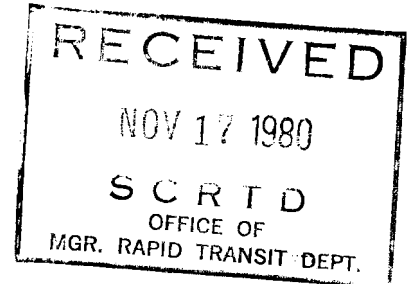


TRANSIT INDUSTRY CORE TECHNICAL SPECIFICATIONS
FOR THE PROCUREMENT OF RAPID RAILCARS

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GUIDANCE FOR USERS OF THIS DOCUMENT



GUIDANCE FOR USERS OF THIS DOCUMENT

I.1 TRANSIT INDUSTRY APPLICATION

Provisions have been made to permit each purchaser to modify the technical specifications by specifying alternative car system features and by providing such completing detail as might be required to ensure that the cars being procured shall be capable of safe, efficient operation within the intended application.

The concept of technical specifications for a rapid railcar system of defined systems as the industry-wide core new car procurement document recognizes that each purchaser's car design reflects the distinctive requirements and constraints of that transit authority's operations.

The operators, in reviewing the draft forms of this document, unanimously requested that the conceptual car system reflect the industry-wide consensus regarding: degree of sophistication, performance-level, maintainability, and energy efficiency. The technical specifications for the baseline car should be the "core" specification.

I.2 CAR DESCRIPTION

I.2.1 BASIC CONCEPT

The rapid railcar system design described herein is electrically powered, steel wheeled, and air conditioned. The basic operating units are dependent-pairs; i.e., an

A-car and a B-car. Each car has a full width operator's cab located at the F-end. A- and B-cars are identical in overall dimensions, with the principal design differences being the distribution of undercar equipment:

- A-cars shall be even-numbered and shall contain the air compressor with its related equipment, but shall not contain batteries and battery-related equipment.
- B-cars shall be odd-numbered and shall contain the batteries with related equipment, but shall not contain an air compressor with its related equipment.

Revenue service shall be provided by trains which vary in length from 2 to 4 dependent-pairs. Power shall be supplied from the contact rail at a nominal voltage of either 600 VDC or 750 VDC, as dictated by the purchaser's operating environment.

I.2.2. THE CORE RAPID RAILCAR SPECIFICATION

A. The Baseline Car

The substance of the specification reflects the following conditions and limitations:

1. It represents those requirements which have been judged by the transit industry to describe the most efficient and reliable rapid railcar available today for its system.
2. It is limited in its coverage to those car systems and subsystem items for which standardization offers the greatest potential economic benefits without severely limiting applicability of the specification to operating transit authorities in 1980.

Therefore, this document is an industry-wide core specification.

B. Purchaser-Specific Rapid Railcar Requirements

Although most United States transit systems may use this specification, each transit authority, including those not yet operating, will be constrained by distinctive requirements based on one or more of the following considerations:

1. Transit authorities could be prevented by site-specific considerations from assimilating into revenue fleets new cars manufactured in total conformance with these core technical specifications.
2. New rapid rail systems could find it necessary to modify the baseline car system design specified herein because of local geophysical, environmental, and climatic constraints.
3. Each purchaser shall retain the prerogative to modify the core, standard technical specifications with such detail as might be necessary to:
 - a. ensure that purchaser experiences with the latest equipment would be reflected in the new cars to promote economic efficiency and reduce life cycle costs (and)
 - b. provide for purchaser specification of carbody configuration and outfitting.
4. Purchaser-specific requirements can take one of three forms; i.e., completing detail, alternates and options.
 - a. Completing Detail Completing detail specifies those car system features which are not covered in the baseline car system design and greater level of detail than is provided in this standardized core technical specifications.

- b. Alternates Alternates are those features which, when substituted or modified on a one-for-one basis within the baseline standard car system, would provide for equipment compatibility with the purchaser's infra-structure. The core specification is neutral with regard to the relative merit of alternatives.

 - c. Options Options are those features which, when added to and incorporated into the baseline standard car system, may change the performance or the service level of the purchaser's derivative car system.
5. The following influences and factors (see Figure I-1) are the criteria which delimit purchaser-specific design requirements. One of these criteria must be cited for each item added to, or deleted from the core specification.

Figures I-2 and I-3 offer examples of each entry criterion.

FIGURE I-1. PURCHASER-SPECIFIC REQUIREMENTS

- A. OPERATOR-INITIATED OR CONSTRAINING POLICIES
 - 1. Operator-Initiated Policies
 - a. Internal Standardization Programs
 - b. Operating Rules and Practices
 - 2. Operator-Constraining Policies
 - a. Labor Agreements
 - b. State and Local Laws
- B. SITE-SPECIFIC FACTORS
 - 1. Wayside and Other Transit System Structures
 - a. Wayside Structures
 - b. Other Structures
 - 2. Route System Physical Features
 - 3. Environmental and Climatic Features
 - 4. Off-Car Interdependent Services
 - a. Electrical
 - b. Electromagnetic
 - c. Electro-Mechanical
- C. ECONOMIC EFFICIENCY AND LIFE CYCLE COSTING

FIGURE I-2. EXAMPLES OF OPERATOR-INITIATED OR CONSTRAINING POLICIES

1. OPERATOR-INITIATED POLICIES

a. Internal Standardization Programs

Examples would include standardizing on:

- The same motor design for all cars regardless of car size
- Number of side doors
- Window glazing sizes, shapes, and materials
- Wheel sizes and profiles

b. Operating Rules and Practices

Examples would include the requirement that

- All cars of a given size be physically and functionally compatible so that trains could be made up with mixed consists (and)
- Any revenue service train must be capable of recovering an inoperable train and moving that train to a maintenance site.

2. OPERATOR-CONSTRAINING POLICIES

a. Labor Agreements

These might affect:

- The hiring of new, or the training and upgrading of existing employees to provide skilled maintenance personnel for advanced technology equipment
- Contracting for external (off-site) maintenance, repair, or rebuilding of carborne equipment
- Contracting for on-site servicing and maintenance support services.

FIGURE I-2. (Continued)

b. State and Local Laws

While all transit authorities must comply with Federal laws, both legislative and administrative, there is no comparable uniformity among State and local laws.

FIGURE I-3. EXAMPLES OF SITE-SPECIFIC FACTORS

1. WAYSIDE AND OTHER SYSTEM STRUCTURES

a. Wayside structures would include:

- platform height, length, and edge-to-track
- signal locations
- contact rail location
- configurations, dimensions, and load limits of elevated structures

b. Other Transit System Structures would include:

maintenance facilities:

- shop buildings' internal dimensions
- load limits of lifts, jacks, and hoists

2. ROUTE SYSTEM PHYSICAL FEATURES

- a. grades (ascending and descending)
- b. tunnel dimensions
- c. restricting curves
- d. restricting turnouts (frog size)
- e. storage track lengths

3. ENVIRONMENTAL AND CLIMATIC FEATURES effects could take one or more of the following forms:

- a. temperature ranges
- b. sustained high humidity levels
- c. saline ambient air
- d. ice on power rail/catenary
- e. snow
 - on mainline, spur, and yard tracks
 - as loads on elevated structures, building, and car roofs

FIGURE I-3 (continued)

4. OFF-CAR INTERDEPENDENT SERVICES are those electrical electromagnetic, and electro-mechanical functions which involve both on-car and off-car elements.
 - a. Electrical service takes the form of external power, the characteristics of which influence propulsion motor efficiency and service life; particularly,
 - nominal voltage value
 - limiting values and durations of voltage swings
 - b. Electromagnetic services include:
 - radio voice communications
 - data form communications
 - video communications
 - train control signals via
 - rail (or)
 - radio
 - c. Electro-mechanical services include:
 - tripstop, overspeed, and train protection systems
 - carborne route selector systems
5. ECONOMIC EFFICIENCY AND LIFE CYCLE COSTING are those features a purchaser might select to achieve economic advantages through increased efficiency or life cycle cost savings.

I.3 USE OF THE CORE SPECIFICATION

I.3.1 ORGANIZATION

The specification is organized in three parts to present the reader with an overview of car systems performance requirements in the first six sections, followed by detailed subsystem requirements and specifications in the next twelve sections (7 through 17). Sections 18 through 23 contain the analyses, plans, programs, reports, testing, support, documentation contract data requirements.

The organizational philosophy is to present each supplier, not with only a detailed section pertaining to his particular area of interest but also with an overview of the car system including subsystem interface requirements. This information should enhance coordination and communications between builder and suppliers.

I.3.2 FORMAT

A. Purchaser-Specific Information

1. Completing Detail

Interspersed throughout the core specification are requirements which must be specified by the purchaser. These requirements will normally differ from system to system based on the purchaser's operational and maintenance practices, distinctive experience and environmental constraints. To complete the technical specifications prior to request for bid, the purchaser must insure that all applicable purchaser-specific information has been inserted.

Each subsection which requires completing detail can be identified by:

- one bullet in the left hand margin next to the subsection number.

The completing detail may or may not appear on the same page as the subsection number but will appear in the designated subsection. The exact location is indicated by an asterisk(s) and a line (*_____) with the asterisk(s) referenced at the bottom of the page where the information is required and stating that "Purchaser completing detail" is required.

In addition, a complete listing of all subsections requiring purchaser completing detail is provided as a checklist in Section A.6, Appendix A.

B. Alternates

Alternates as defined in Section I.2.2B4b are part of the core specification.

Each subsection containing an alternate selection can be identified by:

- ● two bullets in the left hand margin next to the subsection number.

Alternate subsystems are placed under appropriate subsections and indicated as follows:

Alternate I* and Alternate II*, etc.

The alternate may or may not appear on the same page as the subsection number but will appear in the designated subsection. Alternates are marked with an asterik(s) and referenced to at the bottom of the page where they appear with instructions to the user.

The point where alternate text stops and core specification text resumes is indicated by:

in the right hand margin opposite the last line of alternate text.

C. Options

Sample options as defined in Section I.2.2.B.4.C are provided in the specification. They are located at the end of the particular section in which they would appear if selected by the purchaser. Specification language for each option is provided for use by the purchaser in translating the core specification into a complete procurement document.

D. Site-Specific Information

Appendix A contains the following site-specific information:

1. Fixed facility description
2. Ambient environmental conditions
3. Duty cycle requirements

Where the purchaser's site-specific characteristics differ from those listed, the purchaser must either provide site-specific information or substitute its values or characteristics for those specified in Appendix A.



SECTION 1
SCOPE OF THE SPECIFICATION



SECTION 1

SCOPE OF THE SPECIFICATIONS

1.1

GENERAL

These technical specifications comprise the detailed requirements for the performance, construction, testing, and delivery of rapid transit passenger cars and include program management, demonstration, product support, and data requirements. Taken together with the contract drawings and other provisions of the procurement contract, these specifications are intended to be complete and comprehensive and to show all work required to be performed.

All cars constructed and in accordance with these specifications shall be uniform. Any changes made during the production contract shall be fully incorporated in all cars delivered under this contract.

● 1.2

CAR DESCRIPTION

The overall characteristics of the cars shall be as follows:

Model Designation	*
Type of Cars	A-car and B-car
Train Make-up	Any combination of A and B
Number of Seated Passengers	A-car: 70 B-car: 70
Wayside Power	As specified in Appendix A

*Purchaser completing detail

●1.3

COMPATIBILITY REQUIREMENTS

The cars specified herein shall be compatible with cars purchased under specified previous purchaser contracts in that any combination of cars from these contracts may be mixed in a train in accordance with the aforementioned train make-up, and shall operate satisfactorily and efficiently without degrading the performance thereof.

Interface requirements are set forth as follows:* _____

●1.4

REPLACEMENT PARTS INTERCHANGEABILITY

Those replaceable parts which are specified as follows shall be interchangeable with elements on previously purchased cars:* _____

1.5

MATERIALS

All materials and equipment furnished by the contractor shall be new and shall be subject at all times during manufacture, fabrication, and construction to such inspection and tests by the purchaser as the purchaser shall feel necessary to assure that the terms of these specifications are being complied with.

*Purchaser completing detail

SECTION 2
DEFINITIONS AND ABBREVIATIONS



SECTION 2

DEFINITIONS AND ABBREVIATIONS

2.1 GENERAL

Wherever the following abbreviations and terms are used in the Specification, they should be interpreted with the intent and meaning shown below.

AAR Association of American Railroads

A-CAR One-half of a dependent-pair. That car of a dependent-pair equipped with a control cab and with the dependent-pair's only air compressor, but lacking batteries and related equipment

ACCEPTANCE TEST Test performed on a car to be delivered using production items to determine whether or not the item complies with specified requirements for the purpose of confirming that production items are at least equal to the qualified item.

ACRI Air Conditioning and Refrigeration Institute.

ADHESION, CO-EFFICIENT OF During rolling contact, the ratio between the attainable longitudinal tangential force at the wheel-rail interface and the normal force

AFSC Air Force Systems Command

AGMA American Gear Manufacturers Association

AIEE American Institute of Electrical Engineers (now IEEE)

AISC American Institute of Steel Construction.

AISI American Iron and Steel Institute

ALCOA Aluminum Company of America

ALLOWABLE STRESS The maximum stress permitted in a structure under specified design conditions.

AMBIENT AIR The air surrounding the object of interest

ANSI American National Standards Institute

ANTICLIMBER A structural reinforcement at each car end to ensure end-to-end engagement between carsills in any situation where they come in contact

APPROVED Reviewed and found compliant with the specifications.

ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers.

ASME American Society of Mechanical Engineers.

ASTM American Society for Testing and Materials.

AURAL Pertaining to or perceived by the ear.

AUTOMATIC TRAIN CONTROL SUBSYSTEM A subsystem which enforces speed restrictions and prevents exceeding speed restrictions by automatic brake applications; may additionally encompass automatic train operation (ATO), automatic train protection (ATP), and automatic train supervision (ATS)

AUTOMATIC TRAIN OPERATION (ATO) That portion of the automatic train control subsystem which performs any or all of the functions of speed regulation, programmed stopping, door control, performance level regulation, and other functions normally assigned to the train operator.

AUTOMATIC TRAIN PROTECTION (ATP) That portion of the automatic train control subsystem which maintains safe train operation through a combination of train detection, train separation, and interlocking

AUTOMATIC TRAIN SUPERVISION (ATS) That portion of the automatic train control subsystem which monitors subsystem status and provides the appropriate controls to direct the operation of trains to maintain intended traffic patterns and minimize the effects of train delays on the operating schedule

AUXILIARY SUBSYSTEMS Any mechanism or structure other than the carbody, traction motor or propulsion subsystem gearing, which functions during car operation; e.g., car door operation, motor alternator, and car lighting

AVAILABILITY The probability that a subsystem or subsystem element will be operational when required. Mathematically, the ratio of the mean time between failure to the sum of mean time between failure plus mean downtime.

AWG American Wire Gauge

AWO Actual weight of empty car ready for revenue service, but with neither crew nor passengers aboard

AW1 Actual weight of car ready for revenue service with crew aboard and all passenger seats occupied

AW2 Actual weight of car ready for revenue service with crew aboard, all passenger seats occupied and an equal number of passenger standees

AW3 Actual weight of car ready for revenue service and with the largest number of passengers which can enter the car (crush load)

AWS American Welding Society

B-10 LIFE The average car mileage at which no more than 10 percent of all anti-friction bearings in the car fleet shall have failed, with 90% confidence

B-CAR One-half of a dependent-pair. That car of a dependent-pair equipped with a control cab and with the dependent-pair's only batteries but lacking an air compressor

BLENDING A simultaneous dynamic and friction brake application with the friction braking supplementing the electrical braking to provide the required total braking effort

BRAKE ASSURANCE The function provided by a subsystem within the automatic train control subsystem that will cause the emergency brakes of a car to be applied when the actual braking rate of the car is less than the braking rate requested by the automatic train control subsystem

BRAKING, CLOSED LOOP Braking under continuous direction of the train control subsystem

BRAKING, ELECTRICAL Braking in which power generated by traction motors, when driven as generators, is either:

- dissipated as heat by dynamic brake resistor grids (Dynamic Braking), or
- regenerated as direct current electricity conditioned and either used in the car or returned to the contact rail or catenary to help meet the power demand of other motoring cars (Regeneration)

BRAKING, EMERGENCY Irrevocable open-loop braking to a full stop at the maximum design brake rate

BRAKING, FULL SERVICE A non-emergency brake application which obtains the maximum service brake rate consistent with the design of the primary brake subsystem(s)

BRAKING, OPEN LOOP Braking without feedback control

BRAKING, PROGRAMMED Closed-loop braking with the requirement that a stop be completed at a designated point and within a specified distance

BRAKING SUBSYSTEM, FRICTION A combination of elements, controls, and friction devices which operate to retard the car

BUFF LOAD A horizontal compressive load applied to the car, along the centerline at the couplers or anticlimbers

CAB SIGNAL A signal in the operator's cab which conveys the automatic block aspects and indicates the prevailing speed command

CAM CONTROL A propulsion control system

CARLINE A longitudinal roof frame member connected between adjacent purlines to form a complete roof frame structure

CAR WEIGHT, CRUSH LOAD (See AW3)

CAR WEIGHT, EMPTY (See AWO)

CAR WEIGHT, FULL LOAD (See AW2)

CAR WEIGHT, NORMAL LOAD (See AWI)

CDR Critical Design Review

CDRL Contract Data Requirements List

CHOPPER A propulsion control device using solid state electronics to condition power by varying the effective on-time

CIRCUIT, VITAL Any circuit that affects the safety of train operations

COAST The mode of operation of a car in which both propulsion and braking are inactive, except that a small amount of current is permitted to be circulated in the circuits. The small amount of circulated current provides a small retardation effect.

CODE COMMAND A transmitted vital coded signal to initiate action.

COMMERCIAL TEST A test of selected characteristics or properties of a commercial product sufficient to demonstrate product compliance with the commercially accepted defining characteristics for the product type established by trade or technical associations or standards

COMPONENT Usually self-contained, a component comprises parts, devices, and structure and performs a distinctive function necessary to the operation of a subsystem or system.

COMPONENT TESTING Testing planned and conducted during the development phase to assure that the components of the planned product conform to specifications and criteria set forth in the Statement of Work

CONFIGURATION MANAGEMENT Discipline which assures that all equipment, software, and interfaces are identified by engineering data and that all changes thereto are controlled and recorded

CONSIST The specific grouping into a train of identified vehicles

CONSOLE Control panel in the operator's cab from which the operator monitors and controls train operation

CONTACT RAIL Heavy conductor alongside the runnings rails with which the car's current collector makes sliding contact and derives power from the external source of electrical power; for train operation includes supports, insulators, coverboards and accessories (Also called third rail)

CONTACT WIRE Wire above tracks which is the external source of electric power

CONVERTER Any device which changes one voltage level or type (e.g., 600 VDC) to another (e.g., 38 VDC). Most commonly (but not exclusively) applied to static low voltage dc power supplies fed from primary power

COUPLER Device for mechanically coupling cars; also applied to connectors which couple electric and pneumatic train-lines between cars

CPN Critical Path Network

CRITICAL AREA Region of a structure where stresses are at or near the limits of allowable stresses specified

CROSS LEVEL Relative transverse elevation of the two running rails; superelevation

CURRENT COLLECTOR Carborne device to conduct electrical power from the external power source to the car

dBA Sound level measured in decibels on the A-scale

DEAD BAND That portion of time or movement of a circuit, valve or device during which there is no change in output while an accompanying change in input is in effect

DEADMAN CONTROL A pressure or activity actuated device to detect inattention or disability of a train operator.

DECIBEL Standard for comparison of power levels in electrical communication or sound intensities. Value is equal to 0.0002 microbar (20 micropascals)

DEPENDENT-PAIR A two-car consist, composed of a dependent A-car coupled with a dependent B-car. Also called married pair

di/dt Rate of change of electrical current with respect to time

DISPATCHING The process of placing a train into revenue service from a terminal zone or transfer track

DOT Department of Transportation

DRAFT LOAD A tensile load applied to the car through the couplers

DRIVE A system consisting of one or several motors, their direct control equipment (power circuits), and the associated mechanical devices required to produce a useful output

DUTY CYCLE Actual operating conditions including the environment; also the period or percentage associated with the activated state of operation, occurring during normal cyclic operations, in relation to a full cycle

dv/dt Rate of change of electrical voltage with respect to time

DWELL TIME The total time from the instant that a train stops in a station until the instant it resumes moving

DYNAMIC OUTLINE The greatest dimensional cross section of a specific moving car under worst case conditions

ECP Engineering Change Proposal

EIA Electronic Industries Association

ELECTRIC TRACTION MOTOR A rotary electric motor used for propulsion and electrical braking

EMI Electro-Magnetic Interference (includes RFI)

ENDURANCE LIMIT The maximum stress in a material which can be repeated an indefinitely large number of times without causing fracture.

ENGINEERING TEST A test wherein the equipment is operated to determine the adequacy of its design under actual operating conditions as part of a subsystem. The testing shall produce engineering data information for specified operating parameters.

FACTOR OF SAFETY The ratio of the load which would cause failure of a structure to the design load

FAIL-SAFE (SAFETY) A characteristic of a hardware system and its elements, which ensures that they will revert to a safe condition as the result of any fault or malfunction and cannot result in an unsafe condition

FATIGUE FAILURE Failure of a structure by progressive fracture or induced by cyclic applications of stress

FATIGUE DESIGN LOADS A design loading used to account for complex, variable operating loads applied to a structure for a large number of repetitions

FCC Federal Communications Commission

F-END Cab end (front end) of a car; also known as the Number One end

FIELD MODIFICATION Any change, alteration, adjustment, or modification to the equipment or any part thereof not performed at the original manufacturer's facilities

FAIL-OPERATIONAL A characteristic of a hardware system and its elements, the object of which is to ensure that any first failure will result in the system remaining operational and safe

FIRST ARTICLE INSPECTION (FAI) A review of the first unit car produced to determine that the unit has been designed, manufactured and functions in accordance with the approved pre-production drawings and technical specifications

FRANGIBLE Easily broken

FREEWHEELING The mode of operation of a car in which both propulsion and braking are inactive, that is, tractive effort is zero.

FROG Track structure at the intersection of two running rails to support wheels and provide passageways for their flanges as wheels on either rail pass through the intersection

GAUGE, TRACK Distance between the inside face of rails measured 0.625 inches (15.875 mm) below the top of the heads of the running rails and normal to the centerline of the track

HEADWAY The time separation between two trains, both traveling in the same direction on the same track. Headway is measured from the time the head-end of the leading train passes a given reference point to the time the head-end of the train immediately following passes the same reference point.

HIGH VOLTAGE Voltage level of primary power

HFE Human Factors Engineering

HVAC Heating, ventilating, and air conditioning

IC Intercommunications

IDMP Industrial Design Management Plan

IEEE Institute of Electrical and Electronic Engineers

INTERFACE That point at which one system, component, or subsystem comes into physical or functional contact with another system, component or subsystem

INVERTER Solid state power conversion equipment to change direct current electricity into controlled frequency, alternating current electricity

IPCEA Insulated Power Cable Engineers Association

IRRETRIEVABLE Condition where a brake application cannot be released until the train has come to a complete stop

ISO International Standards Organization

JEDEC Joint Electronic Device Engineering Council

JERK The time rate of change of acceleration

LINE BREAKER A current sensing switch which interrupts maximum fault currents to protect power circuits. May also perform line switch functions as described under LINE SWITCH

LINE SWITCH A switch without self-sensing overcurrent capability used to disconnect the propulsion system from external power supply. Remotely operable as opposed to a manual knife switch. May be used to interrupt overcurrent fault if tripped by pilot overload relay

LOAD WEIGHING A function which measures car weight to permit control of tractive and braking effort to achieve approximately equal performance of differently loaded trains

LOW VOLTAGE Voltage level at which most auxiliary subsystems operate

MAIN (KNIFE) SWITCH A manual disconnect switch, normally of the knife type

MAINTAINABILITY A characteristic of design and installation, expressed as the probability that an item shall be restored to a specified condition within a given period of time when maintenance is performed in accordance with prescribed procedures and resources

MAINTENANCE, CORRECTIVE Repair, adjustment, or replacement of components as a result of failures

MAINTENANCE, SCHEDULED Inspection, adjustment, repair, or replacement of components at intervals measured by time or usage.

MANUAL TRAIN CONTROL An operating mode in which the train responds to the actions of the operator through manipulation of controllers

MIL-STD Military Standard

MMAX.90 Greatest time required to repair for at least 90 percent of all actions

MOCK-UP A full scale model used to demonstrate preliminary design and/or specification compliance. Materials and refinement of instructions vary according to the intended usage

MODEL An object built to a smaller scale to demonstrate preliminary design

MODIFIED GOODMAN DIAGRAM A diagram used to determine allowable stresses in a structure under fatigue design loads

MTBF (MEAN TIME BETWEEN FAILURE) The arithmetic mean operating time between successive failures

MTTR (MEAN TIME TO REPAIR) The arithmetic mean of all active repair time

MULTIPLE UNIT (MU) (OPERATION CONTROL) A method of controlling the actions of the propulsion, braking and other subsystems of two or more cars of the train from a single cab

NEC National Electrical Code

NEMA National Electrical Manufacturers Association

NFPA National Fire Protection Association

NHTSA National Highway Traffic Safety Administration

NOISE Sound pressure levels (SPL) or sound levels as defined in ANSI Standards S 1.2-1962 and S 1.13-1971

OPERATOR That person having direct and immediate control of the movement of a train

OVERSPEED CONTROL That portion of the carborne automatic train control system which enforces speed limits in a fail-safe manner

PARTICULATES Finely divided solid matter

PHA Preliminary Hazard Analysis

PRIMARY POWER Energy source for car propulsion

PROFILE, GRADE A straight line along the track centerline representing an established slope measured in relation to the horizontal

PROTOTYPE A unit built to test a new design and which performs essentially the same as the production unit

P-SIGNAL (See Tractive Effort Signal)

PTU Portable Test Unit

PURCHASER The purchasing agency

PURLIN A framing member which extends across the top of a car from one side to the other and supports the roof

QUALIFICATION TEST Test performed using a preproduction or production item to determine whether or not the item complies with specified requirements

QUALITY ASSURANCE Actions, usually of an administrative nature, to ensure that end items will meet specified form, fit, function and finish criteria

QUALITY CONTROL The discipline which ensures the manufacture of a uniform product in accordance with specification requirements

REDUNDANCY The existence in a system of more than one means of accomplishing a given function

R-END Non-cab or rear, number two, end of a car.

RELIABILITY The characteristic which describes the ability of a component, subsystem, or system to perform its specified function without failure and within prescribed limits, expressed as a probability or mean failure rate

REQUEST (See Code Command.)

REVERSE MODE Train movement controlled by operator in cab located at end of train opposite to direction of movement

RFI Radio Frequency Interference; same as EMI and occurring in the radio communications frequency spectrum

ROAD MANUAL MODE Train movement controlled by operator over revenue service trackage

ROLL Rotational motion of a carbody about a longitudinal axis

SAE Society of Automotive Engineers

SAMPLE CAR The first production car of each type at each stage of construction and assembly

SERVICING Replacement of consumables (e.g., oil, grease, filters) on a car

SHELL That part of a carbody composed of roof, sides, end and underframe structure and sheathing but devoid of any interior finish, windows, doors and exterior appurtenances

SPECIFICATION DRAWINGS The drawings which comprise a part of the technical specifications issued by the purchaser

SPEED, BALANCING The steady state speed attained by a train on level tangent track at which resisting forces exactly equal tractive forces

SPEED, CORNER POINT The highest speed at which a specified acceleration or deceleration rate can be attained

SPEED LIMIT, ATC OR MTC The upper limit of train speed as enforced by the train protection system

SPEED LIMIT, CIVIL The maximum speed allowed within a specified section of track as determined by physical limitations of the track structure, train design and passenger comfort

SSHA Subsystem Hazard Analysis

STANDARD UNIT The standard unit is a minimum consist of two dependent cars (an A- with a B- unit) operating as a married pair

STEP SIGNAL A signal having a constant value prior to a certain instant and a different value immediately thereafter

SUBSYSTEM A defined portion of a system which is in turn composed of component parts

SUPERELEVATION On a curve, the amount by which the outer rail is above the inner rail (See Cross-Level)

SUPPLIER Source of equipment and materials required by the contractor in the manufacture of rapid railcars

SYSTEM A composite of those hardware or software subsystems which are integrated to perform a specific operational function or functions

TIG Tungsten inert gas

TIGHT (Used as a suffix) Apparatus is designated as, water-tight, dust-tight, etc., when so constructed that the enclosing case will exclude the specified material.

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 percentage of the final value

TIME, DEAD Time during which no action occurs

TIME, DOWN The lapsed time during which equipment is not capable of doing useful work because of misadjustment, malfunction or maintenance in progress

TIME, REACTION The time which elapses between the moment an action is called for and when the desired action is initiated

TIME, RECOVERY The time required for a system or condition to return to its original state (or some stated percentage of its original value) after being disrupted or destabilized

TIME, WARMUP The elapsed time from application of power to an operable device until that device is capable of performing its design function

TRACK TESTS Performance tests of the car or of any subsystem running on purchaser's track or on track simulating, as far as practicable, the actual track conditions found on the purchaser's system to verify performance parameters of the specification

TRACTION MOTOR (See Electric Traction Motor)

TRACTIVE EFFORT Propelling (positive) or braking (negative) force

TRACTIVE EFFORT SIGNAL Linear current analog signal that effects continuous proportional control of the tractive effort in braking

TRAINLINE The means of sending a signal to all cars in a consist via a continuous electrical or fluid circuit connected through appropriate coupling devices

TRAINPIPE The means by which a continuous fluid circuit is transmitted through cars in a consist

TRAINWIRE The means by which a continuous electrical circuit is transmitted through cars in a consist

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

TRIP COCK A mechanical device located on the train which, when hit by a trip stop, initiates an emergency brake application

TSC Transportation Systems Center of the U.S. Department of Transportation at Cambridge, Massachusetts

TTC Transportation Test Center, U.S. Department of Transportation test facility at Pueblo, Colorado

TWC Train-To-Wayside Communications

UL Underwriters' Laboratories, Inc.

ULTIMATE TENSILE STRESS The maximum tensile stress at or just prior to rupture

UMTA Urban Mass Transportation Administration, U.S.
Department of Transportation

WASH MANUAL MODE Train movement controlled by operator over
trackage through an automatic washer

WARP, TRACK The vertical distance between the planes formed
by any three of four rail head contact points (two on each
rail forming a rectangle and the remaining point)

WHEEL LOADS-MAXIMUM That loading representing total car
weight transferred to the running rails from each wheel of
the truck and representing the total weight of the car in
ready-to-run condition including maximum passenger loading

WHEEL SLIDE The condition wherein wheel tread speed is less
than train speed

WHEEL SLIP The condition wherein wheel tread speed is greater
than the train speed

WINDSCREEN A vertical transverse panel to protect seated
passengers adjacent to side door openings from weather and
drafts.

