contractor shall supply one set of any required special tools. Special tools include but are not limited to any jigs, fixtures, equipment, gauges, hand tools, power tools, or other tools and equipment necessary to maintain, repair, assemble, and disassemble the vehicle or subsystems that are not commonly available from commercial tool suppliers.

All special tools, other than the PTUs and bench testers that are required to maintain the vehicle shall be supplied along with complete manuals explaining the use of the tool and its care and maintenance.

A list of proposed special tools and equipment shall be provided in the Contractor's proposal.

15.5 Replacement Parts

15.5.1 Recommended Spare Parts

The Contractor shall furnish a list of recommended spare parts and consumable items anticipated to be required on a year-by-year basis over the anticipated 32-year operating life of the cars procured under this Contract. The list of recommended spare parts shall be predicated on the Contractor and Subcontractor experience with similar equipment in service on other properties and the maintenance requirements expected for IDOT or its designee. Consumption rate data and data on lead time for procurement of replacement parts shall be made available to IDOT or its designee in support of these spare parts recommendations. Spare parts recommendation shall consider the longest possible lead-time to obtain parts from the source.

The recommended spare parts list shall include the parts description, part number, quantity recommended, the unit prices for individual parts or carsets of equipment, and the extended price based on the recommended quantities.

15.5.2 Spare Parts for Warranty Repairs

The spare parts ordered by IDOT or its designee for support of revenue operations will, when approved by IDOT or its designee, be made available for warranty repairs or warranty parts replacement. In such an event, the Contractor shall replace the IDOT- or designee-furnished parts with new parts to replace those used for warranty repairs.

15.6 User Education

15.6.1 General

The Contractor shall provide an educational program for IDOT designated personnel, of a quality and depth sufficient to permit such personnel to safely and satisfactorily operate, service, and maintain the vehicles and all carborne equipment, and to train other IDOT or its designee personnel in the operation and maintenance of the vehicles. The educational program shall begin concurrent with delivery of the first vehicle or prior to start of revenue service. This program shall include classroom and hands-on instruction through the use of actual equipment, mockups, models, manuals, diagrams, and parts catalogs, as applicable. Optionally, mockups and models may be produced and used. The Contractor shall assume no knowledge of the features of the vehicles on the part of the designated personnel, and shall design the program to bring the level of knowledge to one fully adequate for the objective. The Contractor may assume that IDOT or designee personnel have the basic skills pertinent to their respective crafts.

The Contractor shall, within ninety (90) days after award of the Vehicle Contract, submit an educational program outline and a schedule for IDOT or its designee's approval, that identifies milestones for submitting the course outlines, instructor and student guides, and for conducting classes. The training outline shall identify each module of instruction and the general topics to be taught and indicate the order in which modules will be presented.

As training materials are being developed, the Contractor shall work closely with IDOT or its designee's staff to ensure that IDOT or designee standards are being met, with respect to the course organization, content, and overall quality of written documents.

Vehicles and spare parts on IDOT or its designee's property may be utilized for educational purposes, insofar as this use does not interfere with the acceptance program or other usage by IDOT or its designee. IDOT or its designee will make available, upon proper notice, cars and trains at accessible shop locations for instructional purposes. All vehicle equipment and spare parts utilized for training purposes shall be restored to new equipment condition, if necessary, by the Contractor subsequent to use for training purposes and the Contractor shall provide full warranty for this equipment.

All training materials, such as training aids and lesson plans, shall become the property of IDOT or its designee at the completion of the training program. The Contractor shall be responsible for the condition of these materials for the duration of the training program, and shall replace all damaged materials unless the damage results from neglect by IDOT or its designee. Lesson plans shall be updated as required during the course of instruction.

Instructors provided by the Contractor shall be fully capable of transmitting in-depth technical information that can be understood by participants.

The program shall be conducted in IDOT-designated classrooms with furniture supplied by IDOT or its designee (desks, tables, lecterns, etc.). Classes shall be scheduled eight (8) hours per day, five (5) work days per week. IDOT or designee holidays shall be observed. Class instruction periods shall normally be fifty (50) minutes in duration with a ten (10) minute break between periods of instruction. Length of practical application periods shall be established by the Contractor.

15.6.2 Operations Training

The Contractor operations training shall instruct one (1) group of 10 representatives. Each course shall consist of classroom time and practical on-train operation. Topics to be covered in the operations training program shall include, but not be limited to the following: vehicle specifications, controls and indicators; vehicle systems (i.e., friction brake, electrical, truck and coupler assemblies, door control, environmental, lighting and communications); vehicle operations (i.e., actual operation of the vehicle in maintenance yards or on the main track, as applicable); troubleshooting procedures; and recovery operations.