YARD MANUAL MODE Train movement controlled by operator
over trackage not used in revenue service

YIELD STRESS That stress at which a material exhibits a
specified permanent deformation, or set



SECTION 3
CAR DESIGN PARAMETERS



SECTION 3

CAR DESIGN PARAMETERS

3.1 GENERAL

This section specifies the general requirements for design, manufacture, and testing of the car.

3.2 CAR DIMENSIONS AND DESIGN

3.2.1 GENERAL

This subsection details the car dimensional characteristics, load conditions, and car weight parameters.

The car dimensional characteristics shall be as detailed in Figure 3-1.

3.2.2 DESIGN CONSIDERATIONS

A clearance of at least 1.5 inch (38mm) shall be provided between truck parts (including wiring) and carbody parts under the most unfavorable conditions of track curvature, wheel wear, lateral and vertical motion and roll, and broken and deflated springs. No part of the trucks except wheels, power collector shoes and trip cock shall be less than 2.5 inches (64mm) above the plane of the top of the rails under any combination of conditions, including fully worn wheels and solid primary and secondary springs.

FIGURE 3-1. CAR DIMENSIONAL CHARACTERISTICS

PARAMETERS	ENGLISH UNITS FEET (INCHES)	SI UNITS METERS	TOLERANCES
A. Car Length			
1. Over coupler faces	75'	22.680	+1" (+2.54cm)
2. Over anti-climbers	74' 8 1/2"	22.771	"
B. Car Height With New Wheels 34" (864 mm) Diameter			
1. Top of rail to top of roof	12' 1 1/2"	3.581	"
2. Top of rail to top of finished floor, measured at the bolsters	3' 10 3/8"	1.118	±1/2" (±1.27cm)
3. Top of rail to top of anti-climber	3' 9 1/2"	1.041	"
4. Top of rail to coupler centerline when coupler centerline parallel to floor with zero camber	2' 6 1/8"	.559	"
C. Passenger Area Height, Finished Floor to Ceiling, Clear			
1. High Ceiling	7' 4 11/16"	2.134	"
2. Low Ceiling	6' 7 5/8"	2.032	"
D. Carbody Width, Maximum			
1. In any plane	9' 9"	2.970	
2. Over Thresholds	10' 0"	3.048	
E. Side Door Openings, Clear			
1. Height	6' 4"	1.930	±1/2" (±1.27cm)
2. Width	4' 2"	1.270	"
F. End Door Openings, Clear			
1. Height	6' 4"	1.930	"
2. Width	2' 8"	.813	"
G. Distance Between Truck Centers	54' 0"	16.459	±1" (±2.54cm)
H. Truck Wheel Base, Maximum	7' 6"	2.286	
I. Wheel Diameter			
1. New	34"	.864	±1/2" (±0.64cm)
2. Worn (Condemning Limit)	31"	.787	

Note: 1) All dimensions identical for A-car and B-car.
2) Dimensions applicable to new properties.

Under any combination of vertical and horizontal curves as specified in Appendix A, the clearance between adjacent cars, except at the anti-climbers and couplers, shall not be less than 3 inches (76mm) under maximum buff conditions, and not less than 0.5 inch (13mm) after coupler or drawbar has telescoped and anticlimbers have engaged. Car end angles and safety barriers shall be designed to assure these clearances.

3.2.3 CAR DIMENSIONAL CHARACTERISTICS

Car dimensional characteristics shall be as detailed in Figure 3-1.

3.2.4 CAR CONDITIONS

The loadings and weight of each car shall be as defined in Figure 3-2.

FIGURE 3-2. CAR LOAD CONDITIONS

AWO	Car ready for revenue service, but without crew or passengers	80,000 pounds (36,290 kg)
AW1	AWO plus 72 seated passengers; no standees; i.e. 73 occupants	91,242 pounds (41,474 kg)
AW2	AW1 plus 72 standees; i.e., 145 occupants	102,330 pounds (46.514 kg)
AW3	AW1 plus maximum number of standees; i.e., 280 occupants	123,210 pounds (55,847 kg)

Note: Occupant weight calculated at 154 pounds (70 kg)

3.2.5 CAR WEIGHT PARAMETERS

A. Maximum Car Weights

The maximum empty A-car or B-car weight shall be 80,000 pounds (36,240 kg) including trucks.

B. Maximum Wheel Loading

As specified in Appendix A.

C. Car Balancing

All cars and trucks shall be designed and manufactured to achieve minimum weight, minimum side-to-side and end-to-end weight unbalance, and maximum car-to-car weight and balance uniformity.

The balance of the completely equipped carbodies shall be maintained within a total of 30,000 inch-pounds (3390 Newton meters). End-to-end unbalance shall not exceed 500 pounds (227 kg).

Including its trucks, no car shall differ in weight:

1. from any other car of the same type (A vs. A or B vs. B) by more than 1,600 pounds (728 kg), nor
2. from the cumulative average weight of all cars of that type by more than 800 pounds (364 kg).

Weights of individual trucks, when fitted with only the truck-mounted equipment common to all trucks, shall not differ one from the other by more than 1 percent of the cumulative average weight of all trucks so equipped.

Weights of individual trucks fitted with equipment not common to all trucks (e.g., handbrake rigging) as well as with equipment common to all trucks, shall not differ from the weight of any truck fitted only with common equipment by more than 1-1/2 percent of the cumulative average weight of all trucks fitted only with common equipment.

D. Car Weight Records (CDRL)*

1. General The contractor shall maintain for each car produced a cumulative record of estimated and actual car weight and balance (center of gravity) data for the purchaser's inspection throughout the car design and manufacturing phases.

Prior to the first design review, the contractor shall submit:

- a. A proposed data record format
 - b. Initial weight and balance estimates
 - c. A proposed procedure for ensuring control of car weight and balance and the location of car-mounted equipment.
2. Record Content The record shall contain as a minimum for each car type:

*CDRL = Contract Data Requirements List

- a. Sum of estimated carbody and car-mounted equipment weights
- b. Location of equipped carbody center of gravity (CG) with indicated location of car shell CG, and the CG's of individual major equipment relative to longitudinal and transverse geometric centerlines of the finished carbody
- c. Magnitude and locus of the center of the carbody load applied to each truck centerplate relative to longitudinal and transverse geometric centerlines of the finished carbody
- d. Weight and CG of each truck as equipped for revenue service
- e. Weight supported by the rail under each wheel
- f. Sum of all wheel loads
- g. Contract empty car weight
- h. List of actual car weights by car-type and car number
- i. Cumulative average car weight by car-type
- j. Graphic comparison of cumulative average car weight with individual car weight by car number for each car type

These data shall be updated and revised throughout the car design and manufacturing phases as calculated weights and actual weight data become available, and shall be submitted to the purchaser at each design review.

A certified weight ticket showing car-type, car number, and delivered car weight shall be presented by the contractor to the purchaser with each car at the time of delivery. Each certified weight ticket shall become part of the permanent record for that car.

3.3 CAR PERFORMANCE PARAMETERS

3.3.1 GENERAL

This subsection details those propulsion and braking requirements which together determine the car performance.

3.3.2 RATING CONDITIONS

The car shall be capable of operation at continuous line voltages as specified in Appendix A, A.2.4, but not outside of the range specified by IEEE Standard No. 11 for the specified nominal voltage. Two continuous thermal ratings are required as specified below:

A. Normal Rating

The continuous thermal rating of the propulsion and friction brake systems shall be based on the most severe duty cycle for a dependent-pair of cars as specified in Appendix A, A.4. The propulsion motor temperature rise for this rating shall be limited to the allowable temperature rise of the next lower insulation class below the full insulation class used in the motor insulation system.

B. Abnormal Load Rating

The continuous thermal rating of the propulsion system shall

be based on the propulsion systems being fully operational on six cars in an eight-car train. The traction motor rating shall be based on the temperature rises allowed for the motor's full insulation class, but in no case less than Class H temperature rise. If a system meeting 3.3.2A requirements were to exceed the full insulation class temperature rises, electric brakes may be cut out or other reduced performance options may be utilized to restrict temperature rises to within the allowable full class values. Test data verifying thermal characteristics shall be provided to the purchaser together with test results of system heating and cooling performance (CDRL).

A train of any size shall be capable of pushing or pulling a dead train of the same size to the next terminal at a reduced performance level. Passengers shall be unloaded from the dead train at the next station.

C. Dead Train

A dead train is defined as one on which every car is unpowered; i.e., has no functioning propulsion and braking subsystem.* Auxiliary subsystems may or may not be functional.

D. Revenue Service Train Sizes

The largest revenue service train shall consist of four dependent-pairs. Compliance with car performance requirements shall be demonstrated with a standard unit train.

E. Friction Brake Thermal Rating

The friction brake subsystem shall have a continuous thermal

*In this core specification, propulsion and braking together constitute a discrete subsystem.

rating to provide all braking for a dependent-pair for one complete round trip at AW3 weight of the propulsion load profile of Appendix A. The electrical brake shall be assumed to be nonoperational throughout this period.

● 3.3.3. REQUIREMENTS

A. General

The specified acceleration, deceleration, and speed shall be met with both new and fully worn wheels.

B. Acceleration, Tractive Effort Commands

Within the jerk rate and dead time limits specified in 3.3.3E and F, the propulsion subsystem shall provide an initial acceleration rate of 2.5mphps (4kmhps). This rate shall be constant from zero speed to the corner point speed specified as follows: * _____; be based on the duty cycle and running time requirements in Appendix A, and consistent with specified compatibility requirements.

The performance specified in Figure 3-3 shall be achieved with a dependent-pair at all weights up to AW2, on level tangent track, and at all voltages between 600 VDC and 675 VDC, as measured at the knife switch.

* Purchaser completing detail

FIGURE 3-3. CAR PERFORMANCE

<u>Minimum Achieved Speed</u>		<u>Maximum Time to Achieve (Seconds)</u>
<u>mph</u>	<u>kmh</u>	
15	24.1	6
25	40.2	11
35	56.3	18
50	80.4	48
70	112.0	110

C. Deceleration, Service Braking

1. Blending Car retardation shall be accomplished by the coordinated efforts of the electrical and friction brake subsystems. Braking rates shall be equal to the P-signal command within the tolerances listed herein.

The P-signal may call for any level of deceleration from zero to the full service brake level. At a car weight greater than AW2, or under conditions which could result in the inability of the electric brake to provide the deceleration rates commanded by the P-signal, the friction brake shall be blended on a per-car basis to provide the requested deceleration rate.

2. Feedback Signal Electrical brake feedback to the blending circuit shall be a signal representative of actual electrical braking effort. The brake blending circuit shall provide an output signal as defined in Section 14.2.6.

3. Deceleration Rates The blended deceleration rates specified in Figure 3-4 shall be available at all weights up to and including AW3.

FIGURE 3-4. BLENDED DECELERATION RATES

Train Speeds	Average Instantaneous Deceleration Rates
70 mph (112 kmh)	2.0 mphps (3.2 kmhps)
70 mph to 50 mph (112 kmh to 80 kmh)	Linear increase from 2.0 mphps to 3.0 mphps (3.2 kmhps to 4.8 kmhps)
50 mph to zero (80 kmh to zero)	3.0 mphps (4.8 kmhps)

Note: Rates specified include train resistance

The average deceleration rate (V/T) achieved, measured from the time a brake call is initiated shall not deviate more than 7 per cent from the requested rate. Peak rates shall not deviate more than 10 percent from the requested rates.

4. Friction Brakes only The deceleration rates listed herein shall be available with the electric brakes inoperative. For all stops above 15mph (24 kmh) made with friction brake only, the average deceleration rate (V/T) achieved shall not deviate more than 20 percent from the requested rate. Peak rates shall not deviate more than 35 percent from the requested rates.

5. Electrical Brakes For cars at any weight up to and including AW2, the deceleration rates listed herein shall be required from the electrical brakes, except at speeds below the electrical brake fadeout speed.

D. Emergency Braking

Under emergency braking conditions, any size train shall maintain an irretrievable braking rate at car weight AW3 as follows:

<u>Initial Speed</u>	<u>Average Deceleration*</u>	<u>Distance to Stop</u>
40 mph (65 kmh)	3.2 mphps (5.2 kmhps)	370-425 feet (113-130 m)
70 mph (223 kmh)	2.4 mphps (3.9 kmhps)	1,700-1,924 feet (518-587 m)

The braking rate specified includes train resistance. Use of the emergency-stop mode of train control shall disable the jerk rate limitation subsystem.

Emergency brake application shall involve only the friction brake system.

E. Speed Limits

When operating in the manual cab signal (MCS) mode, a standard unit shall be capable of maintaining a continuous speed of 70 mph (112 kmh) on level tangent track. When operating in the road manual mode, a standard unit shall be limited to a maximum speed of 50 mph (80 kmh).

* Average deceleration = Initial speed divided by time from BRAKE signal to time of stop.

When operating in the yard manual mode, a standard unit shall be limited to a maximum speed of 15 mph (24.1 kmh). When operating in the carwash mode, maximum continuous speed shall be 3 mph (4.8 kmh).

F. Response Time

Maximum response time from a step change of command signal until the beginning of traction motor armature current change, not including jerk limit, shall be:

- Effort Modulation 0.2 seconds
- Mode Change 1.0 second

Note: Traction motor armature current rather than motor torque is referenced. Since current is readily measurable and a direct indicator of torque current was chosen as the basis for time measurement.

G. Jerk Limits

The rate of change of acceleration or deceleration shall be 2.5 mphpsps (4.0 kmhpsps). The tolerance of this limiting value shall be from minus zero to plus 0.4 mphpsps (0.64kmhpsps). Jerk shall remain within the specified limits during the time period commencing with the initial acceleration/deceleration changes until 90 percent of the requested acceleration/deceleration has been achieved.

Failure of the jerk limiting system shall not reduce the maximum available braking effort, or time to achieve it.

H. Operating Profile

The car performance shall be based on the operational profile information provided in Appendix A.

3.3.4 ENERGY CONSUMPTION

Energy consumption shall be determined based on operation over the average route profile as specified in Appendix A, and shall be tested as specified in Section 20.4.1.3.

3.4 PASSENGER COMFORT ENVIRONMENT

3.4.1 GENERAL

This subsection details the requirements for noise control, shock and vibration control, temperature and humidity, ventilation, and lighting to specify the parameters within which the car shall be constructed to provide a comfortable passenger environment.

3.4.2 NOISE CONTROL

A. General

Equipment, parts, and components shall be designed to eliminate rattling and audible resonance at speeds up to 10 percent above normal top running speed. All noise levels specified herein are:

- expressed in decibels, referred to as 0.0002 microbar (20 micropascals), and

- the A-weighted levels in decibels (abbreviated dBA) as defined in ANSI Standard S1.4-1971, Specifications for Sound Level Meters.

Unless otherwise specified, the slow meter response time or its equivalent shall be used. For measurements under steady operating conditions, the period of observation shall be at least 5 seconds. The median sound level observed shall be reported.

B. Noise Limits

1. Environment Noise criteria specified herein shall be measured in an essentially free-field environment; i.e., out-of-tunnel and away from any reflective surfaces other than the ballast and ties trackbed upon which the car shall be parked and the adjacent flat, clear ground.
2. Auxiliary Subsystems For the purpose of car noise measurements, an auxiliary subsystem is defined as: any mechanism or structure, other than the body, traction motor, or propulsion system gearing, which performs a function at some time during the operation of the car. Auxiliary systems shall include/but not be limited to:
 - a. Propulsion subsystem cooling blowers
 - b. Heating and air-conditioning subsystems
 - c. Propulsion control subsystems
 - d. Braking subsystems
 - e. Door Operators
 - f. Auxiliary power subsystems
 - g. Other motors, converters, inverters, air compressors, hydraulic power units, blowers, fluorescent lamps, and ballasts.

Noise created momentarily by trip cocks shall not be included in any car noise measurements. Brake vent valves, dump valves, and automatic drain valves shall be muffled during testing.

3. Noise Level Limits

a. General

Noise levels shall be in accordance with the American Public Transit Association, 1979 Guidelines For Design of Rapid Transit Facilities, as specified in Figure 3-6.

b. Testing

These requirements shall be demonstrated in a reproducible standard test environment at a common site to be designated by Transit Industry Consensus. All new rapid railcar designs shall be tested for noise level compliance in the standard environment.

The noise levels demonstrated at the common test site may not be achievable on the purchaser's property because of the unacceptable costs required to modify the existing infrastructure.

FIGURE 3- 5. NOISE LEVELS

1.	<u>Interior Noise Levels - No Passengers in Car:</u>	<u>Maximum Noise Level (dBA)</u>
	In open (ballast and ties) at maximum speed on welded rail (+5 dBA on jointed rail)	70
	In open (concrete trackbed) at maximum speed	74
	In tunnel at maximum speed	80
	Each individual auxiliary operating, car stationary	68
	One auxiliary system operating, car stationary	65
	Door operation	72
2.	<u>Vehicle Exterior Noise Levels</u> 50 feet (15m) from track center- line in open with no reflecting surfaces within 100 feet (30m) of test location:	
	Car stationary, all auxiliaries operating	60
		<u>Ballast and Ties</u> (fast meter responses)
		6-or
		<u>2-cars 4-cars 8-cars</u>
	train operating at 60 mph (96 kmh)	80 82 83
		<u>Concrete Trackbed</u> (fast meter responses)
		6-or
		<u>2-cars 4-cars 8-cars</u>
	train operating at 60 mph (96 km)	85 87 88
3.	<u>Vehicle Equipment Noise</u> <u>Levels</u> (15 feet (4.5m) from car centerline):	<u>Maximum Noise</u> <u>Level (dBA)</u>
	a. Vehicles with self-venti- lated motors:	
	Propulsion system at equivalent to 60 mph (96 kmh)	84
	b. Vehicles with ducted ventilation to propulsion motors:	
	Propulsion system at equivalent to 60 mph (96 kmh)	78
	c. All vehicles:	
	Full service brake operation	75
	Car stationary, auxiliary equipment operating	68
	Decrease in allowable levels for presence of pure tones	3

4. Distinctive Car Interior Noise and Pure Tones Any identifiable, distinctive noise; such as, rasping, grinding, banging, knocking, rattling, and rapping, as measured at a distance not greater than 6 feet (1.83m) from the apparent noise source, shall be at least 5 dBA below the noise level from car equipment or car operation in the absence of the identifiable, distinctive noise, or shall not exceed 5 dBA below the specified noise level, whichever is lower. Any pure tone or narrow-band tonal noises inside the car, as measured at a distance not greater than 6 feet (1.83m) from the apparent noise source, shall be at least 5 dB below the noise level from equipment or car operation in the absence of the pure tone, as measured by using a 1/3-octave bandwidth filter, or shall not exceed 8 dBA below the specified noise level, whichever is lower.

5. Exterior Noise Measurement Microphones shall be located at the plane of the axles 50 feet (15.2 m) from the track centerline on each side of the car. Exterior noise, with the car moving or stationary, shall be measured at a section of standard, at grade, ballast and the ties trackbed which shall be free of railings, sound barriers, and other wayside obstructions extending above the elevations of the bottom of the rail between the car and the microphones.

6. Carbody Transmissions Loss The sound transmission loss of the carbody, floor, wall, and ceiling assemblies in completed form shall be adequate to achieve the specified interior noise level limits.

3.4.3 INTERIOR VIBRATION LIMITS, ALL EQUIPMENT INSTALLED

With the car stationary and with each individual auxiliary unit or other vibration-generating equipment operating, the vertical or horizontal vibrations at the floor, walls, seat frames, or any surface with which the passengers or the operator can come into contact shall not exceed the values specified in Figure 3-7. This requirement shall also be met with all auxiliaries operating simultaneously.

FIGURE 3-6. CAR INTERIOR VIBRATION LIMITS

<u>Frequency, f(Hz)</u>	<u>Peak Acceleration (g's)</u>
Zero to 1.4	0.0051 f ² 0.1 inch (2.54 mm) Peak-to-peak displacement
1.4 to 20	0.01
Above 20	0.0005 f 0.03 inch (.76 mm) per second peak velocity

● 3.4.4 WAYSIDE GROUND VIBRATION

Measurements of and limitations on groundborne vibrations created by train operations shall be accomplished in accordance with the following requirements: * _____

3.4.5 TEMPERATURE AND HUMIDITY

The car and all carborne equipment shall be capable of being operated, sorted, and maintained at the specified performance levels without impairment resulting from the natural or induced environment within which the purchaser intends to operate these cars in revenue service as specified in Appendix A.

3.4.6 VENTILATION

Filtered ventilation air at a maximum rate of 1,008 cfm ($.47\text{m}^3/\text{s}$) shall be distributed within the passenger compartment and the operator's cab at all car speeds from 0 to 70 mph (0 to 112 kmh). Interior air used for recirculation purposes shall also be filtered. Contaminant retention capabilities of the filters or filtering method used shall have an equivalent weight efficiency of 80 percent, minimum, as established by the Air Conditioning and Refrigeration Institute Standard 680 and ASHRAE Standard Number 52-68.

Ventilating fans shall operate when there is neither heating nor cooling during ascending temperatures of the car return air from 57 to 76 degrees F (14 to 24 degrees C)

* Purchaser completing detail

and during descending temperatures from 73 to 57 degrees F (23 to 14 degrees C). The ventilating fans shall operate continuously during the heating, ventilating, and air conditioning cycles, except for layover heat.

3.4.7 LIGHTING

As specified in Section 8.3.

● 3.5 SHOCK AND VIBRATION CONTROL

A. Carbody-Mounted Equipment

Components mounted on the carbody shall be designed and mounted to withstand continuous sinusoidal vibration, independently applied along the three major axes, or 0.2g rms input if the natural frequency of the component is less than 20 HZ, and 0.2g rms response if the natural frequency is above 20 Hz. They shall also be designed to withstand independently applied half-sine shock impulses. The number of applications shall be as specified in Section 20.4.1.8.

The nominal stress in any member based on its net cross section shall not exceed the endurance limits of the material. Equipment attachments may yield but not rupture. Different components inside the equipment shall remain contained within the equipment itself.

B. Truck Frame-Mounted Equipment

Components mounted on the truck frame shall be designed and mounted to withstand, without fatigue or deterioration of structural integrity or operational reliability for the

30-year design life of the car, the normally occurring shock and vibration levels with load AWO presented by the support points on the truck frame. The normally occurring shock and vibration levels are as follows:* _____

The components shall be designed to withstand, without exceeding endurance limits, independently-applied minimum vibratory response which has been measured to be:* _____
The loads due to driving or braking motor torques shall be considered in each case.

Components mounted on the truck frame more than 1 foot (305 mm) away from the journal bearings shall be designed to withstand the independently-applied shock response loads which have been measured to be:* _____ The nominal stress in any member based on its net cross section and due to these shock loads or a motor flashover, shall not exceed the endurance limit of the material. Truck design shall not impose any load on equipment they cannot withstand. The equipment attachment may yield but not rupture.

C. Axle-Mounted Components

Axle-mounted equipment shall be designed to withstand, without exceeding endurance limits, vibratory response loads and shock response loads which have been measured to be * _____ The nominal stress in any member, based on its net cross section shall not exceed 50 percent of the material yield strength when subjected to the specified shock loads.

* Purchaser completing detail

3.6 SYSTEMS ASSURANCE REQUIREMENTS

3.6.1 GENERAL

This subsection details those design and manufacturing considerations which together influence the system integrity of the rapid railcar defined by these technical specifications.

3.6.2 DESIGN REVIEW DECISION

A. Issues

At each design review, as specified in Section 19.3.2 the contractor shall provide the purchaser with the status of the car system with respect to the compliance of the following aspects of design with specification requirements (CDRL):

1. Industrial Design Exterior and interior appearance and aesthetics, including lighting, as specified in Section 3.6.3.
2. Human Factors Engineering All interfaces between car or its equipment and passengers (including elderly and handicapped), operators (both male and female), and maintainers (both male and female) as specified in Section 3.6.4.
3. Equipment Interchangeability As specified in Section 3.6.5.
4. Reliability Including failure and degraded modes, probabilities and effects, and verification procedures as specified in Section 3.6.6.

5. Maintainability Including repairability as specified in Section 3.6.7.
6. Safety Hazard identification, evaluation, and mitigation and emergency procedures; such as, evacuation of handicapped, elderly, and injured passengers as specified in Section 3.6.8.
7. Producibility and Quality Including an explanation of procurement, materials, manufacturing and assembly processes, quality, quality standards, quality controls, and quality audit at contractor and subcontractor levels.
8. Documentation and Administration Including a description of the paperwork and procedures to be used for developing, recording, controlling, and correcting information required for design, procurement, manufacture, test, delivery, operation, and maintenance of the cars. This description shall include, at appropriate points in the design review cycle, submittal of sample documents for drawings, vendor and test specifications, quality manuals, manufacturing process sheets, operating and maintenance manuals, design changes, correction of defects and discrepancies, material review, etc.

B. Master Car Design Plan (CDRL)

The contractor shall prepare and submit to the purchaser a Master Car Design Plan (MCDP). The MCDP shall provide an overview and integration of individual plans describing the car as an entire system.

3.6.3 INDUSTRIAL DESIGN

The contractor shall prepare, for purchaser review and comment an Industrial Design Plan (IDP) (CDRL) which shall include all elements requiring appearance, performance, and human engineering interfacing for a car system which is functional, aesthetically pleasing, safe, and maintainable with the purchaser's existing resources and capabilities.

The contractor shall coordinate the following elements of the Industrial Design Plan:

- a. Selection of materials and finishes in accordance with the performance requirements specified in Section 6 and with purchaser preferences
- b. Lighting requirements as specified in Section 8.3
- c. Human factors engineering requirements for the operator, passengers (including elderly and handi-capped) and maintenance personnel, as specified in Section 18.2
- d. Development of mockups, as specified in Section 5

Industrial design reviews shall include a preliminary design presentation and in-progress and final reviews of the mockups.

3.6.4 HUMAN FACTORS ENGINEERING (HFE)

Human factors engineering shall be applied to the design and development program to ensure the development of a reliable, efficient, and safe interface between the person

(as operator, maintainer, and passenger) and the equipment. Human engineering design criteria in MIL-STD-1472 and AFSC DH-1-3 shall be used as guides for equipment design, installation, and maintenance.

A. HFE Guidelines-Passengers

Factors which shall be considered include, but shall not be limited to the following:

- Day/Night Visibility
- Emergency Visibility and Equipment
- Graphics
- Ingress/Egress Provisions (Emergency)
- Ingress/Egress Provisions (Normal)
- Noise Control
- Seating Comfort
- Security
- Temperature and Ventilation
- Standing Security
- Passenger Safety

B. HFE Guidelines-Elderly and Handicapped

For the elderly and handicapped, the following additional factors shall be considered:

- Wheelchair-compatible door openings, aisleways, and seating arrangement
- Door entry and egress identification, including audible and visual signals
- Public address and passenger-crew intercom subsystem

- Stanchions and seat-back handles
- Frequencies not irritating to humans or canines.

C. HFE Guidelines - Operator

For the operator, the following additional factors shall be considered:

- Windshield size and angle
- Side window sizes, configurations, and operability
- Operator's console, controls, and indicators
- Operator's duties and possible concurrent action demands
- Operator's seat
- Operator's awareness assurance provisions
- Auxiliary equipment and controls
- Emergency equipment

D. HFE Guidelines - Maintainer

For maintenance personnel, the following additional factors shall be considered:

- Working space
- Equipment arrangement, accessibility, and modularity
- Elimination of sharp edges
- Sill steps, grab irons, and ladder
- Safety notices
- Electrical covers

3.6.5 EQUIPMENT

All equipment and replaceable components within this equipment shall be physically interchangeable between cars and shall be safely hung and protected by captive covers where covers are required.

Designs shall be such that all equipment and all replaceable components of each equipment-type shall, after calibration, be interchangeable between cars without causing greater than 2 percent change in carborne system characteristics; except that compensation for resistance, capacitance, and impedance variations in transducers, sensors, coils, and windings that are external to the equipment may be accomplished by use of variable trimming components which shall be mounted on the equipment chassis and component boards.

All interchangeable modules and component boards, where appropriate, shall be mechanically keyed in such a manner as to make impossible insertion into other than its correct location on the proper chassis.

3.6.6

RELIABILITY

The reliability terminology used in this specification conforms to the definitions in the American Public Transit Association, Feb. 1978 publication, Rapid Transit Systems Glossary of Reliability, Availability, and Maintainability Terminology for Rail Rapid Transit, which defines reliability as the probability that a system or system subunit will perform satisfactorily for a given period of time when used under stated conditions.

A. Verification (CDRL)

The contractor shall demonstrate during the warranty period achievement of the mean time requirements specified herein by both analysis and demonstration testing. Verification shall be based on the procedures and techniques specified in Section 18.3 and the results of the demonstration specified in Section 20.4. The analysis of Section 18.3 and the results of the Section 20.4 demonstration shall be compared,

and deviations, at the subsystem levels of Figure 3-8, shall be rationalized and presented to the purchaser.

FIGURE 3-7. SUBSYSTEM RELIABILITY REQUIREMENTS
(Single Car Values)

Subsystem	Cumulative MTBF (hours)
Coupler	6,210
Heating and Air Conditioning	2,430
Communications	2,115
Truck & Suspension	1,170
Door	1,665
Auxiliary Electric	1,485
Friction Brake	1,980
Carbody	585
Propulsion	540
ATC	5,000

B. Subsystem Reliability Requirements

The minimum reliability established for each major subsystem within the car are shown in Figure 3-8. A subsystem, as used in this context, is a complete set of equipment which together comprises the respective subsystem; e.g., two truck assemblies, eight complete door assemblies. Generic parts for the subsystems listed in Figure 3-8 are as specified in Appendix B, Task 3, Transit Vehicle Equipment Lists, TRIP.

Any car operating as part of a multiple car consist must meet or exceed 150 hours MTBF.

C. Transit Reliability Information Program (TRIP)

The UMTA Transit Reliability Information Program (TRIP) uses a Generic Part Number (GPN), a twelve-character code which provides a universal, computer-recognizable identity for components which are used on more than one car design, but which perform equivalent functions. TRIP also uses a seven-character Generic Serial Number (GSN) to uniquely identify: Transit Authority, car-type, and car number.

Together, the GSN and GPN describe specific, as opposed to generic, equipment applications.

The contractor shall generate a GPN for each component of the car. This set of GPN's shall then be made available for reliability analyses of and comparisons with equivalent components and assemblies having known field histories.

Additional information concerning the TRIP Program, the GPN, and the GSN can be obtained by contacting the:

TRIP Program Manager, Code 722
Office of Ground Systems Center
Transportation Systems Center
Kendall Square, Cambridge, MA 02142

3.6.7 MAINTAINABILITY REQUIREMENTS

The following maintainability requirements have been established for the car:

- Mean-Time-To-Repair (MTTR) The time required to restore a car to ready-for-service status following a malfunction shall not exceed 2 person-hours, excluding the time required to move the car to the shop. The maximum corrective maintenance time (M max .90) shall not exceed 4 hours.

- Elapsed time to perform scheduled maintenance, including replacement of consumables, on the car shall not exceed 4 person-hours. Scheduled maintenance shall not be required more often than one event in 10,000 miles (16,093 km).
- Subsystem corrective maintenance requirements are shown in Figure 3-9.

FIGURE 3-8. SUBSYSTEM CORRECTIVE MAINTENANCE PROCEDURES
(Single Car Values)

Subsystem	MTTR (hours)	Mmax .90 (hours)
Coupler	2.20	4.86
Heating and Air Conditioning	1.60	3.54
Communications	1.50	3.32
Truck and Suspension	1.47	3.25
Door	0.50	1.10
Auxiliary Electric	1.50	3.32
Friction Brake	1.00	2.21
Carbody	1.50	3.32
Propulsion	2.50	5.53

3.6.8 SAFETY

A. Hazard Categories

- Category I - Negligible Shall not result in personal injury or system damage
- Category II - Marginal Can be counteracted or controlled so that no injury to personnel or major system damage shall be sustained

- Category III - Critical Will cause personal injury or major system damage or both
- Category IV - Catastrophic Will cause personnel fatality

These four hazard categories provide qualitative measures of the worst potential consequences resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, or system, subsystem, or component failure. In addition, hazards to public and private property and equipment other than the transit authority (non-system) shall be identified.

B. System Safety Program Functional Requirements

The goal of the contractor's car system safety program shall be to eliminate all Category II and IV single-point hazards and control Category I and II hazards identified in the Safety Engineering Analysis specified in Section 18.5. This level of safety shall apply under the complete range of track and environmental conditions specified for:

- Personnel boarding, alighting from, and aboard the car
- Personnel in the immediate vicinity of the car and its associated auxiliary and support equipment
- Personnel operating, testing, and maintaining the car
- Transit Authority-associated and privately-owned equipment and facilities in the immediate vicinity of the car and its associated auxiliary and support equipment

C. System Design Features

No single failure of a dynamic element shall result in a Category II or IV hazard. Dynamic elements shall be fail-operational/fail-safe. These conditions are defined as follows:

- Fail-Operational The first failure shall result in remaining operational (although possibly degraded) and remaining safe (acceptable hazard rate).
- Fail-Safe The second failure shall result in remaining safe. Where redundancy is employed to satisfy a safety critical function, the methods employed shall be totally independent to preclude both modes failing from a common cause. In addition, a failure in any mode shall be capable of being detected.

The car system design shall also incorporate:

- Hazard isolation features to contain the effect of any hazardous event as close to the source as possible
- Means to verify safe system and auxiliary system performance and operation, including redundancy
- Component interlocks in those instances wherein out-of-sequence operation could result in a hazard
- Provisions for connector/connector pin/multiplexer channel allocation such that no single loss of same could disable safety critical functions

D. Fire Safety

The car system design shall be as specified in accordance with the fire safety requirements stated in Section 6.9.

SECTION 4
CAR SUBSYSTEM INTERFACE DETAIL



SECTION 4

CAR SUBSYSTEM INTERFACE DETAIL

● 4.1 GENERAL

Purchaser Specification Drawing * _____

● 4.2 TRAINLINE FUNCTIONS (CAR-TO-CAR INTERFACE)

Purchaser Specification Drawing * _____

4.3 ELECTROMAGNETIC COMPATIBILITY

4.3.1 PURPOSE

The contractor shall submit the proposed electromagnetic compatibility (EMC) control method to the purchaser for review and comment prior to the first design review. The contractor shall ensure that proper emphasis shall be placed on, and that adequate attention shall be given to, interface control from the earliest stages of car design. (CDRL)

● 4.3.2 ELECTROMAGNETIC INTERFERENCE

The contractor shall ensure that the electrical, electronic, and communication subsystem shall operate in the operational environments described as follows: * _____ without suffering or causing harmful interference because of electromagnetic radiation or response. The contractor shall control the electromagnetic radiation and the susceptibility of purchased and subcontracted equipment and components,

* Purchaser completing detail

and shall install and progressively test the various sub-systems to demonstrate protection against false energy mis-codes and improper codes. Testing for these purposes shall be performed under the fault conditions described as follows * _____

Radiated interference levels as shown in Figure 4-1 or as specified as follows: * _____ shall be observed as limiting values.

These limits shall not be exceeded when measured at a distance of 100 feet (30.4 m).

● 4.3.3 INTERFACE COMPATIBILITY

All equipment shall be protected from damage due to the electrical line transients specified as follows:

* _____ The contractor shall, at designated design reviews, demonstrate analytically the capability of the total car system with the purchaser's operating environment. The contractor shall develop design criteria limiting equipment-generated voltage transients for assuring equipment tolerance of such transients. The considerations necessary to evaluate the functional interfaces between subsystems shall include (CDRL):

- Power source levels and variations
- Load and source impedance
- Grounding and continuity
- Subsystem controls

* Purchaser completing detail

Interfaces between the total transit car system and its operating environment shall include:

- Types of communications
- Physical constraints upon radio communications
- Communication range requirements
- Train control subsystem
- Car-to-wayside communications
- Car-to-car communications

4.3.4 RIPPLE CURRENT

The maximum line ripple current conducted to the contact rail over the frequency range of 200 to 10,000 Hz shall not exceed ± 5 percent rms of the total line current drawn by the car.

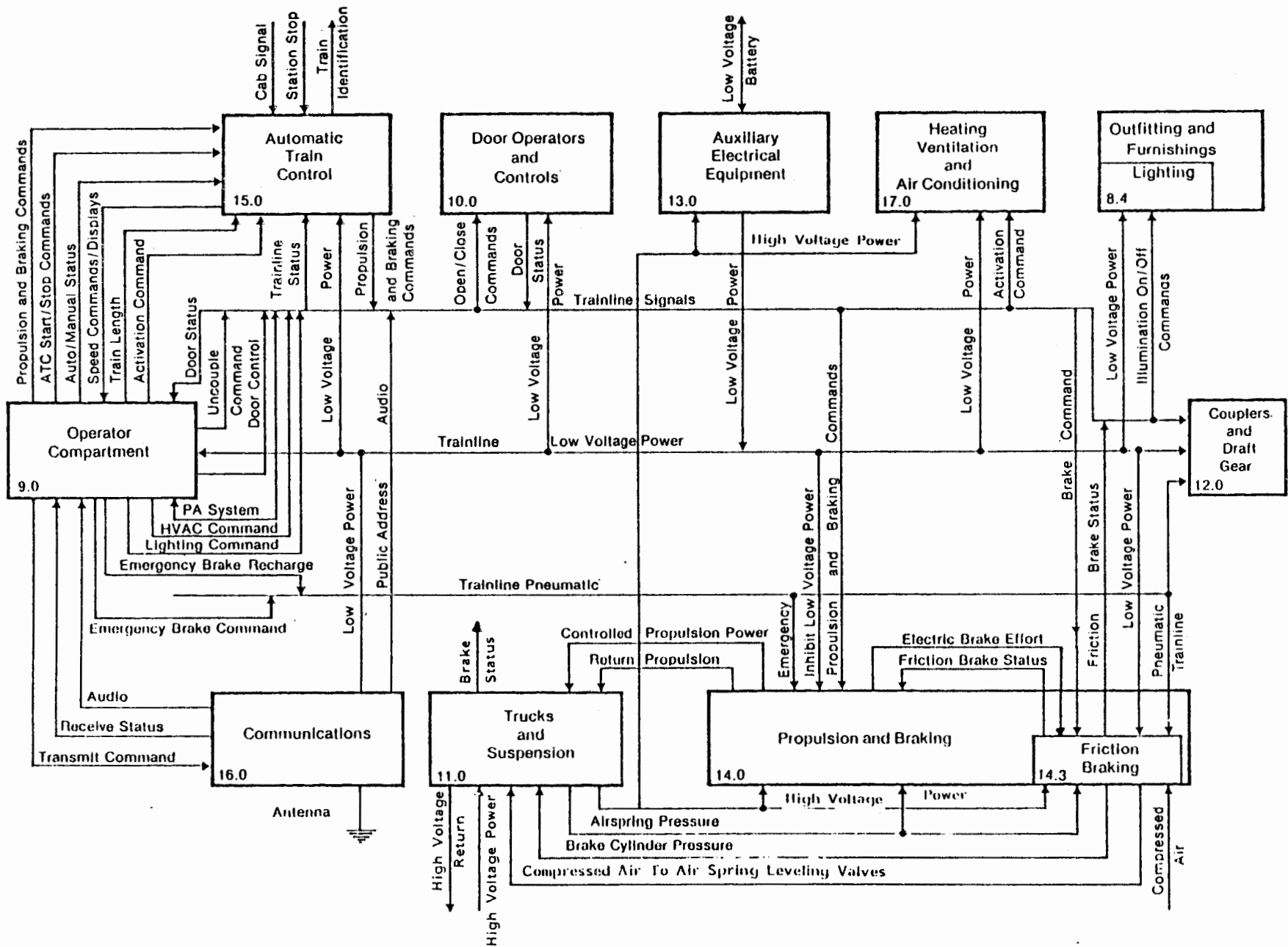
4.3.5 TRANSIENT LINE VOLTAGE GENERATION

All suppliers of subsystems using 600 VDC auxiliary motors in which such motors are compound wound and thus have a shunt field shall prevent the regeneration of hazardous voltages into the contact rail intended to be dead.

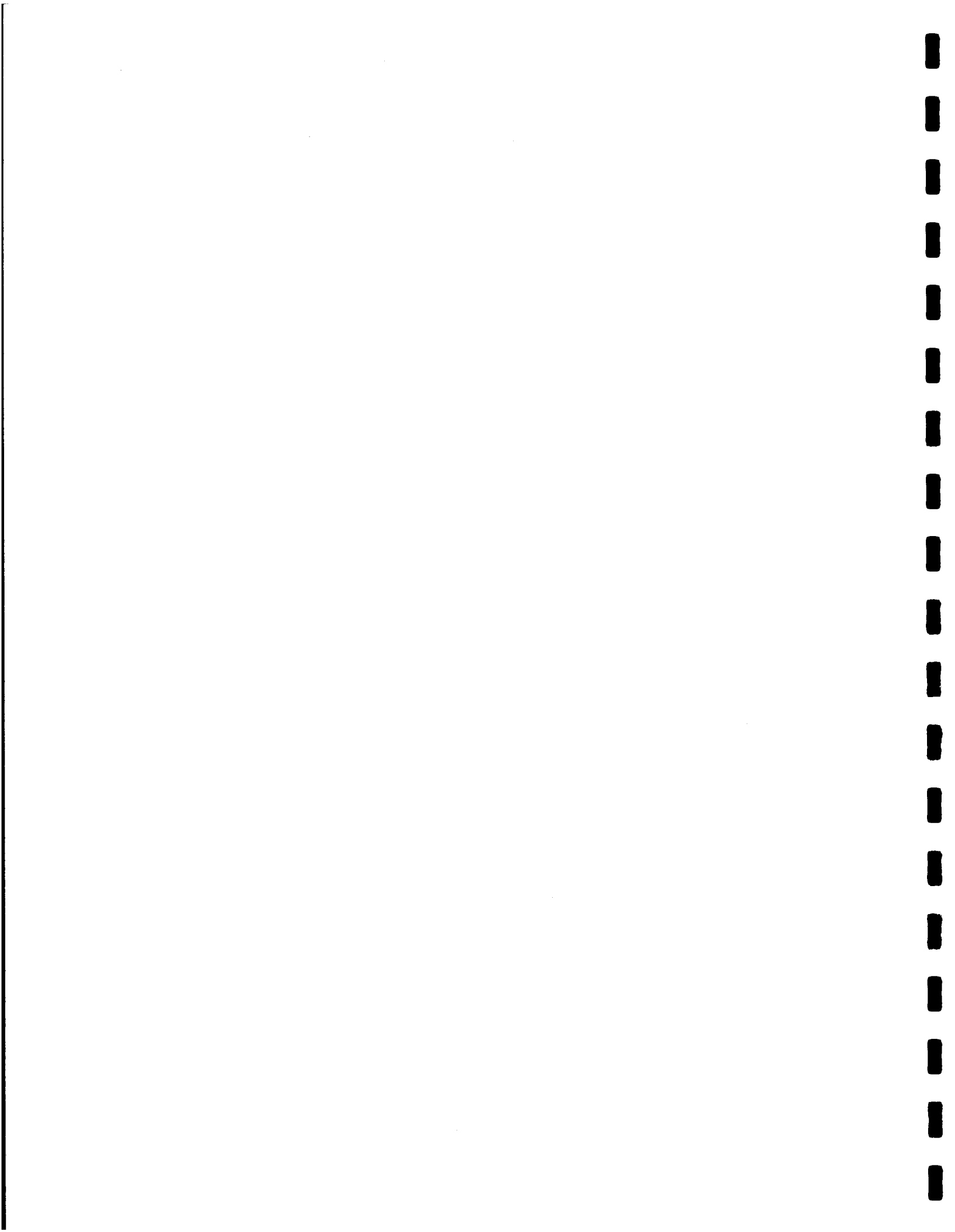
4.4 SUBSYSTEM INTERFACE DETAIL

See Figure 4-1.

FIGURE 4-1. SYSTEM INTERFACE DETAIL



SECTION 5
MOCK-UPS AND SAMPLE CARS



SECTION 5

MOCK-UPS, MODELS AND SAMPLE CARS

● 5.1 MOCK-UPS OR MODELS

The contractor shall construct those mock-ups or models specified as follows: * _____ The contractor shall commence construction of the mock-ups or models immediately following purchaser review of preliminary engineering layout and arrangement drawings, and shall maintain the mock-ups and models updated in accordance with the latest review by the purchaser. Those mock-ups specified as follows:

* _____ which shall be required for training aids shall be constructed for long life and serviceability, and shall be delivered to the purchaser when the contractor commences full production. All other mock-ups or models shall remain in the possession of the contractor until they shall no longer be required for manufacturing purposes, at which time they shall become the property of the purchaser. At that time the purchaser will provide disposition instructions to the contractor.

● 5.1.1 PRELIMINARY DESIGN MOCK-UPS OR MODELS

A. Mock-ups

Mock-ups shall be constructed for the purpose of evaluating preliminary design work, spaces, and interfaces and providing for early identification of potential problem areas and development of alternative solutions. Foam-core or similar

* Purchaser completing detail

materials shall be used together with wood or similar materials to assure mock-up structural integrity. Mock-ups shall detail the following areas:

- Operator cab
- Typical passenger areas, including operating side door subsystem
- Undercar equipment layouts, including a truck
- Ceiling area under evaporators
- Conductor's work station

The mock-up construction techniques shall permit modifications thereto, quickly, easily, and economically following purchaser reviews.

B. Models

The contractor may construct scale models in lieu of preliminary design mock-ups as specified herein * _____

C. Reviews and Tests

The mock-ups and/or models shall be available for sample car design decisions, for in-progress in-production reviews, and for tests and evaluations. The purchaser will review the mock-ups and/or models. (CDRL)

* Purchaser completing detail

5.1.2 SPECIFICATION COMPLIANCE MOCK-UPS

Precise mock-ups shall be constructed by the contractor from arrangement drawings and engineering layouts to demonstrate specification compliance. The mock-ups shall be transportable, shall be constructed of materials which shall assure dimensional and functional accuracy including wall and material thicknesses, and interfaces, and shall permit demonstration of fastening methods.

To demonstrate specification compliance, design practices, and material selection, emphasis shall be placed on the following design criteria:

- Optimal space utilization
- Observance of, and provisions responsive to, purchaser's site clearance constraints
- Subsystem and components interfacing, integration, and interchangeability
- Human factors; i.e., all aspects related to passengers, including elderly and handicapped, and operating and maintenance personnel
- Safety
- Maintenance, accessibility, and serviceability
- Industrial design, including materials selection and finishes

Where practicable, actual hardware and components shall be used. In all other instances, the appearance and function of each component shall be clearly demonstrated by employing graphic techniques.

A. Operator's Cab

The mock-up of the operator cab shall realistically duplicate the location and arrangement of the control console and all its components. The cab shall include all components described in Section 9.3.

B. Car Front End

The contractor shall construct a full-size mock-up of the car front end for the purpose of defining and evaluating design integration, interfaces, and shapes. The mock-up shall also demonstrate all concepts of the purchaser.

C. Passenger Area

Passenger area mock-ups shall represent car seating and interior design. Modular, less than full car length, but full width versions of typical car passenger areas shall be acceptable. Each shall include all of the subsystems and components that are part of the car. A minimum typical arrangement shall include the following items:

- Accommodations for wheelchair patrons
- Air diffusers

- All equipment and components located in the passenger area
- End door
- Conductor's work station
- Grab handles and stanchions
- Interior hardware such as door knobs, latches, locks, handles
- Interior liners, window masks, and heater grilles
- Map holders, ad card holders, and destination signs
- Operable lighting assemblies
- Seating on both sides of the car, longitudinal and transverse
- Side door and the passenger area served
- Windscreens

The mock-up shall also be used for measurement of lighting brightness ratio as specified in Section 8.

D. Side Door

The contractor shall construct a full-size mock-up of a side entrance door. Prototype or production hardware and materials including door operators and entire door control and signal system shall be used to functionally demonstrate specification compliance.

E. Undercar Equipment

The undercar mock-up shall include:

- All representative components, wiring and piping which shall be located under the full length production cars
- Packaging, location, and positioning
- Methods of attachment

Where required, the contractor shall use clear plastic material to permit evaluation of typical hidden interfacing and integration areas. The mock-up shall demonstrate sub-systems and components placement and interfaces unique to each car of the dependent-pair. Production materials and processes for wiring and piping shall be used to demonstrate specification compliance. The first production underframe may be used in lieu of a mock-up.

F. Reviews by the Purchaser

The purchaser will review mock-ups for specification compliance.

● 5.1.3 TRAINING AIDS

Designated specification compliance mock-ups will be utilized by the purchaser as training aids. Training aids required are:

- Operator Cab
- Side Door
- (Any others) * _____

5.2 SAMPLE CAR (CDRL)

The first production car (which is also referred to herein as the sample car) of each car-type shall precede all other cars of that type at each stage of construction and assembly. Purchaser inspection of each sample car for specification compliance will be made at the following stages of completion:

A. Car shell

1. Car shell only
2. Car shell with:
 - Piping and wiring in place and connected
 - Insulation installed
 - Side doors installed and operating, but without side liners installed
 - Overhead air conditioning apparatus in place and connected, but without liners installed
 - Car interior lighting installed
 - Car exterior lighting installed
 - All liners installed, but without seats installed

* Purchaser completing detail

3. Operator cab complete
4. Car complete and ready to run in revenue service

The purchaser may also perform additional inspection of the sample car at other points during construction.

SECTION 6

WORKMANSHIP, PROCESSES, AND MATERIALS



SECTION 6

WORKMANSHIP, PROCESSES AND MATERIALS

6.1 GENERAL

This section specifies the requirements for workmanship, processes, and materials to be applied in the design and construction of the car.

6.2 CAR SYSTEM ELECTRICAL WIRING

6.2.1 GENERAL

This section details wiring performance and physical requirements for the car system. Subsection 6.2.1 does not include internal wiring of car-mounted equipment.

A. Wiring Layout

The wiring layout shall be designed in advance of installation and in cooperation with the suppliers of the associated equipment. Insofar as practicable, all wiring shall be prefabricated into standard harnesses and shall be installed with identical arrangement and location in each car having similar equipment. Wiring installed in wire ducts or conduit, other than multi-conductor cables, shall not be cabled.

B. Conductors

All conductors shall be of soft, annealed, tinned copper conforming to ASTM B-33. Minimum stranding shall conform to AAR Specification 589, Table II.

C. Ratings

High voltage power circuits shall use wire rated at 2,000 V minimum. All other circuits shall use wire rated at 600 V minimum.

D. Multiconductor Cable

Multiconductor cable shall meet the above requirements for single conductors. Outer jacket material shall be the same as that used to insulate individual conductors unless mechanical considerations indicate a different material with superior characteristics. Multiconductor cable intended for flexing service shall be designed for the application. Each multiconductor cable shall provide at least 10 percent spare wires.

E. Shielding

Shielding, when required, shall be metal foil, tape shields, or braided using AWG-38 minimum copper/tin-plated ASTM B-33 wire with a minimum effective coverage of 85 percent.

F. Junction Boxes

Junction boxes shall be used, as required, for wire terminations. Harness connections to the boxes, as well as internal wiring to terminal boards, shall be as specified in Section 6.2.4. Exposed exterior junction boxes shall be weathertight.

● 6.2.2. WIRE TESTING

A. General

Wire and cable shall meet the test requirements and fire safety requirements specified in Section 6.9. Certification of satisfactory completion of each indicated test shall be provided to the purchaser.

B. Wire Testing Requirements

1. Dielectric Test per Table 1A of ASTM D-470, ozone-resistant insulation material, 133 percent insulating levels.
2. Insulation Resistance Test per ASTM D-470, Minimum accepted value shall be 1,000 megohms per 1,000 feet (304.8 m) using a 500 VDC megohmmeter.
3. Spark Test Test per UL 44 - Rubber-Insulated wires and cable.
4. Air Aging Test per ASTM D-638. Age sample for seven days at 302 degrees F (150 degrees C) in an air oven. Minimum tensile strength and elongation shall not be less than 85 percent of the unaged values. Also test per IEEE STD-383-1974 and ASTM D-573 for extended life characteristics.
5. Cold Bend Test per NEMA WC5, except test temperature shall be -65 degrees F (-54 degree C).

6. Chemical Resistance An appropriate length of sample shall be measured. Initial values for insulation diameter and total weight shall be recorded. The wire shall be immersed in the test fluid to within 3 inches (75 mm) of each end for 24 hours at 149 degrees F (65 degrees C). During the immersion stage the minimum bend radius of the wire shall be 10 times the diameter of the wire being tested. Upon removal from the test fluid the specimen shall be cooled to room temperature for one hour and the diameter gauged and reweighed for comparison with the original values. The maximum diameter and weight increase shall not exceed 3 percent. Typical fluids for this test include:

- a. Humble No. 2214 Railroad Diesel Lubricating Oil
- b. Humble Diesel 260 or Railroad T Fuel Oil
- c. Mineral Oil
- d. Hydrochloric acid, nitric acid, sodium hydroxide, sulfuric acid, oxalic acid
- e. Potassium hydroxide
- f. Petroleum distillates (i.e., graffiti removers)
- g. Trichloroethane
- h. Kerosene solvents
- i. Trisodium phosphate solution
- j. Skydrol 500 B hydraulic Fluid
- k. Water
- l. And other fluids as follows: * _____

7. Temperature Transient Testing Samples of all insulated wire and cable shall be subjected to maximum temperature transients imposed by the operating loads and the purchaser's operating environment as defined by Appendix A, followed by a cold bend test after the

*Purchaser completing detail

insulation has reached the minimum operating temperature imposed by that environment.

6.2.3 WIRE HARNESSSES, CONDUITS, AND RACEWAYS

A. Wire Harnesses

Multiple conductor harnesses containing more than two wires shall be prefabricated, bench-tested, and completely interchangeable. Each harness between equipment enclosures shall contain a minimum of 10 percent spares, but no fewer than two spares. Each harness shall be permanently marked within 1 inch (25.4 mm) of each termination using machine-printed permanent plastic sleeves. Markings shall be black on white background.

B. Wire Runs

Wire runs shall be continuous and unbroken between connection points, shall be supported at no greater than 2 foot (609.6 mm) spacing, and shall be protected at each support point and bend against mechanical crushing and abrasion. Each conductor shall be insulated for the maximum voltage of any conductor within the same enclosure. A watertight bushing shall be provided on all exposed cables to prevent fluid run-off into connected equipment. All cable bundles and wires shall be routed a minimum of 1 inch (25.4 mm) above the bottom of the equipment enclosures.

C. Wire Length

Slack shall be provided in cables at equipment terminals to provide for shock and vibration-induced movements, equipment shifting, alignment, cover removal, and component replace-

ment. Sufficient wire length shall be provided at points of termination to permit connections without splicing.

D. Conduits

Conduit application shall be held to an absolute minimum. Each conduit application shall be approved by the purchaser. In no case shall deformed, split or otherwise defective conduit be installed. Conduits shall not terminate closer than 10 inches (25.4 cm) above the floor.

All conduit bends and offsets shall be made by the use of special forms and tools and have the largest radius possible so that wires can be drawn through by hand without the use of tackle or power.

Flexible conduit shall be of the best grade interlocking spiral strip steel and protected with a rust-resistive coating.

A minimum of 50 percent of the cross-sectional area of the conduit shall be air space.

All conduits and their connections to electrical equipment shall be installed to form a continuous ground.

E. Conduit Fittings and Boxes

All conduit fittings shall be provided with suitable covers and approved gaskets.

Fittings and boxes shall be mechanically connected to the conduit runs in an approved manner and the conduit system shall be securely fastened to the car framing.

Open ends of conduit shall be provided with strain relief-type fittings with extended rubber cushionings, bell mouth fittings or insulated throat box connections. Air flow shall be precluded through any conduit.

F. Raceways

Metal raceways and their elbows, couplings, and other fittings shall be so designed that the sections can be electrically and mechanically coupled, while also protecting the wires from abrasion. Heads of screws or bolts inside a raceway shall be flush with the metal surface. The sum of the cross-sectional areas of all contained conductors and their insulation at any cross section of a raceway shall not exceed 40 percent of the cross section. Raceways shall preclude water entrapment and shall be provided with drainholes.

G. Circuit Separation

Conductors of different voltage levels shall be located in separate raceways or in raceways containing a barrier to segregate circuits. Wiring of different voltages shall be distinctively identifiable. Communications circuits shall be run in raceways separate from all others and shall be located in the ceiling-roof interspace.

H. Truck and Speed Sensor Wiring

Truck wiring shall be of sufficient length to ensure sufficient slack, and shall be provided with clamp supports and abrasion protection. Speed sensor wiring shall be shielded and installed in flexible conduit. T-splices shall not be permitted.

I. Cable Supports

Cables shall be cleated and bushed when passing through bulkheads and structural members. Sufficient slack shall be provided to prevent mechanical strain where movement could occur between any wire terminals. Drip loops shall also be provided. Cleats and cable supports shall have inert abrasion shields to prevent chafing and cutting of the cable.

J. Cable Exposure

Short cable runs of harnesses entering or leaving exposed raceways shall have plastic sleeving over the raceway edges and grommet-type insulation of any wire penetration holes. Wiring shall be retained to the sleeving with tie-wraps.

● 6.2.4 CONNECTORS

A. General

All equipment enclosures and junction boxes, except primary power circuits, shall be fitted with terminal boards or connectors. Terminal board connectors shall be binding screws or threaded studs on each side for incoming and outgoing connections. Each board or connector shall have the required number of terminations plus a minimum of 10 percent spares, but not fewer than two spares. A permanent marking strip on each terminal board shall be provided and attached adjacent to the wire junction point. A maximum of three wires shall be connected to any one binding screw or threaded stud. Wiring connected to threaded studs shall use brass hardware for spacers when spacers shall be required, and shall have a minimum of $1\frac{1}{2}$ threads exposed beyond the final nuts. Space shall be provided to permit

connecting wire terminals with the following tools:*

_____. All threaded connectors shall be properly torqued to assure sound connections. Connectors shall meet the requirements of Section 6.2.4D.

B. Wire Terminations

All wire terminations shall be crimp-style terminal lugs in accordance with SM-25036L. Solder connections shall not be permitted except for printed circuit applications. Corrosion protection shall be required on all base metals.

C. Power Cables

Cables shall be terminated with a crimped compression terminal. Slack shall be provided to preclude breaking or pull-out from bushings or terminals and to allow two terminal changes.

D. Multipin Connectors

Multipin, positive lock, crimp-style connectors shall be employed where required and shall meet the mechanical and electrical requirements of MIL-C-005015.

E. Cable Identification

The contractor shall use a basic identification system in conformance with ANSI Y32.16 or the following requirements:*

*Purchaser completing detail

F. Grounding Connections

All grounding connections shall be made on 1/8 inch (3.18 mm) copper pads which shall be brazed to a steel plate. The pad and steel plate assembly shall then be welded to a structural member. The entire assembly shall be bolted to the structural member with the bolt passing through the terminal lug, copper pad, steel plate and structural member. A common ground wire for multiple devices shall not be permitted. Electrical equipment shall be individually grounded. If grounds are attached to aluminum alloy members, the ground connection between aluminum and steel members shall be by an approved means to preclude electrolysis.

6.2.5 ELECTRICAL EQUIPMENT BOXES

A. Doors and Enclosures

Doors and enclosures shall be weatherproof and be captive. Enclosures shall be vented. The first three car-sets of enclosures, doors, and all external mechanisms shall be subjected to a spray of water at 40 psi (276 kPa) through a 0.25 inch (6.35 mm) orifice. The water shall be directed at the enclosure from all angles practicable from a distance of 3.3 to 5 feet (1 to 1.5 m) for at least 5 minutes. The enclosure shall be acceptable if there is no evidence of water within the enclosure following the 5-minute spray test.

B. Interlocks

Interlocks shall be provided on doors and covers for inverters, converters, and other electrical devices to de-energize capacitors within 30 seconds as specified in

Section 14.2.5C7 from these circuits when these doors and covers are opened.

C. Conduit Entry

All conduit entries into equipment boxes shall be weather-proofed with a replaceable O-ring seal which cannot be dislodged without removing the conduit. All open-ended conduits shall be installed in such a manner as to ensure gravity-drainage. Conduit fill shall not exceed 50 percent. Where a single wire enters an equipment box without a conduit, the entry shall be made waterproof by a suitable strain-relief bushing with an O-ring seal.

6.2.6 PRINTED CIRCUIT BOARDS

Printed circuit boards shall be designed and manufactured to the following criteria:

- Printed circuit boards shall be of the glass epoxy type with components mounted only on one side. The copper laminate shall be firmly attached to the board and shall not blister or peel when heated to soldering temperature.
- Circuit board material shall be a minimum thickness of 0.0625 inch (1.59 mm).
- The component side of the board shall be printed with component references and such information as might be required for diagnostic testing; such as, capacitor and diode polarity and at least two leads of all transistors and thyristors. Boards shall be plug-in type and individually indexed so that only the proper card

can be inserted in each receptacle.