15.6.3 Maintenance Training

The Maintenance Training shall consist of three major subgroups, Maintenance training, Management Familiarization training and Emergency Response training:

15.6.3.1 Maintenance Training

The Contractor shall provide maintenance training sessions for one group of 10 representatives. The courses shall consist of classroom hours and hands-on hours in an IDOT or designee maintenance facility, working on actual equipment.

IDOT or designee employees shall be exposed to the depth of detail that is necessary for the performance of preventive and corrective maintenance operations. Students shall be afforded

the opportunity to perform the more complex maintenance functions on the vehicle and in the shop, in addition to troubleshooting systems with faults artificially introduced in the equipment while using the appropriate subsystem test devices.

The Maintenance Training shall instruct on the systems outlined in Table 2 as applicable to the vehicle delivered.

15.6.3.2 Management Familiarization Training

The Management Familiarization training shall instruct one group of 10 representatives. The course shall consist of classroom time and time on the train. The course shall provide a general overview of the vehicles and explain the main features of the major systems and components installed.

15.6.3.3 Emergency Response Training

The Emergency Response training shall instruct one group of 10 representatives. Each course shall consist of classroom time and time on the train. Topics to be covered in the emergency response course shall include, but not be limited to, emergency equipment location, vehicle access, recovery operations, etc.

15.6.4 Training Program Duration

NOTE: The actual training program and the total duration depend on the equipment installed on the delivered vehicle. Additional training can be provided upon request.

The typical training program breaks down into the following courses and course durations:

Table 1 - Operations Training

Course	Title	Duration
Op 1	Operator Training (Group 1)	8 hrs
	TOTAL:	8 hrs

Table 2 - Maintenance Training

Course	Title	Duration
MF 1	Management Familiarization	4 hrs
Maint 1	Familiarization and Overview	8 hrs
Maint 2	Carbody and Lighting	8 hrs
Maint 3	Operating Cab, Controls (Cab cars	8 hrs

Course	Title	Duration
	only)	
Maint 4	Auxiliary Power / Head End Power	24 hrs
Maint 5	HVAC	24 hrs
Maint 6	Truck	16 hrs
Maint 7	Coupler and Draft Gear	8 hrs
Maint 8	Brakes, Pneumatic Distribution System	40 hrs
Maint 9	Side Doors	24 hrs
Maint 10	Toilet / Water / Waste (if applicable)	8 hrs
Maint 11	Communications and Destination Signs (if applicable)	16 hrs
Maint 12	Event Recorder / Monitoring / ATS (if applicable)	24 hrs
Maint 13	Preventive Maintenance	8 hrs
Maint 14	Food Service Area and Equipment	16 hrs
Maint 15	Car Control and Command Network (if proposed)	24 hrs
ER 1	Emergency Response	8 hrs
	TOTAL :	268 hrs

SECTION 16

16 SAFETY PLAN

16.1 Contractor Safety Plan

This Section defines the system safety requirements and safety plans required by IDOT and funding agencies for the successful completion of this project.

The Contractor's safety plan must conform to the requirements of APTA "Manual for the Development of System Safety Program Plans for Commuter Railroads" (2006) and also reference 49 CFR as contained in appendices.

16.2 System Safety Plan

The Contractor shall prepare a plan to implement and maintain a comprehensive System Safety Program (SSP) in accordance with MIL-STD-882D-Department of Defense, Standard Practice for System Safety. The plan for the SSP shall be submitted for IDOT or its representative's review within 120 days from Notice to Proceed (NTP).

16.3 Safety Reporting Requirements

The Contractor shall submit copies of Material Safety Data Sheets (MSD) for all appropriate materials to IDOT or its representative.

16.4 Hazard Identification and Analysis

The Contractor shall identify all failure-induced and normal operating (non-failure condition) hazards in accordance with FTA guidelines found in DOT-FTA-MA-26-5005-00-01 – Hazard Analysis Guidelines for Transit Projects. Hazards shall be compiled into a list and submitted for review by IDOT or its designee prior to delivery of the first production car.

The Contractor shall perform hazard analyses on all hazards identified in the hazard lists. Analyses shall demonstrate that the vehicle conforms to provisions of the Specification and that all identified hazards are either eliminated or reduced to levels of risk agreed to by IDOT or its designee.

Electrical circuit failure mode analyses performed as part of a hazard analysis shall include a sneak circuit analysis. Analyses shall identify all design errors and maintenance errors that could result in unsafe conditions. Existing hazard analyses of like equipment operating under like conditions may be offered with the agreement of the Engineer, in lieu of performing a complete analysis of proposed equipment.