- Clearance shall be provided between components to permit testing, removal, and replacement without difficulty. Circuit boards shall be mounted vertically.
- Both sides of the assembled printed circuit board shall be coated with an insulating and protective coating. Coating material shall be Type AR per MIL-I-46058 or equivalent.

6.3 PIPING

6.3.1 MATERIAL

Unless otherwise described herein, all piping shall be seamless copper tubing and/or stainless steel tubing. Copper tubing shall be in accordance with Federal Specifications WW-T-799, Type 1, Class I, or wrought copper or cast brass to conform with ANSI B16.22 and B16.18. Copper tubing for air conditioning lines shall be Type K, 1/4 hard.

The solder composition used to join copper tubing shall conform to the requirements of Section 6.7.4.

Where necessary, wrapping material for piping shall be Armaflex FR or other approved fire retardant, closed cell foam insulation. A sealing compound shall be used to seal threaded pipe connections and fittings.

●6.3.2 REQUIREMENTS

All air hoses shall as a minimum conform to AAR M-618-71 with fittings and hose assemblies as specified in AAR M927-69. Copper tubing or pipes shall not contact aluminum parts. All clamps used to attach hoses to their fittings and to support other piping shall conform to the following requirements:*_____. Installation, cleaning, and testing of the complete piping system shall be in accordance with ANSI B31.1.

6.4 MATERIALS

6.4.1 GENERAL

Composition, mechanical properties, and quality level shall conform to the designated AISI, SAE, ASTM, and AAR Specifications. Commercial materials not covered by a specification shall be clearly identified by the commercial trademark and the supplier's identity and address (CDRL). A description of the material composition shall be provided to the purchaser. Prior to attachment or jointing, all materials shall be mill-finished unless otherwise specified. All joining surfaces shall be clean and free from dirt, grease, and other contaminants.

6.4.2 CARBON AND LOW ALLOY STEELS

A. Heat-Treated Alloy Steel

Structural heat-treated alloy steel, suitable for welding shall either conform to the requirements of ASTM A-514, Grade F, or be nickel-copper-columbium-type steel.

*Purchaser completing detail

B. Low-Alloy, High-Tensile Steel

Low-alloy, high-tensile structural steel shall conform to the requirements of ASTM A-606 and shall have a minimum of 4 times the corrosion resistance of carbon steel.

C. Castings

Steel castings shall conform to the requirements of ASTM-A-27, Grade 70-36 or Grade 65-35, or AAR M-201, Grade B. High-strength steel castings shall conform to the requirements of ASTM A-148, Grade 90-60, or AAR M-101, Grade C. Low alloy nickel steel (2 percent minimum) castings for truck frames and truck bolsters shall conform to the requirements of AAR M-201, with a minimum ultimate tensile strength of 75,000 psi (517 500 kPa). Malleable or ductile iron castings shall conform to the requirements of ASTM specification A-47, Grade 35018, or ASTM A-536, Grade 60-40-18.

D. Steel Forgings

Steel forgings shall conform to the requirements of AISI C-1045, normalized and tempered.

E. Hot-Rolled Bar Steel

Hot-rolled bar steel shall conform to the requirements of AISI C-1020, Grade 50.

F. Rivet Steel

Rivet steel of .375 inch (9.5 mm) or less, except that used on the body underframe, shall conform to the requirements

of ASTM A-31, Grade A. Rivet steel of greater than .375 inch (9.5 mm), and that used on the body underframe, shall conform to the requirements of ASTM A-131.

G. Steel Bolts

Carbon steel bolts for structural joints shall conform to the requirements of ASTM A-325.

H. Spring Steel

Spring steel for wear plates and coil springs shall conform to the requirements of ASTM A-689, Grade A.

I. Steel Wheel Forgings

Steel wheels shall conform to the requirements of ASTM A-25, or AAR M107, class A or B.

J. Axle Forgings

Axle forgings shall conform to the requirements of ASTM A-729.

K. Couplers

Coupler material, unless otherwise specified, shall conform to the requirements of the applicable AAR Coupler Specifications.

6.4.3 CORROSION-RESISTANT STEELS

A. Austenitic Stainless Steels

Corrosion-resistant steels shall be austenitic stainless, conforming to AISI Type 201 or 301. Steels with .03 percent carbon content shall be used where arc welding is required.

B. Cold-Rolled Stainless Steel

The maximum grade of stainless steel used in the cold-rolled condition shall be 3/4 hard.

6.4.4. ALUMINUM ALLOYS

Aluminum alloys shall conform to the composition, strength, quality, and corrosion-resistance requirements of the specifications of The Aluminum Industry Association (AIA). Aluminum alloy designations shall be those registered with the AIA. Aluminum alloys joined by fusion welding shall be weldable, high strength, corrosion-resistant and shall not require heat treatment after welding. Sheet and plate aluminum alloy shall be 3003-H14, 5052-H32, 5052-H34, 5083-H321, 5083-H323, or 6061-T6. Aluminum alloy castings shall conform to the requirements of ASTM B-26, B-85, and B-108. Castings shall be free from blowholes, cracks, shrinkage, and other defects which could act to preclude completion of design life. Aluminum alloy rivets used in structural applications shall be 6061-T6, 6053-T61, or 2117-T4. Aluminum alloy bolts, nuts, and screws shall not be permitted.

A. Fabrication and Fastening

1. General The forming of aluminum parts, their joining by bolting, riveting, and welding, and the protection of contact surfaces shall conform to requirements of Aluminum Company of America's Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles, except as otherwise specified herein.

2. Joining of Materials Measures shall be taken to preclude the possibility of dissimilar metals contacts to thereby preclude electrolytic corrosion.

Aluminum alloy surfaces shall not be secured to, nor shall they make direct metal-to-metal contact with, surfaces of copper, brass, bronze, silver, lead, tin, nickel, stainless steel or alloys thereof. In the car structure, where the parts shall be permanently covered and concealed following assembly, components made of copper, copper bearing aluminum alloys, brass, bronze, silver, and nickel shall not be employed. The surfaces of aluminum alloy parts secured to ferrous parts shall be protected as prescribed herein, with a one-part polysulphide or a silicone sealant used as the joint insulating compound. Alternatively, an insulating joint material completely covering the facing surfaces may be used. Such a material shall be non-hygroscopic, free from chlorides and heavy metal ions, and, if fibrous, shall be impregnated with bitumen or other water-repellent substances. All dissimilar metal joints shall be made completely water-proof.

3. Insulation Surface covering or insulation shall be provided to all bolts, rivets, securing clips, and devices to preclude contact with aluminum alloys.
4. Bolting and Riveting The head and unthreaded portion of the shank of the bolt shall be in contact with the aluminum part when secured in place. Bushings may be used. Rivets driven hot may be covered by a protective oxide coating. The preferred method of riveting shall be with the formed rivet head in contact with the aluminum alloy.

6.4.5 INTERIOR HARDWARE

Interior hardware shall be securely attached with recessed Phillips oval-head screws. Where machine screws are used, tapped metal shall be reinforced by welding or by the use of clinch-type elastic stopnuts. Screws shall not tap into aluminum.

End and cab door locks shall be constructed with pivot bolt-type latches. Keepers shall be the electrical-release type. Keyholes shall fit the keys snugly and shall be provided with an escutcheon plate.

All interior hardware shall be stainless steel, satin finish or nickel bronze.

●6.4.6 NON-METALLIC MATERIALS

Non-metallic materials used for interior appointments shall not be affected by the following industrial cleaning agents:* _____ . Flame spread and smoke generation

*Purchaser completing detail

characteristics of all major interior materials and the service life of those characteristics shall have been certified by an approved independent testing laboratory and shall have attached to the material certificates recording conformance with the requirements specified in Section 6.9.

6.4.7 PLYMETAL PANELS

Plymetal panels shall be in accordance with MIL-P-8053.

6.4.8 CAULKING COMPOUNDS AND SEALANTS

A. General

The use of caulking compounds and sealers shall be minimized. Applications shall be in accordance with supplier recommendations.

Caulking primers shall be quick-drying, colorless, non-staining sealers of the type and consistency recommended by the caulking materials supplier for the specific application. Packing (backstop) shall be non-staining resilient material: such as, glass-fiber roving, neoprene, butyl, polyurethane, other closed-cell foams, or other compressible material compatible with the caulking compound used. Butyl-type shall be extruded polysiobutylene sealer compound of 100 percent solids.

B. Applications and Workmanship

Joints, spaces, and junctures to be packed and caulked or sealed shall be completely dry and thoroughly cleaned of all dirt, dust, oil, and other foreign materials which could adversely interact with the caulking compound or sealant.

When so stipulated by the supplier, protective coatings shall be removed from surfaces to be caulked or sealed. When caulking against aluminum frame members with adhesive-type compounds, all film-type isolation or separation coatings which have been applied to the aluminum surfaces shall be removed to the maximum depth of the caulking seam immediately before applying the caulking. All voids and joints shall be completely filled. The entire perimeter or each opening shall be caulked. The finish of caulking joints on flush surfaces and in internal corners shall be neatly pointed. Excess material shall be removed. Exposed caulking shall be free of wrinkles and uniformly smooth. Storage shall be at temperatures below 50 degrees F (10 degrees C). Compounds shall not be used after they have become too jelled to be discharged in a continuous flow. Modification of caulking compounds by adding liquids, solids, or powders shall not be permitted. When using two-part compounds, only the amount of caulking which can be installed within 4 hours shall be prepared. All adjoining surfaces, finishes, and fixtures shall be protected throughout the caulking operations and any stains, marks, or damage thereto as a result of caulking and sealing work shall be corrected.

6.4.9 ELASTOMERS

A. General

Elastomeric parts include: door and window seals, glazing strips, truck bumpers and snubbers, structural and compressible gaskets, and mounting pads, and shall be of either rubber or urethane.

B. Materials

Elastomeric parts shall be fabricated from materials which shall retain their physical properties under the environmental conditions specified in Appendix A. Elastomeric parts shall not be painted.

C. Properties

Elastomeric materials shall demonstrate the following minimum properties when tested in accordance with the applicable test methods specified in Figure 6-1.

FIGURE 6-1. ELASTOMERIC MINIMUM PROPERTIES

<u>Physical Property</u>	<u>ASTM Test Method</u>	<u>Performance Requirement Value</u>
Hardness, durometer A	D-2240	45 to 75
Tensile strength	D-412	1,500 psi (10.35 kPa). minimum
Ultimate elongation	D-412	300 percent, minimum
Flame resistance	None	Must not propagate flame or exhibit flame dripping
Ozone resistance	D-1149	No cracks
Heat aging resistance	D-573	-
Oil aging resistance	D-471	+80 percent compression set, maximum
Permanent set resistance	D-395 (Method B)	25 percent, compression set, maximum
Tear resistance	D-624	200 pounds/inch (.90 kg/25.4 mm), minimum

D. Metal Parts

Metal parts to which elastomeric parts or materials are cured shall be made of SAE 1020 or AISI 1045 hot-rolled steel.

E. Finish

Unless otherwise specified, all elastomeric parts shall be natural finish, smooth, and colored as specified by the purchaser.

● 6.4.10 DECALS

Application technique for all marking films, decals, and adhesives shall be in accordance with the supplier's recommendations. Film shall be opaque and shall completely hide a contrasting black printed legend and white surface. There shall be an initial degree gloss value of 40 when tested in accordance with ASTM D-523. Films shall retain adhesive properties after one week of continuous exposure to a temperature of 150 degrees F (66 degrees C). Films shall conform to the contours of the car interior and exterior surfaces. Overall thickness of the processed film shall be between 0.0015 and 0.0045 inch (0.04 and 0.11 mm). Films shall withstand immersion in either distilled water or SAE No. 20 motor oil for 24 hours at a temperature of 70 to 80 degrees F (21 to 27 degrees C) without degradation of adhesion, color or appearance. Marking films shall withstand the effects of the detergents and washing procedures specified as follows: *_____.

*Purchaser completing detail

●6.4.11

FIBERGLASS-REINFORCED PLASTICS

Resins shall be thermosetting, fire-retardant polyester materials, selected to meet the physical and molding process requirements indicated. The primer coat shall consist of two-component epoxy zinc chromate composed of approved base, activator, and thinner elements. The finish coat shall be synthetic acrylic enamel.

A. Reinforcement

Fiberglass reinforcement shall meet the physical and process requirements specified in Figure 6-1. Glass content by weight shall be 25 to 30 percent chopped strand matting and roving combination for structural applications. Gelcoat shall be resistant to scuffing, fire, weather, perspiration, and to the following cleaning agents:*_____. Fiberglass shall be pigmented throughout to match the surface color. The minimum thickness of gelcoat shall be 0.015 inch (0.38 mm) and shall remain craze-free throughout the design life of the car. Additives, fillers, monomers, catalysts, activators, inhibitors, pigments, and flameproofing materials shall be added to the resin mixes as required to produce finished products with the characteristics specified. Mineral filler shall not exceed 28 percent of the finished weight for the preformed, matched die molding process. Fiberglass-reinforced plastic shall be manufactured by one of the following methods:

Method I

- Open molding
- Hand layup
- Spray layup, or chopped strand blown

*Purchaser completing detail

Method II

- Matched die molding
- Preform

B. Requirements

Production techniques shall ensure that glass fiber reinforcement is distributed throughout the final product in such a manner as to preclude formation of resin-rich sections. Reinforced plastic parts shall have greater thickness at attachment joints and edges. Exposed sharp edges shall not be permitted. All open-molded parts shall be gelcoated. Plastic laminates which are to be painted shall be gelcoated to match the color specified. Surfaces shall be uniform, smooth, and free of porosity and crazing. Fiberglass-reinforced plastics shall possess as a minimum the properties listed in Figure 6-2 when tested in accordance with the applicable specification.

FIGURE 6-2. FIBERGLASS-REINFORCED PLASTICS,
MINIMUM PROPERTIES

<u>Physical Property</u>	<u>ASTM Test Method</u>	<u>Performance Requirement Value</u>
Hardness, Barcol	None	45
Tensile strength	D-638	10,000 psi (69 000 kPa)
Compressive strength	D-695	20,000 psi (138 000 kPa)
Flexural strength	D-790	20,000 psi (138 000 kPa)
Impact strength	D-256	10 foot pounds per inch of notch (13.56 joules per 15.4 mm)
Heat resistance	None	175 degrees F, (79 degrees C), continuous
Thickness	None	0.125 inch (3.175 mm), minimum

6.4.12 HIGH-PRESSURE LAMINATED MELAMINE PLASTICS

Material shall be a two-ply laminate consisting of a hard plastic film facing permanently bonded to a base sheet and conforming to NEMA Standard LD3/

●6.4.13 FLOOR COVERING

A. General

The floor covering shall utilize synthetic or natural rubber. Reinforcing fillers shall be hard clays added to impart hardness values of 85 to 95 Shore A. The rubber composition shall be homogeneous and shall resist acids, alkalines, and the following solvents:*_____. The floor covering shall not become slippery when wet.

The floor covering shall conform to the requirements stated in subsections 6.4.13B through 1.4.13F.

B. Tensile Strength

The tensile strength of the flooring shall not be less than 500 psi (3.450 kPa) when tested in accordance with ASTM D-412 using die C for preparing the dumbbell specimens.

C. Ultimate Elongation

Ultimate elongation shall not be less than 25 percent when tested in accordance with ASTM D-412 using die C for preparing the dumbbell specimens.

* Purchaser completing detail

D. Flexibility

The floor covering shall neither crack nor craze when tested in accordance with Method 3111 of FED-STD-501. Mandrel diameter shall be 1 inch (25.4 mm) normal.

E. Dimensional Stability

The floor covering shall not change in linear dimensions more than ± 0.35 inch per linear foot (.80 mm per 305 linear mm). Stability shall be determined in accordance with ASTM D-1204.

F. Installation

A resilient material shall cover the entire car floor including a sanitary coving at bulkheads and side walls. The coving shall extend a minimum of 3.93 inches (100 mm) from the finished floor and shall be retained by stainless steel molding attached with concealed fasteners.

●6.4.14 COLORS, TEXTURES, AND FINISHES

The colors, textures, and finishes of all materials shall conform to the following specifications:*_____.

6.5 ASSEMBLY

6.5.1 CORROSION DETERRENCE

A. Carbon and Low Alloy Steels

Chromium plating on steel shall meet the requirements of ASTM B-177. Epoxy primer meeting the requirements of

*Purchaser completing detail

MIL-C-22750C may be used.

All ferrous metals, unless specified elsewhere to be protected by other methods or to not require protection, shall be galvanized in accordance with the requirements of ASTM A-123-73 or ASTM A-383-77. Galvanizing, if required, shall follow fabrication. Repairable damage to galvanized coatings shall be repaired in accordance with DOD-P-21035.

B. Corrosion-Resistant Steel

Corrosion-resistive steels, except stainless steel, shall be plated or coated except in dissimilar metal contact applications as described in Section 6.5.2.

C. Aluminum Alloy

Aluminum alloys shall be prepared and coated for corrosion protection in conformance with Aluminum Industry Association (AIA) standards. Aluminum alloy parts on the car interior which are accessible and subject to handling shall have a hard anodic coating conforming to A41 of the AIA standards. Aluminum alloy parts with limited access shall have a coating conforming to A31 of the AIA standards. Unexposed aluminum parts shall be prepared and coated for corrosion protection.

D. Other Metals

Brass, bronze, copper, and nickel alloys shall not require surface treatment.

6.5.2. DISSIMILAR METAL PROTECTION

Dissimilar metals shall be protected in conformance with MIL-STD-889B. Selection and protection of dissimilar metals relative to electrical wiring and electronic equipment shall be in conformance with MIL-STD-454F, Classes 2 and 3. Isolation of incompatible metals and materials shall be provided in all installations except air conditioning and heating coils.

A. Copper

Copper may abut, overlap, or join only to tin, lead, or stainless steel. Where this occurs, the copper shall either be coated with bituminous plastic cement or separated by inert material.

B. Fastenings

All ferrous metal fasteners, clips, and brackets shall be separated from aluminum and copper by nylon washers installed during fabrication and assembly of the cars and its components.

6.5.3 JOINT FITTING

A. Metal-to-Metal Connection

Where metal is riveted or bolted to metal in a stainless steel structure, contact surfaces shall be free of dirt, grease, rust, and scale and shall be coated, except for stainless steel parts, with a metal base primer. If aluminum parts are used for any purpose, metal-to-metal

connections shall be in accordance with the latest revision of Alcoa Technical Report Number 254.

B. Wood-to-Metal Connection

Where wood and ferrous metal surfaces are bonded together, .020 inch (.51 mm) thick zinc coated steel plate shall be used. If aluminum parts are used, wood-to-metal connections shall be in accordance with the latest revision of Alcoa Technical Report Number 254.

C. Wood-to-Wood Connection

Where wood and wood are placed together, abutting surfaces shall be sealed with either Norway Spar Varnish or with an equivalent sealing compound.

D. Bolt and Rod Coating

All bolts and rods passing through wood shall be coated, over those parts imbedded in the wood, with aluminum paint conforming to Federal Specification TT-P-38.

6.6

FASTENERS

All mechanical fasteners shall conform to either ANSI standards or ISO standards. Intermixing of metric and ANSI standard fasteners shall not be permitted. All fasteners shall be either stainless steel, chromium-plated, or galvanized steel, depending on specific application. Chromium plating shall conform to ASTM A-166-61T, Type DS. Galvanizing shall be hot-dip with a minimum thickness of 0.0001 inch (0.025 mm) purest quality zinc. Fasteners shall be either mechanical or threaded-type. All threaded fasteners

shall conform to ANSI Class 2 thread requirements, unless otherwise specified. All threaded fasteners shall be self-locking or provided with locking devices. Sheet-metal screws shall not be used.

6.6.1 BOLTS AND NUTS

Steel bolts shall conform to the requirements of ASTM A-325, Class BD, or A-490, as applicable. Nuts shall meet the requirements of ASTM A-194, A-325, or A-563-76A, as applicable. Bolts and nuts shall be cut to TS threads with a Class 2 fit, minimum. Bolts shall either be furnished with high temperature elastic stop nuts or shall be drilled for use with, and furnished with cotter pins and nuts suitable for cotter-pin applications. Peening of bolts shall not be permitted. A minimum of 1-1/2 threads and a maximum of 6 threads shall protrude beyond the nut or fastener. Bolts used in structural applications shall be no smaller than 0.375 inch (9.5 mm) in diameter. Aluminum alloy bolts, nuts, and screws shall not be permitted. All steel screws, bolts, and nuts shall be zinc-chromate treated, except for stainless-to-stainless joints where stainless steel bolts and nuts shall be used. All carbon steel bolts shall be SAE Class 5 strength minimum and sized for common hardware. The number of different sizes of bolts shall be held to a minimum. Lock bolts with swaged collars shall be permitted.

● 6.6.2 RIVETS

Steel rivets shall conform to ASTM A-502, A-31, Grade A, or A-131 as applicable. The use of blind rivets shall conform to the following requirements:*. Aluminum alloy rivets shall conform to 6061-T6 or 6053-T61.

*Purchaser completing detail

6.6.3 LOCKING DEVICES

Locking devices shall be selected from those listed below. All lock washers and lock nuts shall be zinc-chromate treated.

A. Lock Washers

Lock washers smaller than 0.075 inch (19 mm) size shall be commercial standard. Those 0.075 inch (19 mm) and larger shall conform to Mil. Std. Part MS35340.

B. Prevailing Torque Fasteners

Prevailing torque fasteners may be used instead of lock washers or other locking devices, except on items requiring removal for scheduled maintenance. Where prevailing torque fasteners are used, the bold threads shall have chamfered ends, be clean and smooth without burrs, and of such a length that at least two threads but no more than six threads shall protrude beyond the locking device. Bolts used with plastic locking devices shall not be drilled for cotter pins and shall not be subject to heat levels which could warm the plastic material. All self-locking nuts shall comply with the Industrial Fasteners Institute requirements. Prevailing torque fasteners shall be applied and installed in accordance with manufacturers' recommendations.

6.6.4 TAMPERPROOF FASTENERS

All exposed fasteners shall be tamperproof.

6.7 METAL JOINING

6.7.1 GENERAL

This subsection specifies the workmanship, processes, and materials for welding, brazing, and soldering.

6.7.2 WELDING

A. Conformance

All welding, unless otherwise specified, shall be in accordance with the requirements of the applicable American Welding Society (AWS) specifications. The contractor shall ensure that welders are qualified to operate welding equipment and produce the specified welds.

B. Materials and Welding Practice

1. Aluminum Welding rod, wire, or filler material shall be chosen with respect to make, type, size, composition, and suitability to the application, and shall be in accordance with Chapter 94 of the AWS Welding Handbook. Welding electrodes for steel, and manual shielded metal arc welding, shall conform to the E60 or E70 series. Bare electrodes and granular flux used in the submerged-arc or gas metal arc process shall conform to the provisions of AISC Section 1.17.3. The welding of aluminum shall conform to the provisions and recommendations of the AWS publication, Welding Aluminum.

2. Stainless Steel The materials for welding stainless steel shall conform to the provisions and recommenda-

tions of Section IX of the ASME Boiler and Pressure Vessel Code. Fillet welds shall be extended around the edge of members wherever practical. Manual welds of thickness greater than 0.0250 inches (6.35 mm) shall be made with at least two beads. Machine welds of any thickness may be made with one or more beads. In any welding operation, the next successive bead shall not be applied until all scale has been completely removed from the underlying bead and surrounding metal. Welds shall be ground only in the direction of the weld. All parts to be joined by welding shall be adequately supported during the welding operation to ensure minimal distortion. Sealing compounds shall be used between surfaces of the joint to ensure sealing against environmental elements. All welding shall produce complete and adequate fusion with the basic material throughout the weld.

C. Resistance Welds

Resistance welding operations shall employ accurate control of cleanliness, current, time, electrode size and shape, and tip force to produce uniform welds of specified strength which shall not be subject to surface corrosion. For each type of metal joint or built-up assembly to be resistance welded, a prior sample of the joint shall first be welded with the prescribed settings of current, time and tip pressure, and then either static tested for shear strength or tested to destruction by tearing to ensure that a weld nugget is pulled out of one of the plates. Sample welds shall be subject to purchaser approval. Weekly and whenever there is a change in welder, material, material assembly thickness, electrodes,

or welding machine settings, sample welds shall be made and tested by either the shear-strength or the teat-test method. Complete records of the set-up and test results shall be maintained by the contractor. Visible spot welds shall conform with the appearance requirements of Section 7.2.1A.

6.7.3 BRAZING

All brazing shall be in accordance with the requirements and recommendations of the American Welding Society as specified in the AWS Welding and Brazing Handbook. Brazing to stainless steel structural members shall not be permitted.

6.7.4 SOLDERING

Soldering shall be used only in non-structural applications. Tin-antimony solder shall be used for all copper tubing and fittings, except for air conditioning tubing which shall be soldered with silver solder. The flux used shall be non-corrosive. Solder joint fittings shall conform with American Standards Specifications B16.22 and B16.18 for wrought copper and cast brass, respectively. Only silver solder containing no antimony shall be used on brass.

A. Tin-Antimony Solder

Tin-antimony solder shall conform to the following chemical composition or better:

Tin	95.0	percent, nominal
	94.5	percent, minimum
Antimony	5.0	percent, nominal
	4.5	percent, minimum
Copper	0.8	percent, maximum
Other	0.10	percent, maximum
Impurities		

B. Silver Solder

Silver solder shall have the following nominal composition:

Silver	50.0	percent
Copper	15.5	percent
Zinc	16.5	percent
Cadmium	18.0	percent

●6.8

PAINTS, COATINGS, AND PROTECTION

A. General

All surfaces shall be completely free of rust, scale, grease, and other foreign material immediately preceding application of each coat of primer or finish paint. All body dents, roughness, or other surface imperfection shall be removed by straightening, filling not to exceed 1/8 inch (3.18 mm) in thickness over an area not to exceed 36 square inches (23 _ 26 mm²), and sanding prior to application of the first priming coat. All surfaces to be painted shall be prepared as recommended by the paint supplier. All paint shall be prepared for application in accordance with the paint supplier's recommendations. Thinning materials or paint additives shall be those recommended by the paint supplier. Paint shall conform to the following requirements:* _____ . Painting materials shall be brushed,

*Purchaser completing detail

sprayed, or dipped and baked or air-dried in accordance with the paint manufacturer's written instructions, the service requirements of the surface or part to be painted, and the application method. Each coat shall be uniformly applied to produce the thickness recommended by the paint supplier over all surfaces to be covered, and shall present a neat appearance free from runs, sags, or other application defects. All painted surfaces which become scratched or damaged during shipment, storage, handling, or installation shall be restored to in-plant, pre-delivery finished appearance. Touch-up paint shall be identical in all respect to the painted surface to be restored.

B. Exposed Areas

Areas exposed to corrosive fluids or cleaning solutions shall be protected with the following:*_____.

C. Low Alloy, High Tensile Steel

Following fabrication, low alloy, high tensile steel parts shall be prepared for painting in conformance with ASTM D-2200, and immediately thereafter shall be painted with one coat of primer conforming to Federal Specification TT-P-664 plus one coat of sealer gray paint to preclude rusting. The underframe shall receive two coats of sealer gray paint in addition to the initial primer coat.

D. Enclosure Interior

Equipment enclosure interiors shall be primed and single-coated with white insulating varnish or shall be single-coated with insulating varnish and finish-coated with a white enamel.

*Purchaser completing detail

E. Fire Retardation

Only paints that conform to the fire retardation requirements of ASTM-D-1360 and ASTM D-1361 shall be used.

F. Exterior

Painting of fiberglass-reinforced plastic on the car exterior shall be single-coated with a primer and double-coated with a synthetic acrylic enamel. The final coat shall be graffiti-cleaner resistant.

If painted, the body shell shall be protected with a primer and a high-gloss acrylic enamel paint. The final coat shall be graffiti-cleaner resistant. If painted, the painting process shall comply with the requirements of Section 6.8.1.

6.9 FIRE SAFETY

6.9.1 GENERAL

All combustible materials used in the car shall meet the requirements specified in this section. This section is a condensation of Appendix C, Guidelines for Flammability and Smoke Emission Specifications.

6.9.2 FLAMMABILITY

A. Scope

These requirements shall apply to all combustible materials used in the car, except electrical insulation.

B. Thermal and Acoustical Insulation

Thermal and acoustical insulation shall comply with the following requirements throughout the life of the car:

1. The flame propagation index (Is) shall not exceed a value of 25 during the ASTM E-162-76 Radiant Panel Test.
2. There shall be no flaming, running, or dripping of material.
3. Wire mesh screening shall be used (per Section 5.9.2 of ASTM).
4. A 6 inch (152 mm) pilot flame shall be used (burner tip situation 1-1/4 inch (38 mm) beyond the flame to prevent extinguishment).
5. The back and sides of the specimen shall be wrapped with aluminum foil.

C. Miscellaneous

Exterior shell, windscreens, seat frames, seat shrouds, partitions, ducting, and rubber flooring material shall be capable of passing the ASTM E-162-76 Radiant Panel Test with a flame propagation index (Is) not exceeding 25, without flaming or dripping.

D. Flooring

The complete floor assembly/structure shall be capable of meeting the requirements of ASTM E-119 (latest revision)

when exposed for either a nominal or a minimum test period, whichever is greater, to the heat source on its underside. The minimum test period shall be 15 minutes.

E. Equipment Panels

All panels that provide separation between the car interior and any electrical or mechanical equipment, other than: communication panels, light switches, destination switches, etc., shall meet the requirements of ASTM E-119 (latest revision).

F. Elastomers

Elastomers shall meet the requirements of ASTM C-542-71A, without flaming or dripping.

6.9.3 SMOKE EMISSION

A. Sccepe

These requirements shall apply to all combustible materials used in the car except electrical insulation. However, electrical insulation shall possess all of the electrical properties specified in Section 1.9.4.

B. Testing Requirements

All materials shall be tested for smoke emission in accordance with NFPA Standard No. 258-76, Standard Test Method for Measuring the Smoke Generated by Solid Materials. The optical density, D_s , in either flaming or nonflaming modes, determined in accordance with the test, shall have the following limits:

For air ducting, thermal and acoustical insulation, and insulation covering, Ds shall not exceed 100 within 4 minutes after the start of the test. Dm shall not exceed 300.

For all other materials, with the exception of flooring material, Ds shall not exceed 100 within 90 seconds after the start of the test, and shall not exceed 200 within 4 minutes after the start of the test. Dm shall not exceed 300.

6.9.4 ELECTRICAL INSULATION

Guidelines for the selection and specification of electrical insulation for use in transit fire environments are contained in the following reports:

- a. UMTA-MA-06-0025-79-1, Flammability Tests. Electrical Insulation Fire Characterists, December, 1978.
(PB#294-840/4WT)
- b. UMTA-MA-06-0025-79-2, Toxicity, December, 1978.
(PB#294-841/2WT)

The contents of these reports shall be used as guidance in the selection and specification of electrical insulation materials, in consideration of the various fire environments and related contending procedures disclosed by the system design.

6.10 SYSTEM SAFETY

The contractor shall ensure system safety by the preparation of the safety engineering analysis and the system safety program required by Section 18.5.

SECTION 7
THE CARBODY



SECTION 7

THE CARBODY

7.1 GENERAL

This section specifies construction and performance of the carbody, including the basic shell and all related structures and elements which together shall make up a finished car. Carbody structural integrity shall meet the operational performance and safety requirements specified herein. The carbody arrangement and dimensions shall be in conformance with purchaser's Specification Drawings and Figure 3-1.

7.2 STRENGTH REQUIREMENTS

7.2.1 COMPRESSION LOADING

The baseline car shall be designed for a static compressive end load of 200,000 pounds (90 718 kg) acting along the carbody longitudinal centerline, and distributed at the center of the anticlimber over an area not exceeding 100 square inches (650 square cm) without permanent deformation of any part of the carbody structure. The combined stresses due to the above loading condition acting in conjunction with the vertical load condition of Section 7.2.2 shall not exceed 80 percent of the structural material yield strength. The carbody shall be tested for this combined load condition in accordance with the plan required by Section 19.3.4.

7.2.2 VERTICAL LOADING

A vertical, evenly distributed load of AW3-minus-AW0 applied to the structure shall not cause the stress level in any structural member to exceed 50 percent of the yield strength of the materials of construction.

A. Stiffness

Carbody stiffness under all vertical loading conditions shall be compatible with the camber requirements of this Section and with the vibration and noise requirements of Sections 3.4.2 and 3.5.

B. Camber

The carbody shall be constructed with 0.75 inches (19 mm) maximum positive camber measured relative to a horizontal line between bolsters, and shall result in a camber no less than zero with an AW3 load. Camber measurements shall be made at each side sill at locations midway between bolsters.

7.2.3 COLLISION POSTS AND CORNER POSTS

Each car end shall consist of steel framing members which in turn consist of two forward collision posts (one at each side of the end door opening) and two forward corner posts. Each forward post shall span the underframe structure and anti-telescoping plate.

7.2.4 LOADING REQUIREMENTS - COLLISION AND CORNER POSTS

Carbody end structures shall be designed in accordance with the requirements of Section 18, Vertical End Members, of the AAR Specifications for the Construction of New Passenger Equipment Cars.

In addition to these requirements, the collision posts and corner posts, their attachments, and supporting structures shall withstand the following static design loads without yielding or buckling:

Member	Design Load	
	lbs.	kg
Each End		
1. Forward Collision Post	126,000	57 152
2. Forward Corner Post	42,000	19 050

Each of the above loads shall be applied longitudinally in a plane 18 inches (457 mm) above the top of the underframe and shall bear over the front face of the post for a height of 6 inches (152 mm).

7.2.5 TRUCK CONNECTION

A truck safety mechanism shall provide a connection between carbody and trucks such that the trucks shall be raised with the carbody unless intentionally detached therefrom. Positive stops shall be provided on the carbody and truck bolsters to limit the vertical and transverse movement of suspended trucks. The truck-to-body connection shall withstand an ultimate shearing value of 150,000 pounds (68 039 kg) and a vertical load of 50,000 pounds (22 500 kg). The car underframe at each truck attachment site shall support the weight of a suspended complete truck without exceeding the allowable stresses specified in Section 7.2.2. Bolster-locating rods may be used to attain 15,000 pounds (68 039 kg) longitudinal strength.

7.2.6 CRASHWORTHINESS

The carbody shall be designed with maximum energy-absorbing capability within the specified strength parameters. In the event of a collision between trains on level tangent track with mating anticlimbers locked together, the crushing of the structure shall commence at the extreme ends and progress toward the bolster. Each entire end shall remain intact and attached to the roof and floor structure.

The contractor shall submit a crashworthiness analysis (CDRL) to include a mathematical demonstration that each car shall be constructed to assure that energy shall be absorbed by crushing all car ends in a train in a collision on level tangent track prior to commencement of crushing between bolsters on any car within either of the trains involved in the collision.

● 7.2.7 JACKING

The side sills shall be designed to provide lifting or jacking points in accordance with the following detail:

* _____ . The lifting or jacking points shall be:

- Pads at the bottom of the side sills at centerline of bolsters designed for supporting a de-trucked car
- Pads at the bottom of the side sills between bolsters designed for lifting of car with lift hooks

* Purchaser completing detail

- Pads at the bottom of the extreme ends of the side sills designed for jacking of car along the right-of-way
- Pads located to accommodate maintenance facility requirements

Lifting or jacking at the pads shall not produce stresses greater than one-half of the yield point of the materials of construction.

The carbody shall also be capable of resisting, without permanent deformation all torsional and bending loads caused by any jacking condition, including diagonal jacking at two of the most adversely opposed jack pads.

7.2.8 EQUIPMENT SUPPORTS

The underframe structure shall provide equipment supports of sufficient strength and rigidity to meet both the vibration requirements specified in Section 3.5 and the following ultimate load conditions:

- Any longitudinal direction 8.0 g
- Any lateral direction 3.0 g
- Any vertical direction 4.0 g

Equipment mounting bolts shall be installed heads-up and in a manner to assure accessibility of mounting bolt heads.

A. Underfloor Equipment

Underfloor equipment shall resist without failure the following ultimate load conditions:

- In any longitudinal direction 6.0 g
- In any lateral direction 2.0 g
- In any vertical direction 3.0 g

Following the loss of one support point, the remaining supports shall restrain the equipment in a support structure under 1.5 g vertical loading, acting downward. All supports shall be fatigue-resistant throughout the car's design 30-year life. Mounting fasteners shall not restrain equipment in tension or shear against the force of gravity.

7.3 CARBODY SHELL STRUCTURE

The car shell structure shall meet all design and strength requirements specified herein. Construction shall provide structural stiffening and reinforcing members as required for structural integrity, equipment mounting, and for cosmetic appearance. Drain holes shall be provided where necessary to preclude water entrapment. In areas where water might be ingested; such as, but not limited to, door pockets and air inlets, corrosion-resistant drain pans and drain lines shall be provided to ensure diversion of drain water clear of all equipment and structure.

Equipment shall be safety-hung such that, in the event of a fastener failure, the equipment shall be held captive.

7.3.1 GENERAL DESCRIPTION AND APPEARANCE

The body shell shall include: sides, roof, and end assemblies mounted to underframe and subfloor. Visible fastener heads shall be minimized. Visible resistance welds shall cause a minimum of surface indentation and material discoloration and shall be arranged in uniform patterns.

Samples shall have a minimum surface area of 12 inches by 6 inches (305 mm by 152 mm) and shall include resistance welds if they are to be used in body shell construction.

7.3.2 INSULATION

A. Heat Transfer

Heat transfer through the carbody shall not exceed a rate of 800 Btu/hr/degree F (422 watts/hr/degree C) with the car stationary, out-of-tunnel, all windows and doors closed, and no mechanical or electrical car-mounted equipment operating.

B. Properties

All insulating material not impervious to fluid entrapment shall be completely enclosed in watertight material. Insulating material shall be self-extinguishing, resistant to dilute acids, greases, gasoline, aliphatic oils, and vermin. It shall be unaffected by sunlight and ozone and shall not embrittle with age. Insulation shall be held securely in place by mechanical means which shall not fail because of vibration. Fire safety characteristics of the insulation shall conform with Section 6.9.

Insulation shall be installed in accordance with supplier's recommendations. Prior to being overlaid with insulation, parts subject to corrosion shall be treated to precluded corrosion.

Insulating materials shall meet the following application requirements:

- Rigid insulation Glass fiber pre-formed board shall be acceptable.
- Non-rigid insulation Spun glass fiber batts or rolls shall be acceptable.

Fiberglass batts and rolls shall be cut 0.5 inch (13 mm) oversize prior to installation and shall have the edges suitably protected to prevent fraying.

C. Materials

All insulating materials shall be graded and labeled, Standard, by the appropriate industry associations and underwriters. Labels shall either be permanently affixed to the materials, or the label information shall be imprinted onto the materials.

7.3.3 UNDERFRAME

The underframe shall consist of the structural assembly on which the floor shall be mounted and to which the sides, ends, trucks, couplers, and undercar equipment shall be attached. Material and construction requirements shall be as described in these Specifications, shall resist the coupler and draft gear-induced loads specified in Section 12.3, shall withstand the truck ultimate longitudinal shear load as specified in Section 11.3.4A, and shall withstand AW3 vertical loading.

A. End Underframes

The end underframe shall be a welded assembly consisting of the end sill, draft sill, and bolster. If single bevel welds are used, backup strips shall be included. The assembly shall act as an integral unit to transfer loads generated at the anti-climber, coupler, and truck interfaces. The design shall provide for load path continuity at joints.

B. Draft Sill

The draft sill structure shall be designed to resist the buff and draft loads induced by the coupler-draft gear unit as specified in Section 12.3 in addition to any loads induced by the anticlimber as described in this section. No damage or permanent deformation shall result from any loading up to the load which activates the emergency release mechanism in the draft gear. Bolt-hole elongation shall not result from any load specified in Section 12.3.

C. Body Bolster

The body bolster shall be a built-up structure capable of transferring all loads passing between the trucks and the carbody. The bolsters shall be capable of reacting to any design loads transferred from the draft sill. Fatigue-resistant design shall be a prime requirement of the body bolster structure.

D. End Sill

The end sill structure shall be the mating structure between the anticlimber and the draft sill for the transfer of collision loads. Together with the end frame structure, the end sill structure shall be capable of reacting, without permanent deformation, to a 75,000 pound (24 020 kg) vertical load, acting vertically and induced by the anticlimber.

E. Crossbearers

Crossbearers shall be the main lateral floor beams which tie securely to the side sills to form the basic framing for support of the floor panels and the underfloor equipment units. Supplementary beams and intercoastals shall be used as required for equipment support and to control floor deflection. Primary loading shall consist of passenger, floor, and interior item weights, together with specific underfloor equipment loads. Vertical, lateral, and longitudinal load conditions shall be generated by underfloor equipment units as specified in Section 7.1.1.

F. Anticlimbers

An anticlimber shall be attached to each of the end sills of each car and shall extend laterally over at least the middle one-third car width. The anticlimber shall be an assembly of two 3-inch (76.2 mm), 7.1 pounds per foot (9.75 Newtons) ship channels welded together with the assembly welded to the underframe end sills.

G. Side Sill

The side sill shall be that part of the underframe to which the side frames are attached at laydown.

H. Subfloor

The subfloor area under the plymetal floor shall be insulated against heat and sound transfer with materials specified in Section 6.4.6. The subfloor structure shall provide for shielding and retention of the insulation and for vertical load transfer between the floor and main underfloor beams. The retaining sheets shall be adequately reinforced to prevent sagging and drumming. Openings in the subfloor shall be minimized. Essential holes shall be fitted with effective protective covers.

7.3.4 CAR ENDS

A. Cab End

Each cab end may consist of a molded fiberglass reinforced plastic shell over metal framing members as specified in Section 6.4.12. The end frame structure shall be so designed that the fiberglass reinforced plastic end shall not carry any of the loads or forces on impact or collision. All forces shall be transmitted to the car through the end frame primary structure. The fiberglass reinforced plastic end shall not be considered to be part of the car structure.

B. Non-Cab End

The non-cab end shall be of all metal construction with exterior sheathing as specified in Section 7.3.1.

7.3.5 CAR SIDES

The sides shall consist of outer skin, vertical post framing members, and longitudinal stiffening members between the roof rail and the side sill. The side structure shall withstand without exceeding 50 percent yield the loadings induced by vertical bending, carbody compression, and car jacking.

Adequate reinforcement shall be incorporated into the members framing the door and window openings to limit deflection and fatigue stress. Deflection shall not act to restrict side-door operation nor to cause window glazing to loosen, leak, or suffer damage. No wrinkles, buckles, waves, etc., shall be permitted. The sides shall be corrugated or as smooth as possible on the outside with a maximum acceptable variation from a straight line on flat surfaces of 1/8 inch (3.0 mm) in 3 feet (914 mm) measured in any direction. The slope of any such deviation shall not exceed 3/16 inch (4.76 mm) in 12 inches (304.8 mm).

7.3.6 ROOF

The roof structure shall consist of outer skin over carlines. The skin may include corrugated material. Rain gutters shall extend over side doors, train crew side windows, and openable side windows. The roof structure shall withstand without yielding the loads of roof-mounted equipment and passenger seat support stanchions and handholds in addition to the following:

- Vertical down loads of 250 pounds (113 kg) spaced every 30 inches (762 mm) corresponding to a maximum of three people on the roof at the same time.
- A normal pressure of 60 pounds per square foot (293 kg/m^2) to allow for passage through a car washer. The wash zone shall be assumed to be limited to a 12-inch (305 mm) wide band extending transversely across the carbody.

The joints shall be sealed with a waterproof compound.

7.3.7

FLOORS

Floors shall include the panels on which the interior covering shall be laid together with the necessary under-floor beams attached to the underframe structure. The floor shall experience no permanent deformation during the normal design life of the car. The floor shall be designed to withstand the dead load plus an equivalent passenger load of 100 pounds per square foot ($488.3/\text{m}^2$) without exceeding 50 percent of the yield stress of the material.

Vertical deflection shall be limited to $1/360$ of the short span. Floor panel splices shall be arranged to coincide with structural underfloor members. The floor shall consist of plymetal panels which shall be fastened to the underframe in such a manner as to prevent chafing or horizontal movement between adjacent surfaces.

Acoustical and vibration isolation shall be provided between the floor and the underfloor and shall comply with the requirements of Section 3.4. The assembled floor shall be level

and flat, except for specified camber, with the upper surface free from indentations. All exposed edges of the floor panels shall be sealed, including openings for ducts, conduits, and joints between floor sections. The assembled floor shall meet the flammability requirements of Section 6.9.2E.

7.3.8 UNDERFLOOR

Underfloor equipment shall be arranged in conformance with the mock-up specified in Section 5.1.1. Equipment requiring periodic inspection shall be accessible without requiring removal of other apparatus. All underfloor equipment shall be readily accessible either from maintenance pits or from car side. All underfloor equipment and structure shall be painted.

7.4 GLAZING

● 7.4.1 General

Alternate I*

Laminated Safety Glass

All windows and glazing applications shall be located and installed where indicated on Specification Drawing ** _____ . Laminated safety glass shall be in accordance with Figure 7-1A except as otherwise specified. The windows shall consist of a lower portion of glass glazed directly into openings

* Purchaser will delete undesired alternates

** Purchaser completing detail

provided in the car structure and an upper portion of glass within that part of the window arranged as a ventilating panel.

FIGURE 7-1A. LAMINATED SAFETY GLASS DESCRIPTION

<u>Application</u>	<u>Color</u>	<u>Light Transmittance</u>	<u>Material Thickness</u>
Passenger side windows	Clear	No less than 82 percent with 0.25 inch (6.25 mm) thickness	0.25 inch (6.35 mm)
Cab side, side doors, and non-cab end	Clear	No less than 82 percent with 0.25 inch (6.35 mm) thickness	0.375 inch (9.5 mm)
Interior partitions, doors, and windscreens	Clear	25 percent with 0.25 inch (6.35 mm) thickness	0.25 inch (6.35 mm)

Alternate II*

Plastic Glazing Material

All windows and glazing applications shall be located and installed where indicated on Specification Drawings**.

Plastic glazing material shall be in accordance with Figure 7-1B, except as otherwise specified. The windows

* Purchaser will delete undesired alternates

** Purchaser completing detail

shall consist of a lower portion glazed directly into reinforced openings provided in the car structure and an upper portion within that part of the window arranged as a ventilating panel.

Plastic glazing material shall be capable of passing ASTM E 162-76, Radiant Panel Test with a flame propagation index not exceeding 100.

FIGURE 7-1B. PLASTIC GLAZING MATERIAL DESCRIPTION

<u>Application</u>	<u>Color</u>	<u>Light Transmittance</u>	<u>Material Thickness</u>
Passenger Side window	Tinted bronze to match Lexan color No. 71006	25 percent with 0.25 inch (6.35 mm) thickness	0.25 inch (6.35 mm)
Cab side, side doors, and non-cab end	Clear	Not less than 82 percent with 0.25 inch (6.35 mm) thickness	0.375 inch (9.5 mm)
Interior partitions, doors, and wind-screens	Tinted bronze to match Lexan color No. 71006	25 percent with 0.25 inch (6.35 mm) thickness	0.5 inch (12.7 mm)

● ● 7.4.2 END WINDOWS

A. Cab End

Cab-end windshields shall meet all applicable requirements of ANSI Z26.1 for windshield safety glass. The glazing material shall be retained in a continuous neoprene glazing section and shall be replaceable from outside the car without the need for sealing compounds. Windshields shall have the following characteristics:

1. Strength Requirements Windshields and glazing applications shall withstand pressure loads with a minimum safety factor of 2.5. Deflection shall be limited to 1/80 of the short span with the specified pressure and impact loads acting normal to the window surface. Both positive and negative pressures shall be considered. The pressure load shall be 50 pounds per square foot (244 kg/m^2) during the deflection test. The windshield shall withstand the impact load of a 5 pound (2.25 kg) steel ball at 70 mph (112 kmh). Any penetration shall be confined to the outer layer. The inner layer shall not be penetrated and shall not release fragments into the car interior. The retaining frame shall securely retain the glazing material without suffering permanent deformation.
2. Optical Properties Visible light transmittance measured normal to the windshield surface shall meet the requirements specified in ANSI Z26.1.
3. Service Life The windshield shall have a service life of a minimum of two years without degradation of the optical properties below the specified values due to windshield wiper action, defroster thermal effects, delamination, or weathering. The inner surface of the windshield shall be resistant to cleaning agent damage when cleaned in accordance with supplier recommendations.

B. Non-Cab End

Alternate I*

1. Non-Cab End The windows at the non-cab end shall be single-glazed, clear laminated safety glass.

Alternate II*

1. Non-Cab End The windows at the non-cab end shall be plastic glazing material. #

● ● 7.4.3

SIDE WINDOWS

Alternate I*

A. Cab Side Windows

The side windows of the operator cab shall be of single-glazed, clear laminated safety glass, shall slide (retract longitudinally), into the car wall with a smooth motion, and shall be manually operable. The windows shall be rattle-free and airtight.

Alternate II*

A. Cab Side Windows

The side windows of the operator cab shall be of plastic glazing material, shall slide (retract longitudinally),

*Purchaser will delete undesired alternate

into the car wall with a smooth motion, and shall be manually operable. The windows shall be rattlefree and airtight. #

B. Passenger Compartment Side Windows

Passenger compartment side windows shall be single-glazed and split-vent style with upper quarter of each window operable inward.

Alternate I*

1. Glazing material shall be laminated safety glass.

Alternate II*

1. Glazing material shall be plastic glazing material. #
2. Window sash shall be retained in the window opening with integral removal seals, shall be readily removable in the event of an emergency and shall be capable of replacement from outside the car with tools normally found in rapid railcar maintenance shops but without sealing compound.

7.4.4

DOOR WINDOWS

A. End Doors

End door windows shall be in accordance with Section 7.4.1B.

* Purchaser will delete undesired alternates

Alternate I*

B. Side Doors

The upper half of each side door leaf shall contain a single-glazed window set directly into neoprene glazing strips. The window shall be laminated safety glass.

Alternate II*

B. Side Doors

The upper half of each side door leaf shall contain a single-glazed window set directly into neoprene glazing strips. The window shall be plastic glazing material. #

C. Interior

Alternate I*

1. Cab Door The interior cab door shall have a window in the upper half of laminated safety glass in accordance with Section 7.4.4 and with the characteristics described in Figure 7-1A.

Alternate II*

1. Cab Door The interior cab door shall have a window in the upper half of plastic glazing material in accordance with Section 7.4.4 and with the characteristics described in Figure 7-1B.

* Purchaser will delete undesired alternates

To preclude light from the passenger area from reflecting in the operator's windshield, the laminated safety sheet glass shall contain a polarized zero-degree, black louvered light control film interlayer. The louvers shall be oriented vertically. #

2. Windscreen The glazing material for the upper half of the windscreens located transversely between each side door opening and adjacent longitudinal seat shall be * _____.

Alternate I**

● ● 7.4.5

LAMINATED SAFETY GLASS

Laminated safety glass shall conform to ANSI Z26.1, and shall be formed of a minimum of two plies of glass, separated by one ply of polyvinylbutyral (PVB). All glass edges shall be SAE No. 6 Edgework. Color light transmittance and thickness shall be as specified in Figure 7-1A. Map frames shall be protected by a .12 inch (3.05 mm) thick crystal sheet glass.

Alternate II**

7.4.5

PLASTIC GLAZING MATERIAL

Plastic glazing material shall have a minimum service life of 5 years without developing haze greater than 5 percent, and shall withstand the normal impact of a solid 5 pound (2.25 kg) steel ball at 25 mph (40 kph) at the centerpoint. Penetration shall be confined to the outer glazing. Color, light transmittance, and thickness shall be as specified in Figure 7-1B. #

* Purchaser completing detail

** Purchaser will delete undesired alternates

7.5. DOORS

7.5.1 GENERAL

All exterior doors, except end doors, shall be sliding doors which fully retract into adjacent side wall pockets upon opening. The outer skin of each exterior door shall be the same facing material as the car skin. The inner surface of the outer skin of all exterior doors shall be coated with a vibration damping material if the doors are not of honeycomb construction. The design of the bottom guide and threshold shall act to minimize dirt and debris accumulation and shall eject foreign material from the track during door operation. Doors in the closed position shall not rattle or vibrate.

● ● 7.5.2 END DOORS

A. General

Alternate IA*

Both end doors shall be single leaf, sliding-type and manually operable.

Alternate IIA*

Both end doors shall be single leaf, inward swinging, and manually operable.

Alternate IIIA*

Both end doors shall be single leaf, outward swinging, and manually operable.

* Purchaser will delete undesired alternates

Alternate IB*

The end door of the cab end shall be single leaf, sliding, plug-type, hinged door of metal-faced construction, manually operated, and shall have a mechanism that shall cause the door to close and latch when released.

Alternate IIB*

The end door of the cab end shall be single leaf, inward swinging, plug-type, hinged door of metal-faced construction, manually operated, and shall have a mechanism that shall cause the door to close and latch when released.

Alternate IIIB*

The end door of the cab end shall be single leaf, outward swinging, plug-type, hinged door of metal-faced construction, manually operated, and shall have a mechanism that shall cause the door to close and latch when released.

Alternate IC*

The end door of the non-cab end shall be single leaf, sliding, plug-type, hinged door of metal-faced construction, manually operated, and shall have a mechanism that shall cause the door to close and latch when released.

Alternate IIC*

The end door of the non-cab end shall be single leaf, inward swinging, plug-type, hinged door of metal-faced construction, manually operated, and shall have a mechanism that shall cause the door to close and latch when released.

* Purchaser will delete undesired alternates

Alternate IIIC*

The end door of the non-cab end shall be single leaf, outward swinging, plug-type, hinged door of metal-faced construction, manually operated, and shall have a mechanism that shall cause the door to close and latch when released. #

B. Construction

Each end door shall have a window in the upper half of a type specified in Sections 7.4.1A and 7.4.1B. Door seals shall be airtight during train operation. The doors and latches shall withstand a pressure of 50 pounds per square foot (244 kg/m^2) with a minimum safety factor of 2.0 against yield.

C. Hardware and Mounting

Alternate ID*

Each non-cab end door shall be single leaf, hung at the top from a low friction self-aligning, ball arrangement, and with a guide at the bottom to restrict lateral movement. Doors in the closed position shall not rattle or vibrate.

Alternate IID and IIID*

Cab end doors shall be hinged and manually operable with a mechanism that shall cause self-closing and latching when released. The mechanism shall have an adjustable decelerating device to ensure a safe closing operation. #

* Purchaser will delete undesired alternates

Provisions shall be made for locking the end doors in the closed, latched position using the purchaser's standard key. On both F and R ends, the purchaser's standard key shall be limited to use from the inside of the car to lock or unlock the inside handle only. The outside handle is to be operable under all conditions. Handles shall be arranged so that vibration cannot cause the latch to move to the opposite position while either engaged or disengaged. An emergency door lock release mechanism shall be provided which shall be operable only when the car is stationary.

An electrical unlocking device shall be provided for the operator's use.

● ● 7.5.3

SIDE DOORS

A. General

Side doors shall be bi-parting sliding doors, with each leaf fully retractable into the adjacent side wall pocket upon opening. Each door leaf shall be actuated by:

Alternate I*

an electro-mechanical door operator

Alternate II*

a pneumatic-mechanical door operator #

as specified in Section 10.1. All door leaves of the same hand designation shall be interchangeable. There shall be a window in the top half of each door leaf as specified in Section 7.4.3.

* Purchaser will delete undesired alternates

B. Construction

Door panels shall be of metal-faced construction, using the same facing material as the car exterior. All joints and edges shall be sealed except where a hollow-type construction is used. Interior surfaces of hollow-type construction shall receive a protective coating in accordance with Section 6.5. Each door panel shall be insulated, and drain holes shall be provided in door bottoms.

C. Hanging

Each door leaf shall be hung at the top from a low friction, self-aligning, ball arrangement with a guide at the bottom to restrict lateral movement. Doors in the closed position shall not rattle or vibrate. Door hangers shall be designed for off-vertical hanging and shall provide at least two points of support to effect true alignment. Hanger and track shall be accessible for inspection, adjustment, and door removal. Hangers shall have provisions to permit vertical adjustment and shall be weatherstripped. Door stops shall also be provided. Design of the bottom guide and thresholds shall act to preclude any foreign material from affecting operation of the door.

D. Strength and Rigidity

Side doors shall have sufficient strength and rigidity to sustain, with a maximum deflection of 0.25 inches (6.4 mm) and without permanent deformation, a load of 200 pounds (90 kg) applied to the inside of the door plane at the center of the front edge, over an area of 6 square inches (38.7 cm^2) while the door is supported on blocks at both ends.

Side doors shall be equipped, on their closing edge, with a quick disconnect and adequately secured detachable section to which shall be applied formed elastomer buffers of one-piece design and quality. The design of the elastomer door edge shall form an effective noise and weather seal and shall permit the car to be pressurized. The elastomer door edges for the right and left door leaves shall be identical. The door shall open against resilient elastomer bumpers mounted in the door pocket.

E. Sealing

Doors shall be sealed against weather, sound transfer, and conditioned air outflow. Water entry into the car shall be precluded under all operating conditions, including passage through a car wash. Fasteners used to attach weatherstripping at the edges of the door shall be locked to preclude their backing out or marring the finish on the inside of the door. A corrosion-resistant drain pan shall be located below the floor in each door pocket area and shall drain water clear of all underfloor apparatus.

● 7.5.4 INTERIOR DOORS

A. Construction

Interior cab doors shall be single-leaf panels, 1 inch (25.4 mm) thick. The upper portion of each door shall contain a window in accordance with Section 7.4.3C. Ventilation through the door shall be accomplished as follows

* _____ .

* Purchaser completing detail



SECTION 8
OUTFITTINGS AND FURNISHINGS



SECTION 8

OUTFITTING AND FURNISHINGS

8.1 GENERAL

This section provides the level of detail appropriate to ensure that both the interior and exterior of the car shall be outfitted and furnished in accordance with the purchaser's requirements.

Details of the operator cab are specified in Section 9.

8.2 OUTFITTING

● 8.2.1 SPECIAL PROVISIONS

A. Elderly and Handicapped Provisions

A dedicated space for priority seating and wheelchair patrons shall be provided in each car. Handholds and stanchions shall be provided to facilitate the movement of elderly and handicapped passengers. Clearances required for wheelchair movement shall be demonstrated in the sample car.

B. Emergency Equipment

A fire extinguisher conforming to the following requirements shall be provided in the operator cab of each car: * _____.

* Purchaser completing detail

The fire extinguisher shall be clearly identified, shall be installed to permit inspection without removal, and shall bear the purchaser's identity permanently inscribed into the outer surfaces of the unit.

Mounting brackets and attachments shall not yield at the following loads, acting independently and in any direction: 3g vertical, 6g longitudinal, and 2g lateral. Mounting provisions shall preclude fire extinguisher rattling and shall include a quick-release latch.

● 8.2.2 PASSENGER AREA APPOINTMENTS

A. General

All interior appointments and their detail shall be in accordance with this section and with Sections 3 and 6.

There shall be no sharp corners, edges, or protrusions which could cause personal injury. Thermal coefficients of expansion shall be matched, accommodated, or otherwise provided for. Specification compliance shall be demonstrated in the sample car.

Repair and cleaning procedures for all car interior materials shall conform to the following requirements: * _____.

B. FLOOR COVERING

As specified in Section 6.4.14.

* Purchaser completing detail

●8.2.3 CEILING AND WALL LINERS

A. General

All liners shall conform to the following requirements:

1. Materials, colors, texture, and designs of installed interior liners including fasteners and fastening methods will be provided to the contractor by the purchaser's industrial design contractor.*_____.

A maximum of three types of fasteners shall be permitted.

2. Liners shall be designed to eliminate unnecessary joints and to accommodate dimensional changes due to manufacturing tolerances and environmental conditions.
3. Liners and panels shall provide a safe and functionally integrated car interior.
4. Anti-squeak tape shall be used between liners and any structure which they contact or to which they shall be attached. Only one layer of tape shall be applied.
5. Attachment to car structure shall be made with concealed fasteners. Liners covering components requiring maintenance shall be hinged and also equipped with captive, quick-release fasteners on the other edges.

* Purchaser completing detail

B. Ceiling Liners

All ceiling liners, including access panels, shall be constructed of 6061-T4 aluminum alloy panels with a porcelain finish. The backing surface of ceiling liners shall be covered with sound and vibration-absorbing material.

C. Sidewall Liners

Wainscot panels shall either be of integrally colored, high-pressure laminate faced aluminum, or of rigidized stainless steel. The backing surface of wainscot panel liners shall be covered with sound and vibration-absorbing material.

D. Windshield and Side Window Masks

Masks for each windshield and side window shall be one-piece molded fiberglass-reinforced polyester or plastic and designed to eliminate dirt collecting areas.

E. Side Door Pockets

Side door pockets shall be of the same material as window masks, or aluminum-faced with high pressure laminate. Each door pocket shall be one piece and shall incorporate an access panel to the door mechanism for maintenance purposes. Pocket design shall provide an area in the upper portion to accommodate a frame for glass or plastic-covered transit system maps or unenclosed advertising.

8.2.4 CAR ENDS, BULKHEADS, AND PARTITIONS

A. General

Car ends, bulkheads and partitions shall be of integrally colored, high-pressure laminate.

B. Windscreens

Windscreens shall be provided at each side of each side door. Each windscreen shall be designed to accommodate a glazed upper panel as specified in Section 7.4.4C2 and a lower panel constructed of plymetal with a decorative facing on each side. A stainless steel stanchion shall be designed as an integral part of the windscreen. The entire assembly shall withstand a load in any direction of 330 pounds (150 kg) without permanent deformation.

● 8.2.5 PANELS, DOORS, AND FRAMES

A. Access Panels and Doors

Access panels and doors shall match adjacent interior panels and liner materials and installation in all respects. They shall be designed to eliminate unnecessary joints and to accommodate dimensional changes due to manufacturing tolerances and carbody flexing, twisting, and vibrating. All finished access panels and doors and their adjacent openings shall incorporate a continuous U shaped edge reinforcement. Panels shall be retained by a continuous hinge extending the full length or height of each panel. Ceiling access panels to air conditioning evaporator units shall be hinged and equipped with fabric-covered safety chains and spring clips for access to, and removal of, equipment.

B. Heater Grille Panels

Heater grille panels shall be fabricated of stainless steel, perforated in a suitable pattern, and sloped to preclude accumulation of debris. Hole sizes and shapes shall preclude insertion of ballpoint pen-size instruments. The panels shall be secured at all edges with readily accessible concealed fasteners. Heater access shall determine the panel length and attachment method.

C. Display Frames

Frames for advertising or system maps with a viewing area 21 x 22 inches (533 mm x 559 mm) shall be provided on each side door pocket or as specified in drawing *_____ . Map frames shall enclose a protective glass or sheet of transparent plastic sheeting, and shall be interchangeable. Advertising shall not be covered by glass or plastic.

8.2.6 CABINETS AND HARDWARE

A. Equipment Cabinets

Cabinets housing electrical equipment shall be constructed of metal with doors of the same material. All air circulation grilles and louvers shall be stainless steel and designed to preclude insertion of foreign objects through grille openings. Cabinet tops shall be no higher than the lower edge of adjacent windows and shall be protected from weather. No equipment shall be located under seats.

* Purchaser completing detail

B. Interior Hardware

As specified in Section 6.4.5.

●8.2.7 LOCKS AND KEYS

A. Locks

All locks shall either be pickproof railway-type or pin-tumbler type. Locks shall be designed to last the life of the car.

B. Keys

Conforming to the following requirements:* _____ Car keys shall be required to operate all locks and controls on the car. All keys shall be the milled bit-type with drilled ends and of corrosion-resistant material. The keys shall be distinguishable from one another by size and shape.

Two sets of keys shall be provided for each car.

1. Master Control Key The master control key shall activate the operator console.
2. Door Operation Key The door operation key shall operate the side doors, end door electrical locks from the operator console and end signs and side signs.
3. Standard Car Key The standard car key shall operate all locks on the car not operated by the master control key.

* Purchaser completing detail

4. Registration All keys shall be registered for use exclusively on the purchaser's rapid railcars and shall be permanently marked: ILLEGAL TO DUPLICATE. All keys shall be delivered separately from the rapid railcars.

8.2.8 HANDHOLDS AND STANCHIONS

The car shall be equipped with handholds and stanchions for safe on-board circulation and to provide seating and standing assistance. Stanchions, handhold fittings, and connections shall be stainless steel tubing no greater than 1.625 inches (41.2 mm) in diameter (to include any insulation), shall provide rattelproof fastenings, and shall be free of burrs and sharp edges.

Each stanchion shall withstand, without permanent deformation, a load of 330 pounds (150 kg) applied normally at the midpoint of its free span. Each handrail shall withstand a distributed load of 10 pounds per inch (4.5 kg per 25.4 mm) applied at any angle within a 45 degree cone from vertical downward.

● 8.2.9 PASSENGER SEATING

GENERAL

A. Design Criteria

Passenger seats shall be designed in accordance with the human engineering criteria specified in Section 3.

B. Seating Arrangement

The seating arrangement shall conform with specification drawings * _____.

● 8.3 CAR EXTERIOR

A. Thresholds

Side and end door thresholds shall have an abrasive tread, anti-slip surface. End door walkways shall have a diamond pattern surface, shall cover the entire width of the door opening, and shall have weathertight connections.

B. Grab Handles

Grab handles shall be not less than 0.675 inches (17 mm) in diameter. A minimum clearance of 2 inches (51 mm) shall be provided between each grab handle and any part of the carbody, including doors and latch handles. Grab handles shall be within the clearances specified in Appendix A and located as follows: * _____.

C. Barriers at Corner Posts * _____

D. Climbing Steps

Climbing steps with anti-slip treads a minimum of 10 inches (254 mm) wide shall be provided to permit car entry through the end doors. The steps shall measure 8 inches (203 mm)

* Purchaser completing detail

clear depth and shall support the load imposed by a 300 pound (135 kg) person with a safety factor of 1.5 against yield. The steps shall be within the clearances specified in Appendix A.

E. Graphics, Markings, and Signs

1. General Exterior logotypes, car numbers, and passenger-assistance messages shall be as specified in Section 6.4.11 and in Specification Drawings * _____ and shall be demonstrated in the mock-up.
2. Passenger Assistance Information to assist the passenger; such as, wheelchair position location and availability, shall be in accordance with Specification Drawings. * _____
3. Car Number Signs Car number signs, with easily readable numerals on a contrasting background, shall be applied on both sides of each car at the cab end. Car numbers shall also be provided in the vicinity of the center of each undercar so that car identification can be readily determined from inside the pit.
4. Emblems and Logotypes All emblems and logotypes shall be applied in accordance with Specification Drawings.
* _____

* Purchaser completing detail

8.4

LIGHTING

● 8.4.1

CAR INTERIOR LIGHTING

A. Illumination Requirements

1. Intensity The average light intensity at the seated passenger's reading plane, after 20 hours of operation, shall be at least 35 footcandles (377 lx) with lamps operating at nominal voltage. Minimum intensity at car ends shall be 25 footcandles (269 lx). The task plane shall measure 14 inches (356 mm) square and shall be centered 33 inches (838 mm) above the floor, 24 inches (610 mm) from the front of the seat backrest, along the centerline of the individual passenger seat, and at 45 degrees from the vertical. Average light intensity at the floor in the passenger aisles shall not be less than 15 footcandles (161 lx).

2. Brightness Ratio The color and hue of the car interior shall be coordinated with the specified brightness ratios. Reflectivity of interior surfaces shall be no less than:
 - Ceiling 70 percent
 - Walls 60 percent
 - Floor 30 percent

The average brightness ratio between:

- Lighting fixtures and adjacent areas shall not exceed 80:1.
- Any adjacent areas in the normal field of view shall not exceed 60:1
- Maximum and average fixture brightness shall not exceed 5:1

The brightness area of concern is defined as: The area viewed by a foot-lambert instrument (brightness meter) which incorporates a 5 degree field of view for establishing relative brightness values. The normal field of view of the passenger is defined as: All angles below, or less than, 30 degrees above the horizontal plane in which zone all brightness evaluations are to be conducted. The contractor shall coordinate brightness requirements with the supplier and demonstrate specification compliance in the mock-up.

3. Fixtures

- a. Center Light Fixtures The fixtures, if used, shall conform to the following requirements

* _____.

The fixtures shall be arranged for relamping by means of a hinged fixture door which shall contain the lens. The fixture door shall be made with a concealed, hinged extrusion and a complimentary quick-acting closure device actuated by a single fastener. The fastener shall be held captive, and shall be designed to be vandal proof.

- b. Side Fixtures Side fixtures, if used, in the high ceiling area shall consist of seven 6 foot (1830 mm) and two 4 foot (1220 mm) fixtures for the A-car and B-car per side. Each fixture shall accommodate one 72 (1830 mm) or 48 (1220 mm) inch T-12 fluorescent lamp. Side fixtures in the low ceiling area shall consist of two fixtures per side each accommodating two 48 inch (1220 mm)

* Purchaser completing detail

T-12 fluorescent lamps. One fixture at each end of the car shall house one emergency lamp. A single ballast inverter shall be used to power two lamps. Where there is an odd number of lamps, the last lamp shall be powered by a single lamp ballast inverter. Side and end doors shall be illuminated during any emergency lighting activations.

The side fixtures shall be installed in a continuous line on each side of the car and shall provide direct lighting to the seated passenger's reading plane and shall contain provisions for back lighted advertising cards.

The lower portion of the fixture shall have a clear lens panel directing high intensity, glare-free light to the reading plane of the passenger. The lens shall have no grooves, ridges or crevices which could accumulate dust and dirt.

The curved front portion of the fixture shall be a door with a translucent panel with provision for mounting a translucent advertising card 11 inches (274 mm) high. Translucent advertising cards shall not be used in the end fixtures in the low ceiling area. The front translucent door shall provide additional light for the standing passenger. This door shall be made with the top member as a concealed hinge extrusion and the bottom member as an extrusion with a complementary quick acting closure device actuated by a single, vandal proof captive fastener. Access to fluorescent lamps for relamping shall be through this door.

The diffusing lens and curved front portion of the fixture shall be of the same material approved for the center lighting fixture lens.

The housing of the fixture shall be aluminum and shall contain hinged access panels to permit access to door track, wire ways and other equipment located behind the fixtures. All access panels shall be provided with a minimum of quick fasteners consistent with good design. Fasteners shall be held captive and shall be designed to be vandal proof.

B. Operator Cab

As specified in Section 9.

8.4.2 CAR EXTERIOR LIGHTING

A. Marker Lights

Marker (running) lights shall be installed on the upper corners of the F-end of each car. Assemblies shall incorporate a glass spread-type red lens 4 inches (102 mm) in diameter. Lamps shall be bayonet base-type of 40 watts. Peak intensity shall not be less than 87.6 foot-lambert (300 cd/m^2). The lamps shall be operated from the nominal 32-volt battery source and shall be controlled by a circuit breaker. Lights shall be interlocked with the coupler cutout device to permit illumination only on uncoupled ends of the train.

The housing shall be fabricated from 300 series stainless steel and shall form a watertight joint with the carbody. Maximum fixture size shall be 5.5 inches (138 mm) in diameter.

The fixture shall permit relamping from the outside. Covers shall be retained by captive fasteners.

B. Headlight and Taillight Installation

The sealed glass lamp shall be installed into stainless steel housings and retaining bezels. The headlight housing shall incorporate provisions for adjusting beam centerline over a range of +3 degrees in any plane. The retaining bezels shall be hinged and easily openable using standard tools. Headlight replacement shall be possible from the car exterior and shall not require aiming position readjustment. The housing shall form a watertight joint with the carbody. Two headlights and two taillights shall be provided on each car. Control of headlights and taillights shall be automatic, through the master controller. When the reverser key is in the OFF position, the circuit illuminating the red taillights shall be energized and the circuit illuminating the headlights shall be deenergized. When the reverser key is in the FORWARD position, the circuit illuminating the headlights shall be energized and the circuit illuminating the taillights shall be deenergized. The taillight of the last car shall be energized by a loop circuit in the coupler head as specified in Section 12.5.1E. The headlight and taillight circuits shall be carried through a coupler switch which shall automatically: (1) open the circuits when cars are coupled, extinguishing both headlights and taillights and (2) close the headlight and taillight circuits when cars are uncoupled, thereby permitting either the headlights or taillights to be energized in accordance with the position of the reverser key.

C. Headlight Performance

Headlights shall be clear lens, sealed-beam lamps of PAR 46, rated at 24,000 peak beam candlepower in a beam size of 8 degrees vertical and 17 degrees horizontal. (Beam width equals 10 percent of peak candlepower.) Lamp shall be similar to Model 60 PAR 1.

D. Taillight Performance

A 40 watt, 50 volt incandescent element shall be provided in a sealed reflector and red lens assembly to provide a wide beam for a highly visible warning signal.

8.4.3 EMERGENCY LIGHTING

All lights shall be retained functional and connected to the power bus as energized by the battery in the event of loss of traction/propulsion power. Ten seconds after loss of external power, two-thirds of the main ceiling fluorescent fixtures shall be automatically disconnected. The remaining one-third shall function as emergency lighting, shall be evenly distributed throughout the car, shall assure illumination of doorways, vestibules, and car aisleway; and shall be provided for a minimum time as determined by the analysis required by Section 13.5.9.

SECTION 8A
OUTFITTINGS AND FURNISHINGS (OPTIONS)



SECTION 8A

OUTFITTING AND FURNISHINGS OPTIONS

8A.1 GENERAL

The following option is provided and may be made part of the purchaser's procurement documentation.

If this option is chosen add the following to 8.3.E as number 5.

Miscellaneous Signs Underfloor apparatus shall be marked by means of embossed metal plates, welded or mechanically fastened to the apparatus being identified, and with the background lettering in a contrasting color. Each air brake reservoir and all cutout cocks, switches, fuses, and junction boxes shall be mark-identified. The cover of each apparatus box shall list each major item of apparatus contained therein. Warning advice, including the normal maximum voltages of circuits therein, shall be provided on the outside of boxes containing electrical apparatus energized at greater-than-battery potential. Identifying labels for switches, circuit breakers, terminal strips, and indicating lamps shall be of metal or plastic with depressed lettering of a color contrasting with the background.

Except as otherwise specified, exterior signs and numbers shall be decals of exterior-type decorative vinyl film, porcelain on steel, fiberglass reinforced plastic, or etched or engraved stainless steel filled with paint. Where logo-type is applied to vinyl film, it shall be protected by a final lamination of clear vinyl film. Edges of vinyl film shall be sealed in accordance with supplier recommendations.



SECTION 9
OPERATOR CAB



SECTION 9

OPERATOR CAB

9.1 GENERAL DESCRIPTION

The F-end of each car shall be equipped with a full-width operator cab. Operator cab doors and windows shall be lockable.

The operator cab and its equipment shall be arranged in accordance with Section 5.1.2A of the specification.

9.2 HUMAN ENGINEERING CRITERIA

Human engineering criteria, as specified in Section 3.6.4C, shall form the basis for efficient design and arrangement of the operator cab.

Design and arrangement of all controls, gauges, and switches, except system bypass switches, required for train operation shall permit identification and be within reach of a seated operator from a single, adjusted seat position. Design and specification compliance with criteria described in Section 3.6.4C shall be demonstrated in the mock-ups or sample car.

Preceding the appropriate design review, the contractor shall identify and provide to the purchaser a list of all person/machine interfaces (CDRL).

9.3

OPERATOR CAB DETAIL

The operator cab shall contain as a minimum the following:

- a. Adjustable Seat
- b. ATC Audible Tone Alarm
- c. ATC Equipment
- d. Automatic Sign Control
- e. Coat Hook
- f. Communications Control Unit (CCU)
- g. Contact Rail Shoe Paddles
- h. Control Console
- i. Door Controls
- j. Fire Extinguisher
- k. Handbrake
- l. Heater and Defroster
- m. High Voltage Control Panel
- n. Low Voltage Circuit Breaker Panel
- o. Operator Auxiliary Control and Indicator Panel
- p. Operator Cab Air Conditioning and Controls
- q. Overhead Lights
- r. Radio and Controls

9.4

OPERATOR CAB LIGHTING

9.4.1

DESCRIPTION

The operator shall be provided with an overhead ceiling-mounted fluorescent lamp fixture for general illumination of the equipment area. The console panel and all of the compartment shall be non-reflective.

9.4.2 INTENSITY

Intensity of cab lighting shall be a minimum of 25 foot candles (269 lux) at the console plane.

9.5 OPERATOR CONSOLE

An operator console shall be provided in each operator cab. This console shall house the master controller and all of the controls and indicators needed for operation and supervision of the train in the mode selected.

The console display panel shall be hinged at the rear or side to permit tilting upward at least 90 degrees for servicing and repair. The console may be divided into two separately hinged parts for this purpose. Quick disconnect fasteners shall be used for all display panel wiring. The console shall be designed to preclude liquids from entering the display panel.

9.5.1 CONTROLS AND INDICATORS

The control console shall include the controls and indicators listed in Figure 9-1 at the end of this section. Switch position identification shall be etched on the console panel for all unlighted switches with more than one fixed position.

9.5.2 LIGHTING

Each pushbutton and indicator on the control console and auxiliary control and indicator panel shall be illuminated from the low voltage power supply by a minimum of two lamps. Illumination shall be adjustable by the console light brightness switch and shall assure visibility and legibility of

the pushbuttons and indicators under the brightest ambient light conditions. All lights on the console and auxiliary control and indicator panel shall be capable of being relamped from the front. Where a lens is removable for lamp replacement, it shall be keyed for return only to the correct location. The console light brightness switch shall include a spring-return lamp test position for indicators not readily tested by manipulation of controls.

9.6 AUXILIARY PANELS

9.6.1 SWITCHES AND INDICATOR LIGHTS

The auxiliary panel switches shall include all switches and indicator lights listed in Figure 9-1.

9.6.2 HIGH VOLTAGE CIRCUIT CONTROLS

A panel containing high voltage circuit breakers shall be installed in each car. The following circuits shall be protected through the panel:

- a. Floor Heat (magnetic trip breaker)
- b. Overhead Heat #1 (magnetic-only trip breaker)
- c. Overhead Heat #2 (magnetic-only trip breaker)
- d. Blower Fan #1
- e. Blower Fan #2
- f. Air Conditioning #1
- g. Air Conditioning #2
- h. Air Compressor (four pole breaker, fourth pole (unprotected) used to interrupt negative return) or converter
- i. Cab Heater (magnetic-only trip)

The circuit controls shall be as specified in Section 13.8. The circuit control panel shall be as specified in Section 13.8.1.

9.6.3 LOW VOLTAGE CIRCUIT BREAKERS

A panel containing low voltage circuit breakers shall be installed in each car. The following circuits shall be protected on that panel:

- a. Forward
- b. Reverse
- c. Series Full Field
- d. Series Intermediate Field
- e. Main Lighting
- f. End Sign
- g. Cab Light
- h. Dynamic Brake
- i. Switching
- j. Multiple 1
- k. Multiple 2
- l. Multiple 3
- m. Reset
- n. Ground Switch
- o. Propulsion Control
- p. Automatic Train Control
- q. Hold
- r. Battery
- s. Door Opening and Unlocking
- t. Door Operator Feed
- u. Door Operator Feed
- v. Door Signal Feed
- w. Main Lights Trainline
- x. Emergency Lights

- y. Heat and Air Conditioning Trainline
- z. Heat and Air Conditioning Control
- aa. Public Address
- bb. Inter Communication
- cc. Coupler F End
- dd. Air Brake
- ee. Headlight
- ff. Side Destination Sign Selection
- gg. End Door Lock
- hh. End Door Signal
- ii. Horn
- jj. End Sign Motor
- kk. Radio

9.7 OPERATOR SEAT

●9.7.1 GENERAL

The operator seat shall conform to the following requirements:* _____.

The complete seat assembly shall meet the flammability and smoke emission requirements as specified in Section 6.9.

9.7.2 LOCATION

Operator seat position shall be established by the contractor and reviewed by the purchaser during the mock-up stage.

9.7.3 ADJUSTABILITY

All adjustments shall have positive position restraints. Height adjustment shall contain a spring-loaded mechanism.

*Purchaser completing detail

9.7.4 LOADING REQUIREMENTS

In all positions, the seat structure, support, attachments, and adjustment locking mechanisms shall withstand, without permanent deformation or disengagement, the following loads:

- A vertical, uniformly distributed load of 330 pounds (149 kg) applied at the forward edge of the seat.

- A horizontal, uniformly distributed load of 495 pounds (223 kg) applied to the upper edge of the seat back at its rearmost back angle.

9.8 HEATER AND WINDSHIELD DEFROSTER

9.8.1 HEATER

The operator cab shall be provided with a floor heater capable of maintaining cab temperature at or above 65 degrees F (18 degrees C).

The cab heater housing shall be constructed of heat-resistant materials and shall utilize enclosed heater elements. A circuit breaker shall control the heater. Heater elements and controls shall be readily accessible for servicing and repair. Heater elements shall operate satisfactorily within the voltage requirements stated in Section 13.1.

9.8.2 WINDSHIELD DEFROSTER

The operator's windshield shall be completely defogged and defrosted in the swept area during all car operations and under all atmospheric conditions. De-icing of the windshield interior shall be accomplished by either an auxiliary heater

unit or by an electrically-heated film in the glass, but not by electrically-heated wires in the operator's line of vision. Operating temperatures shall not damage or shorten the service life of the glass or framing.

9.9 WINDSHIELD TRANSPARENCY

9.9.1 WINDSHIELD WIPERS

A heavy-duty air or electrically driven windshield wiper shall be provided for the operator cab windshield. The wiper shall be capable of clearing the viewing surface at all operating car speeds and in all climatic conditions.

A pantographic pattern shall be provided clearing an area 18 inches (457.2mm) in width by 22 inches (558.8 mm) in height and from 36 inches (914.4 mm) to 58 inches (1473.2 mm) above the floor. The wiper drive assembly shall be readily accessible from inside the cab and shall not require removal of any other apparatus to gain access to the assembly.

The windshield wiper control shall be located on the operator console.

Provision shall be made for manual movement of the wiper arm without damaging the mechanism.

9.10 MISCELLANEOUS CAR EQUIPMENT

●9.10.1 FIRE EXTINGUISHER

A fire extinguisher as specified in Section 8.2.1B shall be installed in the operator cab and located*_____.

*Purchaser completing detail

9.10.2 HORN

A pneumatic horn shall be installed at the cab end under the floor of each car and controlled from the operator cab. The horn shall have a minimum output of 97 dBA at a distance of 100 feet (30 480 mm) from the front of the car with a consumption not to exceed 20 cubi feet (0.84 cubic meters) of air per minute. A cutoff valve shall be provided in the cab.

9.10.3 PARKING BRAKE

A handbrake shall be located in the operator cab as specified in Section 14.4.3.

●9.10.4 COAT HOOK

A garment hook shall be provided in the operator cab in conformance with the following requirements:*_____. Location shall be established in the mock-up.

●9.10.5 CAB CONTROLS AND INDICATORS

As specified in Figure 9-1.**

*Purchaser Completing detail

**Those cab controls and indicators listed in Figure 9-1 are intended to be a comprehensive guide from which the purchaser will select items or add items for the desired level of control for his car.

FIGURE 9-1. SUMMARY OF CAB CONTROLS AND INDICATORS (15 pages)

Item No.	Control	Function	Nomenclature	Location *	Normal Color Lighted	Color of Indication	Remarks
1.	Console Lock	<p>First step in activating the propulsion and braking controls.</p> <p>Unlocks the reverser switch, the master controller, and the mode selector switch.</p>	Console Lock; OFF, ON	(1)			Once the key is in the ON position it can be returned to the OFF position only when the reverser switch is OFF, the master controller is in EMERGENCY, and the mode selector is in Manual Cab Signal (MCS)
2.	Reverser Switch	<p>Second step in the sequence of actuating the propulsion and braking controls.</p> <p>Selects direction of train motion.</p> <p>Electrically isolates all other master controllers on the train from the control circuit once a direction is selected.</p>	FORWARD, OFF REVERSE				

*Locations:

- (1) Directly in front of the Operator on the control console.
- (2) On right side of cab bulkhead
- (3) On left side of cab bulkhead.
- (4) On cab bulkhead behind the Operator.
- (5) On a panel at the Operator's eye level to the right of the cab front window.

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
3.	Mode Selector Switch	Selects mode of operation from available modes.	MCS, Man-Fwd, Man-Rev.	(1)			<p>Switch must be in the WAYSIDE SIGNAL MANUAL position in order to lock the console.</p> <p>Any one position can be selected when the master controller is in the FULL SERVICE position.</p> <p>Interlocks prevent changing from a cab signal mode to a wayside signal mode while the train is in motion.</p>
4.	Master Controller	<p>Controls propulsion and braking in either manual or regulated speed operation.</p> <p>Controls the initial charging of the train's brake system for all modes of operation.</p>		(1)			<p>Increasing power position numbers provide increasing positive tractive effort levels. Coast provides no tractive effort. Increasing brake positions provide increasing negative tractive effort levels. Emergency is pneumatically propagated but the master controller shall have an electric contact operating a magnet valve in the pneumatic train-</p>

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
5.	Emergency	Initiates emergency	Emergency	(1)		Red	<p>line. Handle cannot be moved unless Mode-Direction Switch is in Man-Fwd or Man-Rev position.</p> <p>Master controller handle must be in EMERGENCY position in order to lock the console and cannot be moved until the console is unlocked.</p> <p>Button is operable only when the console is active.</p> <p>Button operation, when operating in the ATO mode, shall override any wayside command.</p> <p>Button initiates emergency brake application electrically.</p>

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
6.	Horn Pushbutton	Sounds horn	Horn	(1)			
7.	Windshield Wiper Control	Turns wiper on and controls wiper speed.	Windshield Wiper; Off, Slow, Fast	(1)			Provides two operating speeds plus parked position.
8.	Door Control Panel	Light indicates that all side doors are closed	Side Doors Closed	(1)	White		Door indication is illuminated on active console only. Light is wired in parallel with "P" wire gauge and the air gauge lights.
9.	Bypass push-button	Bypass button permits propulsion system to operate with side doors open or unlocked.	Side Door Bypass				Button is used for emergency train movement only and may be operated from active console only.
10.	Unlocked cab or end door(s)	Light indicates unlock cab or end door(s)	End Doors Unlocked		Red		Light illuminates on all consoles when a cab or an end door is unlocked.
11.	Door Open Pushbuttons (2)	Opens side doors on entire train.	Open	(2) (3)		Black	Two DOOR OPEN pushbuttons are located in each door control unit. One button opens all the side doors, on that door control unit side, to the

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
12.	Door Close Pushbuttons (2)	Closes side doors on entire train.	Close	(2) (3)		Black	<p>left of the door operator. The other button opens the doors to the right of the operator. Right and left are as operator faces side window.</p> <p>Two DOOR CLOSE pushbuttons are located in each door control unit. See remarks on Item No. 9 above.</p>
13.	Doors Closed Indication Lights (2)	Indicates, when lighted, that all side doors in that zone are closed and locked.	Zone Light	(2) (3)	Red		<p>Two zone lights are located in each door control unit. Zones are to the left and right as the operator faces the cab side window.</p> <p>Indication lights are lighted only when the door control key is in the ON and the INDICATION positions and the doors are closed and locked.</p> <p>Located on door control unit panel.</p>

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
14.	Door Control Master Key Switch	Activates door control unit for door operation and door indication. It also allows turning environmental controls on for a timed interval and turning environmental control off when it would otherwise remain on for timed interval.	Master Key; ON, OFF Indication	(2) (3)			<p>One master key switch located on each door control unit. Key is removable from the OFF position only.</p> <p>Located on door control unit panel.</p> <p>Environmental control is used for precooling or preheating of train. Once environmental control is activated by turning key to ON position, it remains so activated until timer expires or key is turned to E.C. OFF position</p>
15.	Speedometer	<p>a. Pointer indicates train velocity on a a clock-type dial, or</p> <p>b. velocity is presented by a digital display</p>	<p>a. MPH, numbered and graduated from 0 to 80 in increments of five mph. or digital display graduated in .01 mph.</p>	(1)			<p>Active in each console of the train.</p> <p>Dial or digital display is illuminated on the active console when the doors are closed and locked.</p> <p>The speedometer panel includes the cab signal indication display.</p>

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
16.	Brakes-On Indicator	Indicates that any friction brake on the train has been applied.	Air Brake	(1)	Red		
17.	Reset Push-button	Resets tripped motor control circuit line switch or brake overload relays	Eeset	(1)			Momentary Switch.
18.	Main Lights ON and Off Push-buttons	Energizes and deenergizes interior main lights control trainline	Interior Main Lights; ON, OFF	(1)			One switch.
19.	Cab Light Switch	Permits flourescent cab ceiling lights to be turned off locally when interior main lights control trainline is energized.	Cab Light	(4)			Switch
20.	Cab Signal Indication Brightness	Control level of illumination		(1)			Part of the speedomete unit.

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
21.	Air Gauge	Indicates brake pipe and brake cylinder	Air Brake	(1)		Red and Black	Red hand on dual pressure gauge indicates brake pipe pressures and black hand indicates brake cylinder pressure. Gauge indicates dual pressures in each car but is only illuminated on the active console when all side doors are closed.
22.	Signal Buzzer Pushbutton	Sounds buzzer in every cab.	Buzzer	(1)			Located on communications panel.
23.	Cab Heater Control	Turns cab heater ON or OFF		(4)			High voltage circuit breaker.
24.	Alarm	Sounds an audible alarm when: (a) an over speed condition occurs when operating in the MCS mode; (b) operating in a mode out of correspondence with the signal system.					Located in the ceiling.

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
25.	Train Identification Selector Switches (2)	Changes tuned frequency of car-carried coils to identify train to way-side and interface with car's sign control sys-	Tens, OFF, 0, 1,2,3,4,4,6,7, and 8; Units, OFF, 0, 1,2,3, 4,5,1,7, and 8	(1)			Part of train identification panel. Switches, energized on active console only; have the capability of selecting 81 car identities.
26.	Radio Squelch Control	Provides manual adjustment of the radio squelch threshold.	Radio Squelch	(1)			
27.	Radio Volume Control	Provides continuous variation from 10 to 100 percent of maximum volume at the cab radio speaker.	Radio Volume	(1)			
28.	Intercom (IC) Volume Control	Provides continuous variation from 10 to 100 percent of maximum volume of the cab IC speaker.	IC Volume	(2)			
29.	Side Sign Start Switch	Starts the train's side sign mechanism	Side Sign Start	(1)			Located in train identification panel. Side sign mechanism selects the sign which is in accordance with the

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
30.	Coupler Control Panel	Contains coupler controls		(1)			intelligence received from the train identity interface. Switch energized on active console only. (see Item No. 26)
31.	Key Switch	Energizes coupler control panel	Key Switch	(1)			Key is removable from the OFF position only.
32.	Uncouple Pushbutton	Starts automatic uncoupling cycle and blows at any foreign matter from both coupler head air lines	Uncouple and Air Line Blow Out	(1)			Automatic cycle performs the functions necessary to prepare the electric, pneumatic, and mechanical couplings for final separation and air line blow out. Pushbutton must be operated again if separation is not achieved in 10 seconds.

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
33.	Retrieve Pushbutton	Retrieves electrical contact pins.	Retrieve	(1)			Button is used to isolate electric train lines in operator's train section from the adjacent train section.
34.	Advance Pushbutton	Advances electrical contact pins.	Advance	(1)			Button is used to restore electric trainline continuity between operator's train section and the adjacent train section.
35.	Lamp Test Pushbutton	Tests all console indication lamps.	Lamp Test	(1)			Depressing pushbutton switch illuminates all console lamps.
36.	P-Wire Gauge	Indicates the magnitude of the P-wire braking signal current.	Amperes, P-Wire; 0, .2, .4, .6, .8, 1	(1)			<p>P-wire signal is proportional to braking rate.</p> <p>Gauge is active in each console of the train.</p> <p>Gauge is illuminated in the active console only when all side doors are closed and locked.</p>

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
37.	Communication Mode Selector Switch	Selects mode of communications as follows:		(1)			Part of communications panel.
38.	Switch in PA Mode	Provides for announcements over the train's public address system.	PA				Operator talks over train's public address system by speaking into his Vox microphone.
39.	Switch in Intercom Mode	Provides for communication between cabs over the train's intercom system.	IC				Operator talks over train's intercom system by speaking into his Vox microphone.
40.	Switch in Radio Mode	Enables operator to transmit over train's radio.	RAD				Operator transmits over train's radio by speaking into his Vox microphone. Operator's reverser switch must be ON.
41.	Switch in Vox OFF Mode	Disconnects operator's Vox microphone.	Vox Off				Transmitter receiver unit microphone can be used to transmit radio messages only.
42.	Radio Transmitter Indication Light	Indicates radio transmission when illuminated.	Radio Transmission	(1)			Located in the communications panel.

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
43.	Radio to PA Mode Switch	<p>With the switch in the TRAIN position, received radio messages heard over the train's public address system.</p> <p>With switch in the CAB position, received radio messages heard over the cab speaker.</p>	Cab, Train	(1)			<p>Located in the communications panel.</p> <p>Rocker switch is the spring return type and is normally in the CAB position.</p> <p>When the switch is held in the TRAIN position, the communications mode selector switch is overridden.</p>
44.	Vox Microphone	For communication over the train's public address and intercom systems and over the train's radio.		(1)			
45.	Radio Speaker	For communication in the radio mode.		(1)			
46.	PA/IC Speaker	For communication in the PA or IC modes.		(2)			

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
47.	Cab Signal Aspect Display	Indicates cab signal system commands		(1)			Aspect display is located on the speedometer and is illuminated only on the active console when the reverser is in the FORWARD position.
48.	Zero Speed Aspect	Indicates, when illuminated, command for zero speed or lack of command.	0 MPH		Red		Aspect flashes when train is in motion and is steady when train is stopped.
49.	Speed Aspects	Indicates speed command by illuminating one of the five available speed aspects.	15 MPH, 25 MPH, 35 MPH, 50 MPH, &) MPH		White		Aspect flashes when mode selector is out of correspondence or when there is an overspeed condition.
50.	Conductor's Microphone	For conductor's announcements over the train's public address system.		(2) (3)			
51.	High Voltage Circuit Control Panel.	Provides for control and protection of high voltage circuits.	High Voltage Panel	(4)			Circuit Breakers required.

Figure 9-1, continued

Item No.	Control	Function	Nomenclature	Location	Normal Color Lighted	Color of Indication	Remarks
52.	Low Voltage Circuit Control Panel.	Provides for control protection of low voltage circuits.	Low Voltage Panel	(4)			Circuit Breaker Required.
53.	Parking Brake	Indicates parking brake		(1)		Red	

SECTION 10
DOOR OPERATORS AND CONTROLS



SECTION 10

DOOR OPERATORS AND CONTROLS

10.1 SIDE DOOR OPERATORS

● ● 10.1.1 GENERAL DESCRIPTION

This section specifies the requirements for side door operation and control. There shall be:

Alternate I*

three door openings

Alternate II*

four door openings #

per carside to permit passenger movement between car and platform. Door control signals shall be trainlined to permit a crew member to open and close all doors in either side from the active crew member's station, both forward and to the rear of the active door control cab. Door controls for each side shall be independent and shall be located on a control panel immediately adjacent to the corresponding cab side window. Except as otherwise specified, there shall be no shared components. Door control circuitry shall be designed to preclude uncommanded opening of doors.

Side doors shall be electrically actuated, bi-parting into integral pockets. Each pocket shall fully enclose the

* Purchaser will delete undesired alternate

respective door leaf. Fully opened doors shall present an unobstructed opening measuring 50 inches (1.27 m) wide x 75 inches (1.91 m) high. Local operation of a single door on either carside shall be possible from inside and outside the car by means of a keyed crew switch on each carside.

10.1.2 PERFORMANCE PARAMETERS

Door operators and associated hardware shall be located between the inner and outer surfaces of the car. Access to the entire door operator mechanism shall be provided for removal, installation, repair, and maintenance through a hinged panel or cover equipped with a vandal-resistant locking device. Each side door assembly shall have either one engine per leaf or one engine per assembly. A switch actuated by the operator shaft or levers shall preclude electrical current flow to the door operator motor upon the completion of travel of the connected door leaf in either direction. All adjustments shall be readily available from the exposed side of the door operator. The door operator and operating linkage shall provide sufficient damping to preclude the door from bouncing off its stops at either extreme of the opening/closing cycle.

Each door leaf shall require a maximum of 2.0 seconds to move from the closed position to within 3 inches (76.2 mm) of the fully open position. Each door leaf shall require not less than 2.0 seconds, nor more than 3.0 seconds, to move from the fully-open position to the fully-closed and over-center position. Operating speeds shall be adjustable for door synchronization with provision for door leaf deceleration to preclude impact at either extreme of the opening/closing cycle.

10.1.3 CLOSE AND LOCK

Each door leaf shall exert a minimum closing force of 20 pounds (9.1 kg) and a maximum of 28 pounds (12.7 kg), as measured at midstroke, and shall open or close with a 60 pound (27.2 kg) force applied normal to the interior door surface.

Limit switches used in the door operator shall be of the replaceable unit type. These switches shall be installed by the contractor so that adjustments for proper functioning shall not be necessary following replacement by the purchaser during the service life of the car.

A door position sensor device shall be provided for each door operator. When the sensor is activated by the opening door leaf, it shall cause the inside and outside door operator lights to be illuminated and shall open the feed to the door signal light relay.

●10.1.4 EMERGENCY RELEASE

In addition to providing mechanical locks, zero-speed indication interlocks, and push-back features, the door subsystem shall include a door emergency release capability.

A. Operation

Manual operation of the emergency release lever from the NORMAL position shall enable the associated door leaf to be pushed open without a key or electrical power. Door operation shall be restored to normal by returning the manual lever to the NORMAL position. Operation of this device shall initiate a full service stop. The force required to actuate the emergency release shall not exceed 30 pounds (13.6 kg).

B. Location and Interlocks

The emergency release lever shall be located on the door operator unit behind a locked swing panel adjacent to each door. Accessibility shall be limited to: * _____ . Operation of the lever shall disconnect power to the door control, disconnect mechanical locks, and permit the doors to be opened.

C. Push-Back

Each door leaf shall be equipped with a mechanical push-back feature. This push-back feature shall be a spring-loaded linkage which, in connection with the door operator, shall limit the force developed by the door at the end of its closing cycle. The push-back feature shall allow each door leaf to be pushed back 1.5 inches (38.1 mm), total opening 5 inches (127 mm) with the 1 inch (25.4 mm) compression of each door rubber edge added. Using the push-back feature to open a door leaf shall not permit the door leaf to open fully. The minimum force required to push back each door leaf shall not be less than 15 pounds (6.8 kg) nor more than 25 pounds (11.3 kg).

D. Obstruction Detection

* _____

*Purchaser completing detail

10.2 SIDE DOOR CONTROLS

10.2.1 OPERATION

A. Trainline Operation

A door control unit, mounted one on each side of the operating cab shall include the master door controller, one key switch, door control relays and two zone indication lights. One door control unit per car shall include one signal light relay.

1. Master Door Control One master door controller shall be provided within each door control station to enable a crew member to operate all doors on that side from inside the cab. The master controller shall be equipped with four push buttons arranged to preclude inadvertent operation. Two of the buttons shall control the doors to the rear of the operating position; the other two buttons shall control the doors forward of the control position. One of each pair of buttons shall provide proper sequence for opening the doors. The other button of the pair shall provide proper sequence for closing the doors.

Provision shall be made to preclude entrance of dust or dirt around the push buttons.

2. Key Operated Switch - Master Door Controller One key operated switch shall be incorporated in the master controller which shall control the circuit connections.

- a. OFF Position the key shall be removable with the switch in the OFF position only. When the switch is in the OFF position, the door operating push buttons shall be electrically inoperative and the operator signal light circuit shall be connected.

- b. ON Position The door operating train lines shall be connected to permit operation from any master door controller when its key switch is in the ON position. When the switch is in the ON position, the door operating push buttons shall be electrically operative, the operator signal light circuit shall be interrupted and the zone signal light circuit shall illuminate the zone lights in the master door controller. The trainline circuits shall be arranged to permit operation of the doors in both the forward rear zones from the control position.

B. Local Operation

Crew key switches shall be provided at the doors closest to the cab interior and exterior of both sides of the car. A momentary positive action of the crew key switch shall open one or both leaves of the door pair. The local door control circuitry shall be designed to permit key removal from either the interior or the exterior crew key switch following local door operation and with the doors remaining in the previously commanded position. The key shall be removable only in the normal position of the switch. When doors have been opened or closed by a crew switch, it shall be possible to close or open them by means of the trainlined door controls, and the doors shall thereafter function normally.

A single unit shall accommodate both the interior and exterior crew key switches and shall be located at a height convenient to personnel standing on station platforms.

10.2.2 INTERLOCKS

A. General

The interlock and detection circuits shall be safety-critical circuits.

B. Door Opening

Interlocking of door controls shall preclude door opening until generation of zero-speed signals. The interlocking action shall remove power from the door control, key switch, door-open buttons, and from all door operators on the train.

C. Door Closing

The interlocking of traction and door control systems shall preclude initiation of train movement in any mode of operation until all doors are closed and locked on each car in the train. The trainline circuits performing this interlock function shall provide maximum protection against erroneous door-locked signals. Each door shall be sensed directly for full closure. The switch shall be also arranged that circuits shall be made up before a DOOR CLOSED indication can be so received. The circuit shall not be interruptable by the push-back feature.

D. Manual Operations

Controls shall be arranged so that if, in any of the manual modes of operation, the manual controller is advanced to a power position while the doors are open or unlocked, positive tractive effort cannot be generated until the doors have been closed and locked, and the controller returned to the FULL SERVICE BRAKE position.

E. Bypass Switches

A traction interlock bypass switch shall be provided in the operator cab to permit movement of the train in the event of side door interlock circuit failure. A bypass push button shall be provided in the operator cab to permit the propulsion system to operate with side doors open and unlocked.

F. Linkage

The door linkage between the door operator engine and its door leaf shall contain an overcenter linkage geometry or equivalent mechanism that shall prevent manual opening of a closed door leaf beyond the push-back feature under normal conditions. Manual emergency operation shall be provided in accordance with Section 10.1.4.

● 10.2.3

MANUAL LOCKING

A combination cutout switch and lock shall be provided at each side door operator so that in the event of failure of an operator, the failed operator could be made inoperative, and the door locked mechanically in the CLOSED position. The switch shall also close the door signal circuit thus

providing a CLOSED AND LOCKED indication at that operator. The bypass switch shall be operated by the standard car key and shall be physically located in accordance with the following requirements: *_____.

10.3 SIDE DOOR SIGNAL SYSTEM

Visible signals on the exterior and the interior of the car shall be provided to indicate door system status. Audible signals within the car shall be provided to alert passengers to impending change of status of the side doors.

10.3.1 VISUAL

Red indicator lights in metal housings shall be provided on each side of the car, one over each door. Each light shall be visible in bright sunlight at a distance of 60 feet (18 m) to a person with normal visual acuity. The lenses shall be shaded. Door signal light housings shall be weathertight and shall conform to clearance requirements. The circuitry shall be arranged so that each light shall be lighted when its door is in the UNLOCKED position, and shall be extinguished only following return of the door to the CLOSED AND LOCKED position.

An interior indication at each door operator shall also be provided. Indicator lights shall be provided on the door control units to annunciate DOORS CLOSED AND LOCKED.

*Purchaser completing detail

● 10.3.2

AURAL

Audible signals of approximately one-second duration shall be annunciated inside and outside the car to alert passengers to the door closing operator sequence.

Initiation of the operating sequence shall activate the audible tone adjustable time delay, zero to 2 seconds prior to actual closing of the doors. The sound level of the signal shall be * dBA.

*Purchaser completing detail

SECTION 11
TRUCKS AND SUSPENSION



SECTION 11

TRUCKS AND SUSPENSION

11.1 GENERAL DESCRIPTION

● ● 11.1.1 CONFIGURATION

The trucks and suspension subsystem shall be formed by all truck components from the rail up to the body bolster including any suspension subsystem components rigidly mounted to the carbody. Any mechanical interface requiring welding or drilling on the truck shall also be considered part of the truck. The contractor shall ensure that all truck-mounted equipment can be accommodated without physical interference. Each car shall be supported on two four-wheeled, roller bearing-equipped, swiveling trucks, on each of which shall be mounted two traction motors.

Alternate I*

The distance between truck centers shall be 54 feet (16.4 m) and the truck wheelbase dimension shall be between 82 and 90 inches (2083 and 2286 mm).

Alternate II*

The distance between truck centers shall be ___ feet (___ m) and the truck wheelbase dimension shall be between ___ and ___ inches (_____).

*Purchaser will either delete Alternate II or delete Alternate I and provide the completing detail for Alternate II.

11.1.2 EXPERIENCE

The trucks shall be of a rapid transit, rail passenger motor-truck general design which has been used successfully in revenue passenger service for a minimum of 300,000 miles (482 790 km) each for at least 8 trucks. The trucks shall be produced by a manufacturer of trucks with five or more years of successful experience applying the manufacturing techniques required by that design.

11.1.3 INTERCHANGEABILITY

Trucks shall be designed to permit full interchangeability between ends of the cars and between all cars furnished under this contract, with no modifications to the truck except for installation or removal of handbrake rigging, axle-mounted tachometers, ATO equipment, and load weighing equipment. No welding, drilling, tapping, riveting, or cutting shall be necessary for conversion from a handbrake truck to a non-handbrake truck. Any handbrake rigging to be installed or removed from a truck shall be attached with bolted connections. Wheel, axle, bearing, gearbox, and motor assemblies shall be interchangeable between ends of the truck and between trucks.

● 11.2 RIDE QUALITY

A. General

The car shall be evaluated for riding quality of the trucks on the purchaser's test sections of track maintained within the alignment limits specified in Appendix A.

B. Requirements

The average vertical and lateral acceleration amplitudes,

measured at the floor over either truck pivot point and at the car center, shall not exceed the levels specified as follows: * _____, A car uniformly loaded to AW1 and moving at all steady speeds from 0 to 70 mph (0 to 112 kmh) on level tangent track shall not experience peak acceleration values greater than 0.15 g. when measured to include frequencies less than 30 Hz. The average acceleration amplitude shall be computed by dividing the sum of the peak-to-peak amplitudes of the fundamental wave forms measured over any 5-second interval by twice the number of fundamental cycles during that interval. The average frequency shall be obtained by dividing the number of cycles by 5 seconds.

The secondary suspension subsystem shall have a natural bounce frequency in the vertical direction not to exceed 1.5 Hz under any load condition.

C. Design

The truck design shall not permit oscillations in the operating speed range and shall minimize the effect on ride quality of stable hunting motion at all operating speeds. The vertical natural frequency of the combined primary and secondary suspension systems shall not exceed 7.5 Hz.

D. Wayside Vibration and Noise

To minimize low frequency, ground-borne vibration and noise, unsprung weight shall be minimized, and truck frame designs with frame-on-axle wheel assembly resonance frequency in the range of 12 to 40 Hz shall be avoided.

Ground-borne vibrations requirements shall be as specified in Section 3.4.4.

*Purchaser completing detail

11.3 TRUCK ASSEMBLY

● 11.3.1 PERFORMANCE

A. Requirements

The trucks shall withstand all stresses and vibrations which might develop in service at speeds up to and including 70 mph (112 kmh). The truck shall also endure the static and dynamic loads imposed by truck-mounted equipment. Safe operation of the car shall be assured at all speeds when any or all suspension elements become inoperative.

The truck design must accommodate a mismatch of two wheel sets up to 1-1/2 inches (38.1mm) diameter, must be capable of being lifted with lift chains, and must be capable of being wheel-trued with use of tie-downs.

B. Service Conditions

The truck shall meet the requirements under the track conditions and the operating conditions specified in Appendix A. Car operation shall be assumed to be 50,000 miles (800 000 km) per year with two station stops per mile.

C. Motion Restriction

1. Motion The suspension subsystem shall not permit carbody motion to exceed, under any conditions, the dynamic outline provided by the purchaser.* _____.

2. Clearance All truck parts, except wheels and contact shoes, shall clear the plane of the top of the rails by not

*Purchaser completing detail

less than 2.5 inches (64 mm) under conditions of maximum war, primary spring deflection, and/or elastomer creep over maximum vertical curves as well as on tangent track. Maximum wear is that condition which a piece of equipment reaches where it can be retained in service but beyond which it must be removed from service.

The contractor shall provide for the clearances between the trucks and the carbody and all its parts under all operating and loading conditions including wheel wear. Clearances shall be provided for operation, body-truck cabling and piping, inspection, maintenance, and repair.

D. Equalization

Truck equalization shall be such that with the truck on level track under AWO car load, raising any wheel of a truck vertically a minimum of 2 inches (50.8 cm) shall not change the weight distribution of any wheel of that truck more than an average of one percent per 0.1 inch (2.54 mm).

E. Carbody Height Adjustment

Provisions shall be made in the truck design for up to 1.5 inch (38.1 mm) of vertical adjustment in increments of 0.5 inch (12.7 mm). The design shall permit adjustment with standard maintenance equipment and shall not impair the operation of the truck. Shimming shall not permit the use of loose parts.

11.3.2 STRENGTH REQUIREMENTS

A. Design Loading

The truck structure shall be designed for the static and

fatigue design load combinations specified below. For any part of the structure, the combination that governs shall be used.

1. Combination C, Operating Design Condition The static design loads used in calculating the fiber stresses in the various portions of the truck structure shall be as follows:

- a. Dead load of completely equipped car and truck, PLUS
- b. A uniformly distributed passenger load varying from 0 to 280 passengers weighing 154 pounds (70 kg) each, the maximum load being 43,120 pounds (19 600 kg) per car, PLUS
- c. An allowance for vertical impact of 30 percent of the total static load consisting of loading conditions (a) and (b) above, but not including the truck-mounted equipment, PLUS
- d. A force caused by the maximum acceleration or deceleration resulting from a 33 percent coefficient of friction, PLUS
- e. A force caused by running on a sharp curve at a speed sufficient to throw the entire weight of the car including trucks and motors onto the four wheels on the outside rail.
- f. Under these combinations of loading conditions, the vertical, transverse, and longitudinal loading factors to be applied to each unit of truck-mounted equipment and appurtenances shall be based on the results of a prototype truck load test on the purchaser's property.*

2. Combination D, Fatigue Design Condition The fatigue

*Note: For a new property, see first paragraph under Section 11.3.2.

design loads used in calculating the maximum and minimum fiber stresses in the various portions of the truck structure shall be as follows:

- a. Dead load of completely equipped car and truck,
PLUS
- b. A uniformly distributed passenger load varying from 0 to 40,000 pounds (0 to 18 143 kg), PLUS
- c. An allowance for vertical impact of 20 percent of the total vertical load consisting of loading conditions (a) and (b) above, but not including the truck-mounted equipment, PLUS
- d. A force caused by acceleration or deceleration of 0.20. g, PLUS
- e. A force caused by running on curves at speeds sufficient to cause a lateral load of 0.20 g.
- f. Under this combination of conditions, the vertical, transverse, and longitudinal loading factors to be applied to each unit of truck-mounted equipment and appurtenances shall be based on the results of a prototype truck road test on the purchaser's property.*

B. Allowable Stresses

1. Operating Design Condition The maximum allowable stresses in the various portions of the truck structure, under the Combination C static design loads specified above, shall not exceed the following:

*Note: For a new property, see first paragraph under Section 11.3.2.

Nature of Stress	Allowable Stress (General)	Allowable Stress for Grade VII-x Low Alloy Cast Steel (Fy = 48,000 psi)	
		psi	kPa
Tension	0.40Fy	19,200	132 384
Compression	0.40Fy	19,200	132 384
Shear	0.26Fy	12,500	86 187
Bearing	0.60Fy	28,800	198 576

Fy = Specified minimum yield stress for the type of steel being used.

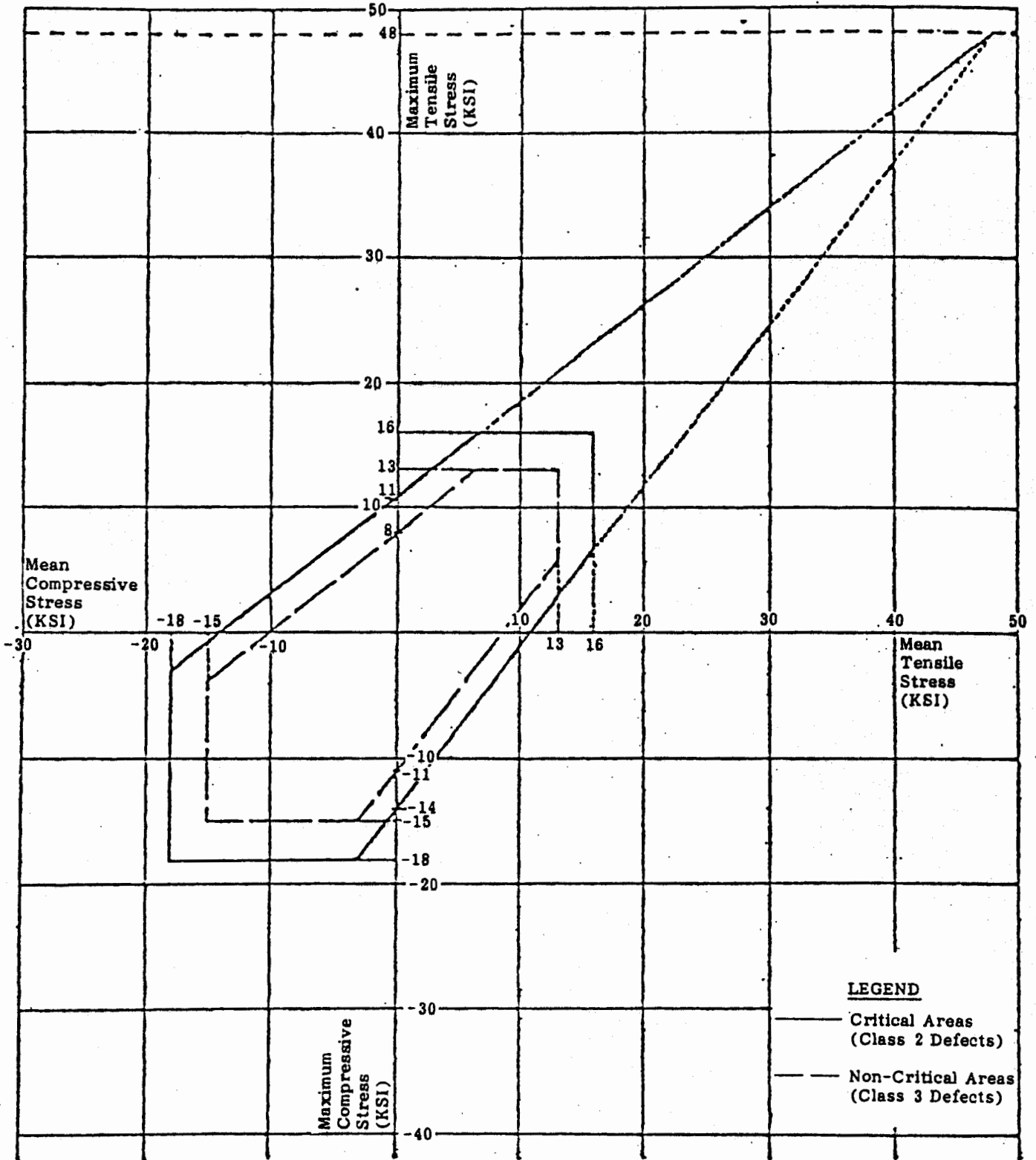
The minimum factor of safety for buckling of the various portions of the truck structure, under the Combination C static design loads specified above, shall be 2.0.

2. Fatigue Design Condition The maximum allowable stresses in the various portions of the truck structure, under the Combination D fatigue design loads specified above, shall not exceed the stresses shown on Figure 11-1, the Modified Goodman Diagram. This diagram was constructed for Grade VII-x Low Alloy Cast Steel, which has the following specified minimum physical properties:

Minimum Yield Stress	48,000 psi (330 960 kPa)
Minimum Ultimate Tensile Stress	75,000 psi (517 125 kPa)
Minimum Endurance Limit	22,000 psi (151 690 kPa)

The range of allowable stresses at a point in the truck structure shall be based on the mean stress at that point. The stress at a point shall be derived from the static vertical loading by the fully equipped carbody, appropriate portions of the truck, and a passenger load of 20,000 pounds (9091 kg).

FIGURE 11-1. MODIFIED GOODMAN DIAGRAM
FOR TYPE VII-x LOW ALLOY CAST STEEL



Values include applicable safety factors

SCALE: 0 4 8 KSI

3. Radiographic Quality The radiographic quality of the truck castings shall be Class II or better in critical areas and Class III or better in non-critical areas according to ASTM Specifications E-446.

Critical and non-critical areas are defined by the stress levels shown on the Modified Goodman Diagram, Figure 11.1.

Phasing of the above load components shall be combined to produce the maximum stress in each structural item. Values and points of load application and reactions shall be appropriate to the force distribution and load paths determined by the truck design configuration.

If any part of the truck structure is required to function as an air reservoir, that part shall be designed and tested to a pressure 1.5 times the maximum operating pressure expected in service. Stresses associated with the pressure vessel function shall be included in the above stresses.

If separate pressure vessels external to the truck structure shall be used as air suspension system reservoirs, they shall be in accordance with the ASME Code for Unfired Pressure Vessels, Section VIII. External reservoirs, shall be provided with plugged drains.

11.3.3 CONSTRUCTION

A. General

The truck frame assembly, when centrally loaded to one-half the AW2 full car weight, shall maintain the axles parallel to within ± 0.15 inch (0.38 mm) at the journal centers, and shall limit the difference between diagonally opposed

bearing locations to 0.10 inch (0.25 mm). When loaded as above and with a horizontal, longitudinal couple equivalent to 3,000 pounds (1364 kg) x 56.5 inches (1435 mm), the assembly shall not permit a relative longitudinal displacement of the side frames greater than 0.25 inches (6.35 mm) measured at the journal center. Frames shall have tram marks above and below each journal bearing housing located within 0.005 inch (.127 mm) of their true positions.

Where pockets or partially-enclosed spaces exist, provision for adequate drainage shall be assured. Moving contact surfaces shall be provided with renewable, low friction wearing elements which minimize transmission of noise and vibration. The frame shall be provided with attachments for the application of swing links, brake parts, motors, gear units, coil springs, and shock absorbers. Transom and pedestal wear plates shall be of rolled manganese steel (Rolman or approved equivalent). All drilled or tapped holes in any part of the truck structure shall have chamfered or rounded edges. Sharp edges on machined surfaces shall be stress-relieved.

Truck parts adjacent to or above current-collector devices and uninsulated power connections shall be shielded against arc damage by dielectric, non-combustible barriers and protective shielding of adequate mechanical strength. All threaded fasteners connecting parts essential to operating safety shall be SAE Grade 5 minimum, but shall be sized as if the hardware were SAE Grade 2. All threaded fasteners shall be retained by locking devices.

B. Materials

Truck frames and bolsters shall either be of cast, low alloy nickel

steel, or of fabricated, welded steel. Cast-steel truck frame members shall be of one-piece construction and shall not contain welded joints or connections. All cast-steel shall be suitable for welding. Fabricated truck weldments and weld repairs to defects in cast trucks shall be stress-relieved.

Truck components shall be clean and free of casting sand, mill scale, welding slag, and other contamination. All machined, ferrous surfaces shall be coated with a strippable rust preventive. All other surfaces, except wheels and axles, shall be painted as specified herein. All truck components shall be given a complete coat of primer prior to assembly. Following assembly, each truck shall be given two coats of paint. Inside surfaces of truck frames and castings shall be painted. All grease fittings, insulators, linkages, threads for adjustment, and wearing surfaces shall be masked before painting. Truck wiring and elastomers shall not be painted.

C. Weight Distribution

The truck frame assembly, when centrally loaded to one-half the AW2 full car weight, shall not permit the difference between the lightest loaded and the most heavily loaded wheels to exceed 1,000 pounds (453.6 kg) on level, tangent track.

D. Life Expectancy

Truck frames and axles shall be designed to maintain stress within endurance limits under the operational environment detailed in Appendix A. The design life for elastomeric components shall be no less than 6 years.

E. Inspection

Inspections shall be as specified in Section 20.4.1.

11.3.4 INTERFACES

A. Carbody

1. Configurations Positive mechanical connections shall be provided between the carbody and trucks, such that the trucks shall be capable of being raised with the carbody without loss of centering engagement when the carbody is lifted. This feature shall provide protection against inadvertent separation of truck and carbody. The connection shall be readily separable with ordinary hand tools.

The truck shall be capable of rotating about a vertical axis with respect to the carbody and shall operate freely over all curves and turnouts specified in Appendix A.

2. Strength The ultimate strength of the truck and the truck-to-carbody connection shall secure the truck to the carbody in a manner which shall prevent truck/carbody separation during derailments, collisions, or other events in which a horizontal load of 150,000 pounds (67 500 kg) shall be applied in any direction at any point on the truck frame. This load may be transmitted from the truck rane to the carbody bolster through structural members, positive stops, or other rigid, mechanical safety devices and/or combinations thereof. The carbody bolster shall be designed to withstand this load without damage.

Truck lifting hooks and members used to attach the truck to the carbody shall be capable of withstanding a vertical load

of 50,000 pounds (22 500 kg) without permanent deformation. Such hooks and members shall be designed to minimize the possibility of damage during derailments below 5 mph (8 kmh).

B. Safety Support Members

All components susceptible to shock and vibratory inputs shall be mounted to minimize the transmission of shock and vibratory forces. Safety support members shall be provided for emergency support to retain major components including traction motors clear of the track in the event of primary-mount failure. Safety support members shall not support any weight until a failure has occurred. Failure of the primary support shall be easily detectable.

C. Jacking

Flat surfaces (pads) approximately 6 inches (154.2 mm) long by 4 inches (101.6 mm) wide shall be provided on the underside of the truck frames near each journal housing to permit simultaneous lifting of the truck and carbody. Trucks shall be designed so that support at only two diagonally opposite pads shall not cause damage.

11.3.5 MAINTENANCE ACCESS

The truck design shall provide unobstructed access to all parts which shall require periodic inspection, lubrication, and/or removal and replacement without requiring removal of any other apparatus. Inspection covers on equipment, when removed, shall provide visibility of all apparatus requiring periodic inspection and/or maintenance. Oil-level and lubrication fittings on the truck shall be readily

accessible for servicing either from a pit or from carside.

All major bolted, threaded, keyed, or pinned connections shall be readily accessible for visual inspection. Threaded fasteners shall be standard, accessible without removal of truck components or the truck from the car, and located to permit removal by standard hand tools.

11.3.6 WIRING

Provisions shall be made for support on each truck of all flexible cables and conduits. Wiring supports shall withstand shocks specified in Section 11.3.2A without failure. An electrical grounding path from the carbody to the rail shall be provided by flexible copper grounding cables connecting the major truck structural components to the grounding brush and ring assembly.

11.3.7 PIPING

Provisions shall be made for support on each truck of all flexible and hard piping and tubing. No water pockets shall be permitted and materials shall be as specified in Section 6.3.1.

11.3.8 POWER COLLECTION

Provisions shall be made on an unsprung member of each truck for mounting power collection equipment on both outboard sides with the power collector assembly so-mounted meeting the requirements specified in Section 13.3.

11.3.9 TRIP COCKS

Provisions shall be made on an unsprung member of each truck for mounting trip cocks on both sides.

11.4 WHEELS AND AXLES

● ● 11.4.1 WHEELS

A. Requirements

Alternate I*

Wheels shall be of forged solid carbon steel 34 inch (869 mm) diameter minus 4, plus 6 tapes. Wheels shall be multiple wear, providing for 1.5 inches (38 mm) wear and 3 inch (76.2 mm) reduction of diameter. An axle set of wheels shall be matched within one half tape. Normal dished wheels shall provide for a hub width of 6.30 inches (160 mm) and reverse dished wheels shall provide for a hub width of 8.0 inches (203.2 mm). Wheels shall be Class A or B, in accordance with Specification ASTM A-25, and/or determined by the contractor dependent on his analysis of anticipated thermal loads for the braking services intended. Wheels shall be bored and hub-marked in accordance with AAR Standards. Tread and flange contour shall be AAR Standard contour.

Alternate II*

Wheels shall be forged solid carbon steel ___ inch (___ mm) diameter minus __, plus __ tapes, Wheels shall be multiple wear, providing for ___ inches (___ mm) wear and __ inch (___ mm) reduction of diameter. An axle set of

*Purchaser will either delete Alternate II or delete Alternate I and provide the completeing detail for Alternate II.

wheels shall be matched within one half tape. Normal dished wheels shall provide for a hub width of ___ inches (___ mm) and reverse dished wheels shall provide for a hub width of ___ inches (___ mm). Wheels shall be Class _ or _, in accordance with Specification ASTM a-25, and/or determined by the contractor dependent on his analysis of anticipated thermal loads for the braking services intended. Wheels shall be bored and hub-marked in accordance with AAR Standards. Tread and flange contour shall be AAR Standard contour.

B. Marking

Wheels shall be legibly identified with serial number, manufacturer's name and date stamped in a location on the wheel as described in the AAR Wheel and Axle Manual. The contractor shall furnish the purchaser with a record of these numbers together with the numbers of the axles to which each wheel is mounted and the numbers of the trucks on which they are installed (CDRL).

● 11.4.2

AXLES

A. Requirements

Alternate I*

Axles shall be manufactured in accordance with ASTM A-729, and ultrasonically inspected in accordance with AAR Specification M-101A. The axle shall be of solid construction. Both ends of each axle shall be furnished with axle centers and threaded holes fitted with rubber plugs.

* Purchaser will delete undesired alternate

Alternate II *

Axles shall be manufactured in accordance with ASTM A-729, and ultrasonically inspected in accordance with AAR Specification M-101A. The axle shall be of hollow construction. If not otherwise covered, plugs should be inserted in the ends of hollow axles. #

In no case shall the maximum static unit stress at the centerline of the bearing exceed 5,000 psi (34 475 kPa), the axle being considered as a simple beam under normal (AW1) load.

Axles shall have an exterior finish in accordance with Section 1 of the AAR Wheel and Axle Manual, as a minimum, and shall have been subjected to a magnetic particle inspection following machining.

Axles shall have standard 60-degree lathe centers and shall be marked in accordance with AAR Standards.

B. Inspection

Requirements for inspection shall be based on AAR standards.

All finished axles shall be free from cracks, flaws, seams and other injurious imperfections.

Axles shall not have been galled or otherwise scarred during pressing on wheels or gear components.

* Purchaser will delete undesired alternate

C. Marking

Each axle shall be assigned a unique serial number which shall be legibly and permanently stamped on the gear seat end of each axle. The serial number shall conform to the following requirements:*_____. The numbering shall start with the number 1, and shall continue in consecutive order. The manufacturer's name, the date of manufacture, and the heat number shall be stamped on the opposite end of the axle in characters not less than 0.25 inch (6.35 mm) high. The contractor shall furnish the purchaser with a record of the manufacturer's serial and heat numbers together with the appropriate serial numbers of the cars and trucks on which they have been installed. (CDRL)

11.4.3. BEARINGS

A. Journal Bearings

Journal bearings shall be roller-type, grease-lubricated, and sealed by labyrinth or radial lip seals. The design shall have a record of successful service in similar or more exacting service. Bearings shall be designed for a B-10 life of 1,000,000 miles (1 600 000 km). The lubricant shall not require replenishment during the service life of a wheel set.

Bearings shall be lubricated with an AAR-approved Grade B lubricant. Each assembly shall have a maximum capacity of 2 pounds (4.4 kg).

* Purchaser completing detail

Bearings shall not require inspection more than once every 500,000 miles (800 000 km).

Journal bearing, wheel, axle, motor, and gear locations shall be numbered 1, 2, 3, and 4 on each truck, with odd numbers applied to the left side of the truck and even numbers applied to the right side with the truck installed under a car as specified in Section 14.2.2. Journal boxes shall be readily removable from the axle. Bearings and journal boxes shall permit easy insertion into axle centers of the centering spindles of wheel truing machines.

The bearings shall be adequately protected against the passage of electric current.

B. Center Bearings

The center bearing on which the body center plate shall rotate shall be located within the truck center plate. The bearing shall be two-piece, conical in section, and either of cast or of an elastomeric center bearing composed of steel and elastomeric layers. The bearing surface of the body center plate which engages the bronze bearing ring in truck center plate shall be ground or burnished.

C. Side Bearings

The side bearings shall be Dresser Transportation Equipment Company's "Waughmat" resilient truck side bearing buffers or equal.

● 11.4.4

ASSEMBLY

Wheels, axles, gears, roller bearing journals, etc., shall be mounted using pressure and fit in conformance with the following requirements: * _____.

A. Wheels and Axles

Wheel sets shall be concentric within .005 inch (0.137 mm) total indicated run-out when rotated in their bearings. Mounted wheels shall not exceed 0.015 inch (0.38 mm) out of parallel to each other or to a plane perpendicular to the centerline of the axle (wobble).

Wheel gauge tolerance shall be 55.6875 inches (1414.5 mm) ± 0.06 inch (1.5 mm).

Wheel-axle sets shall be mounted in pairs matched in diameter within one-half tape size. Wheels shall be pressed on axles by suitable and approved apparatus. Pressure diagrams shall be provided to permit monitoring of the pressing operation.

B. Journals

Alternate I**

The journal box shall be supported and retained in the

* Purchaser completing detail

** Purchaser will delete undesired alternates

side frame by the elastomeric springs between the journal box and truck frame. Pedestal tie bars shall be applied to truck frame pedestal to retain wheel and axle assemblies.

Alternate II*

The journal box shall be retained in the side frame pedestal ways using mating wear plates of rolled manganese steel ("Rolman" or approved equal) welded to the pedestal ways of the truck frame. In addition the tope of the journal box shall be recessed for the application of the equalizer bar bearing plates and insulating cushions. #

Mounting charts and inspection sheets on wheels, journal bearings, etc., shall be supplied to the purchaser for all assemblies (CDRL).

11.5 SUSPENSION DETAIL

11.5.1 PRIMARY SUSPENSION

Primary suspension shall be provided by suitable elastomeric or spring journal bearing mounts. The truck configuration together with the primary suspension elements shall permit movement of each bearing location for load equalization.

Coil springs shall be Grade XII heat-treated steel, carefully tempered, and the ends shall be tapered and ground so that the outside surface of each end shall be flat for at least three-quarters of its circumference and at right angles to the center line of the spring. All sharp corners on the ends of the springs shall be removed so that there shall be no interference with the proper operation of the

* Purchaser will delete undesired alternate

springs in the pockets.

The springs shall be specifically designed for the car specified herein to provide the maximum passenger comfort.

At least 10 percent of the springs shall be tested for both compression and release, and the heights for the various loads shall not vary more than 1/8 inch (3mm) over or under the calculated heights. The permanent set, after compressing the spring solid three times in rapid succession shall not exceed 1/32 inch (.8mm). The load for testing the permanent set shall not be less than 1-1/4 times the solid load.

The year of manufacture and the manufacturer's identifying mark shall be branded on the side of one end of each spring in a manner that will not be detrimental to the service of the spring.

The contractor shall obtain from the spring manufacturer and furnish to the purchaser a certified guarantee against failure of the springs caused by defective material or workmanship. (CDRL)

The primary spring rate shall not be more than 9,995 pounds per inch (179 kg/mm) and the secondary spring rate shall not be more than 7,248 pounds per inch (130 kg/mm).

● ● 11.5.2

SECONDARY SUSPENSION

A. General

The secondary suspension shall incorporate

Alternate I*

Air Springs

Alternate II*

Coil Springs

Alternate IA**

B. Shock Absorbers

Vertical and lateral damping of spring action required to meet ride quality requirements, which is not provided by the air springs and air spring orifices, shall be provided by hydraulic shock absorbers.

Alternate IIA**

B. Shock Absorbers

Vertical and lateral damping of spring action required to meet ride quality requirements, which is not provided by the multiple coil spring suspension, shall be provided by hydraulic shock absorbers. #

C. Bolster Anchor Rods

If the truck is restrained longitudinally by locating rods, the rods, and any brackets by which they are attached to the truck, the truck bolster, and/or the carbody and the member, to which these brackets are attached shall withstand.

* Purchaser will delete undesired alternates

** Purchaser will select same numbered alternate as in Section 11.5.2A

without exceeding the yield strength of the materials used, a longitudinal load equal to at least four times the weight of the complete truck, including motors, gear units, brakes, and other apparatus thereon.

Anchor rods, if used, shall be elastomerically cushioned at both ends, located to minimize transmission of longitudinal truck oscillation to the carbody, and problems with center plate or center pins, and capable of withstanding the static and fatigue loads expected in service. The rods, shall be designed to fail before the structures to which they are attached could be deformed.

D. Truck Connection

The truck connections shall be as specified in Section 7.2.5.

E. Stops

Rigid stops required to restrict carbody motions shall be provided with elastomeric cushions providing not less than 0.5 inch (12.7 mm) of compression and spring characteristic appropriate to attainment of the required ride quality. Truck parts contacted by elastomeric cushions shall be provided with stainless steel wearing surfaces.

Alternate IB*

F. Air Springs

1. Configuration The final spring suspension state that interfaces with the carbody shall consist of

* Purchaser will select same numbered alternate as in Section 11.5.2.A.

air springs. The air-volume characteristic shall provide for such contribution to damping of spring action as the contractor may elect.

2. Failure Response The suspension system shall be designed to provide for simultaneous deflation of the air springs on both sides of the truck in the event of loss of air pressure in one spring.

Alternate II B*

F. Coil Springs

The secondary suspension that interfaces with the carbody shall consist of multiple coil springs. The multiple coil characteristic shall provide for such contribution to damping of spring action as the contractor may elect.

Alternate IC**

G. Cushions and Bumpers

The springs shall be augmented by elastomeric stops to support the carbody in event of air-bag failure. The car shall operate safely at all speeds with any or all air springs inoperative or deflated.

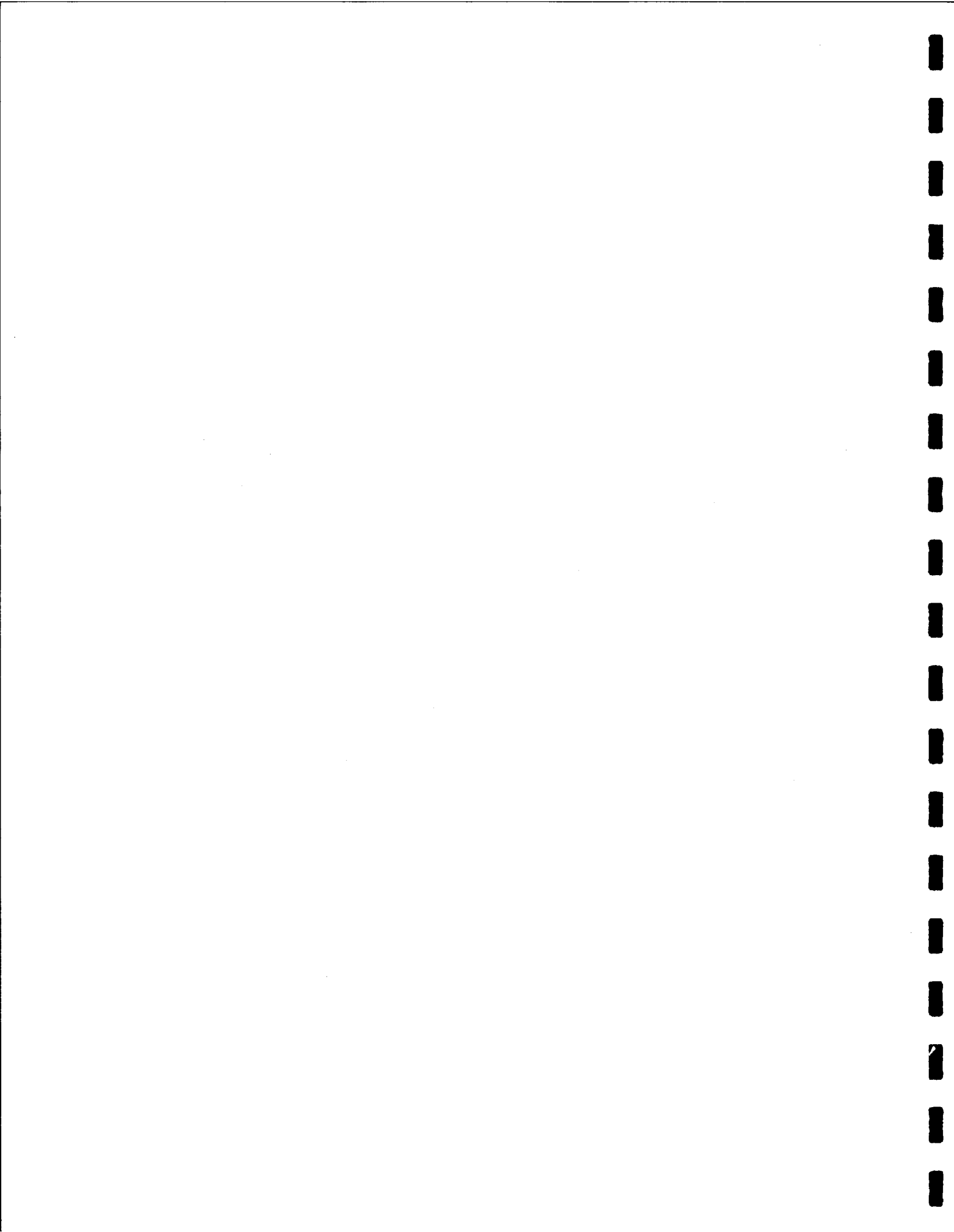
In the event of air spring failure, the car floor shall drop no more than 2 inches (50.8 mm) under an AW2 load, static condition.

#

* Purchaser will select same numbered alternate as in Section 11.5.2.A.

** Subsection G will be inserted only if Alternate I has been selected in Section 11.5.2.A.

SECTION 12
COUPLERS, DRAWBARS, AND DRAFT GEAR



SECTION 12

COUPLERS, DRAWBARS, AND DRAFT GEAR

●● 12.1

GENERAL CONFIGURATION

A. Cab End

A mechanical coupler, fully automatic, tightlock hook type, flat contact face with guide pins, shall be provided at the cab end of each car. Pneumatic connections shall form an integral part of each coupler. Electrical connection shall be through a separate component attached to the mechanical coupler.

B. Non-Cab End

Alternate I*

Linkbar A linkbar shall be provided at the non-cab end of each car.

Alternate II*

Mechanical Coupler A non-automatic mechanical coupler shall be provided at the non-cab end of each car. #

12.2

PERFORMANCE REQUIREMENTS

12.2.1

OPERATIONAL

The coupler and draft gear shall be designed and constructed

* Purchaser will delete undesired alternate

to permit coupled cars to negotiate all horizontal and vertical curves as specified in Appendix A, including operations with maximum mismatch between cars due to spring deflection, wheel wear, and track irregularities. Under no conditions shall the coupler interfere with truck parts, wheel, cables, or other car equipment.

The gathering range of the coupler shall not be less than 2.50 inches (63 mm) in any direction from the coupler centerline and with ten degrees total rotational mismatch. The drawbar and coupler assemblies shall move laterally when a force of not more than 100 pounds (45.4 kg) is applied laterally to the face of the coupler head. The coupler-draft gear assembly shall be designed to provide satisfactory service in emergency operations with trains consisting of twice the normal maximum number of cars as specified in Section 3.3.2B.

● 12.2.2

COMPATIBILITY

Alternate I**

Coupler equipment shall couple mechanically, pneumatically, and electrically and as specified herein be interchangeable with equipment furnished under previous equipment contracts* _____ which shall be operating in scheduled

**Purchaser will insert Section 12.2.2 only if it (1) operates revenue rapid transit service and (2) has elected to require rapid railcar compatibility.

* Purchaser completing detail

service with the cars being procured under this contract. #

12.2.3 CONTROLS

Coupler design shall permit automatic coupling by bringing car cab ends together. Uncoupling shall be accomplished by pressing uncoupling control as specified in Figure 9-1. Manual levers shall be incorporated to permit manual uncoupling of mated coupler systems by one person at trackside using an uncoupling device located to the side of the car.

12.3 STRENGTH REQUIREMENTS

The mechanical coupler and draft gear assembly shall withstand loads of 143,360 pounds (62,600 kg) in compression and tension without permanent deformation.

The coupler-draft gear attachment to the car underframe structure shall withstand any longitudinal load of 176,370 pounds (80,030 kg) without permanent deformation.

The radiographic quality of the castings shall be in accordance with ASTM Specification E-446, and shall be Class III or better.

12.3.1 EMERGENCY RELEASE

The draft gear shall be provided with an automatic release mechanism to provide an emergency release capability for severe end impacts.

The automatic release mechanism shall be designed to release upon a buff load of 132,217 pounds plus or minus 9,920 pounds (60,000 ± 4500 kg), permitting the transfer of excess buff loads to the car's underframe by allowing the coupler and drawbar yoke to travel an additional 3 inches (7.62 cm) before contacting the rear of the drawbar where the yoke shall be further cushioned by the rubber in the draft gear.

The design of the emergency release feature shall require no special tools and a minimum of manual labor to restore the mechanical coupler to a normal operating condition. It shall not be necessary to remove coupler, yoke or drawbar casting to restore draft gear function. The automatic release mechanism assembly shall be specially designed to facilitate pin removal in the event of partial shear if shear pins are used.

Positive indication shall be provided on the exterior of the drawbar housing casting for inspection purposes to indicate the normal position of the automatic release mechanism and whether or not a full or partial release has occurred.

12.4 MECHANICAL DETAIL

12.4.1 CAB END

A device shall be provided to automatically lock the couplers. When locked, the device shall hold the couplers in close face-to-face contact.

Coupler and draft gear length, from the anchor pivot joint to pulling face, shall be 50 inches (1270 mm). Draft gear shall absorb shock in both buff and draft (pull) and shall be self-centering. All weathering surfaces of the coupler-draft gear assembly shall be covered with manganese steel wear plates or hardened steel bushings on both. Drainage shall be provided for rain and melt water. It shall not be necessary to remove the drawbar carrier to remove the drawbar.

●●12.4.2 NON-CAB END

A. Alternate I*

A linkbar shall provide for semi-permanent coupling on non-cab ends of cars. It shall provide for all pneumatic connections. The linkbar shall be provided with hardened steel bushings. Design shall assure drainage of rain and melt water.

B. Alternate II*

The mechanical detail of the coupler at the non-cab end of the car shall be identical to that of the cab-end coupler. #

12.5 ELECTRICAL DETAIL

●●12.5.1 CAB END

A. General

The cab end shall be equipped with a:

* Purchaser will delete undesired alternate

Alternate I*

non-retractable electrical coupler

Alternate II*

retractable electrical coupler

#

B. Coupler Heads

Alternate IA*

Non-retractable electrical coupler heads shall be provided, mounted to the sides of or beneath the mechanical coupler at the cab end of the car-set. The electrical assembly shall be replaceable as a unit. The coupler shall be capable of automatically making the required number of electrical connections between cars, plus 10 percent spares for each size pin, both fixed and movable. Creepage distance between pins shall be adequate for voltage ratings.

Electrical connectors shall maintain positive effective contact under all car operating and lay-up conditions.

Alternate IIA*

Retractable electrical coupler heads shall be provided, mounted to the sides of or beneath the mechanical coupler at the cab end of the car-set. The electrical assembly shall be replaceable as a unit. The coupler shall be capable of automatically making the required number of electrical connections between cars, plus 10 percent spares for each size pin, both fixed and movable. Creepage distance between pins shall be adequate for voltage ratings.

*Purchaser will select same numbered alternate as in Section 12.5.1A.

Electrical connectors shall maintain positive effective contact under all car operating and lay-up conditions. #

C. Trainline Circuits

Circuits shall be established from car to car through self-contained, face-to-face, .030 inch (.76 mm) coin silver alloy-tipped contacts. Individual contacts shall be replaceable without disassembly of the coupler or its wiring harness. Contacts specified shall have a continuous rating to carry 30 amperes at 40 VDC, and 40 amperes for one hour. The B+ contact requires 85 amperes rating continuously at 40 VDC.

D. Requirements

Electrical contact pins shall be designed to maintain a positive pressure with a minimum of 10 pounds (4.54 kg) between coupled contact interfaces. A fail-safe uncoupling circuit shall be provided to preclude unwanted uncouplings. The contacts and associated hardware shall be constructed of corrosion-resistant metal alloy and shall be mounted in a block of insulating material.

The design of the insulating block and contacts shall preclude water entry into the electrical housing with the door open, shall be non-absorbing, and shall neither embrittle nor soften in extreme heat or cold.

When coupled, the electric coupler and contacts shall be protected from dirt, water, rain, and frozen precipitation by a soft rubber gasket completely enclosing the periphery of the insulating block.

E. Cover

Each electric coupler shall be provided with an independently operable cover to protect the coupler contacts from dirt and water, when uncoupled. Operation of the covers shall not depend upon the presence or position of the mating cover. The cover shall automatically swing clear when a mechanical coupling is initiated, and swing closed following uncoupling. The cover's inside surface shall preclude accumulation of dirt, dust, and moisture.

Connections to the back of the electric coupler contacts shall be either by means of compression-type terminals integral with the contact, or by means of eye-type terminals bolted thereto and accessible for maintenance.

Individual contacts shall be clearly and permanently identified by engraving the insulating block and filling the engraving with a non-conducting material of contrasting color.

F. Connections

Connections from the electric couplers to the carbody shall be by means of multiple-conductor cables equipped with self-locking plugs. Crimp connectors shall be used to connect each wire to terminals at the trainline junction box end of the cables. Plugs and receptables shall conform to the environmental and performance requirements of Specification MIL-C-00501, parts MS3400 and MS3406, Classes F or R. Plugs and receptables shall be keyed to preclude the insertion of any plug into the wrong receptacle.

Contacts for loop circuits shall be provided. Loop circuits shall be closed when uncoupled or when the electric portion is retrieved.

G. Housing

The housing of the electric coupler box shall be provided with a covered opening to permit inspection, repair, and connection to terminals and other parts. Cables shall not go through covers. The cover shall be removable, dirt-proof, dustproof, weatherproof, car-washproof, and shall be provided with a drain orifice.

Provisions shall be made to safeguard the electrical coupler heads from damage in the event of improper alignment during the coupling maneuver.

12.5.2 NON-CAB ENDS

Electric connections between non-cab ends shall be by means of multi-conductor cables equipped at each end with self-locking plugs conforming to the environmental and performance requirements of MIL-C-005015, Parts MS3400 and MS3401, Classes F or B. The connectors shall be keyed to preclude insertion into the wrong receptacles. The receptacles shall be located on the car ends.

The contractor shall select cables, strain relief bushings, and connectors to assure a watertight connection without the requirements for potting.

All jumper cables shall be supported and of sufficient length so that no strain shall be imposed on the wires while the train is negotiating the most adverse conditions

described in Appendix A. The number of cables used shall provide the number of wires to make all necessary connections plus at least 10-percent spare wires.

12.6 PNEUMATIC DETAIL

12.6.1 CAB AND NON-CAB END

Car-to-car air line coupling shall be made automatically when couplers are fully engaged mechanically and locked.

A self-closing, vented valve shall be provided which shall automatically close off the brake pipe when cars are uncoupled and open the brake pipe between coupled cars. During the uncoupling cycle, the uncoupled air supply shall modify the operation of the vented valve of the active car such that only the brake pipe of the car being separated shall be vented to atmosphere following uncoupling, thereby ensuring that emergency air brakes shall be applied only on the cars being separated.

The design of the system shall reduce emergency pipe pressure to ensure a pneumatic emergency brake application on both cars in the event of an undesired train separation not initiated by the uncoupling cycle.

Provisions shall be made to preclude undesired buildup of air pressure in the uncoupling cylinder due to uncoupling valve leakage.

12.7 CONTROL DETAIL

12.7.1 CAB END

A. Braking

During uncoupling, the emergency brakes shall be automatically set on the cars to be separated.

No brake application shall be caused on any section of the train from which an operator-initiated uncoupling is made. In the event of an undesired uncoupling, an emergency brake application shall be caused by venting of brake pipe pressure.

B. Auxiliary Equipment

Auxiliary equipment shall be supplied as part of the coupler equipment to operate in conjunction with the electric coupler and the car control relays to perform the following functions:

1. Sense the uncoupled state, de-energize specified trainwires and pipes and activate the car relays needed to establish the adjacent car end as the train end.
2. Sense the coupled state, restore continuity to specified trainwires and pipes control the car relays to establish the car end as coupled end, and make contact.
3. Provide manual means by which all trainwires and pipes could be opened, deenergizing all coupler contacts and electrically isolating coupled cars.

4. Design to prevent inadvertent uncoupling.

12.7.2 NON-CAB END

Provisions shall also be made for vented cutout cocks between carbody piping and coupler hoses. Closing of the cutout cocks shall permit venting of the hoses and removal without bleeding car air. The cutout cocks shall be lock-wired in the open position.

12.8 DRAFT GEAR

12.8.1 DESCRIPTION

A. General

Draft gear shall be provided at each end of each car to carry coupler loads to the carbody via the anchor casting and its attachment to the draft sill. The draft gear shall be of the rubber cushion, pre-loading type capable of absorbing shock both in buff and in draft. Positive indication shall be provided on the exterior of the drawbar housing casting for inspection purposes to indicate the normal position of the emergency release mechanism and whether or not a full or partial release has taken place. The emergency release mechanism shall be specially designed to facilitate pin removal in the event of partial release.

B. Emergency Release

The draft gear shall be provided with an emergency release mechanism to provide emergency disconnect during severe end impacts. At the buff load specified in Section 12.3, the

release feature shall permit the car anticlimbers to engage, thereby transferring the load to the car structure. The coupler equipment shall remain capable of transmitting draft loads following emergency release.

No special tools and only minimum manual effort shall be required to restore the mechanical coupler to a normal operating condition. Disassembly of the draft gear or removal of parts from the car shall not be required.

12.8.2 ANCHORAGE

An anchor casting shall be provided for the attachment of the coupler-draft gear assembly to the car underframe. The casting shall be of high strength steel or ductile iron and comply with the strength requirements of Section 12.3.

Sufficient clearance shall be provided in the casting to permit removal of the drawbar housing without removing the drawbar carrier.

Provisions for lubrication which are accessible from within the maintenance bits shall be provided.

12.9 CARRIER AND CENTERING DEVICES

12.9.1 COUPLER CARRIER

The coupler shall be supported at its normal height by a radial carrier bar which shall support the weight of coupler and drawbar.

The coupler head shall be permitted the required range of movement in the vertical and horizontal planes as specified. Provision shall be made for coupler vertical height adjustment and wear compensation.

●● 12.9.2

COUPLER CENTERING

Alternate I*

The mechanical coupler at the cab end shall be provided with an automatic pneumatic centering device which shall maintain the coupler aligned within its horizontal gathering range when uncoupled. Provisions shall be made for easy manual disengagement of the centering device allowing the couplers to be moved manually. Disengagement and re-engagement shall not require the use of tools.

Alternate II*

The mechanical coupler at the cab end shall be provided with a spring-type centering device which shall maintain the coupler aligned within its horizontal gathering range when uncoupled. Provisions shall be made for easy manual disengagement of the centering device allowing the couplers to be moved manually. Disengagement and re-engagement shall not require the use of tools. #

● 12.10

COUPLER ADAPTERS

Coupler adapters shall be provided to permit emergency mechanical coupling with existing purchaser cars having a different type of coupler. Details of types of couplers in operation as follows: **_____.

*Purchaser will delete undesired alternate
**Purchaser completing detail

●12.11

CHECKING GAUGES

Checking gauges shall be provided by the contractor to permit dimensional integrity maintenance for critical operation of the coupler and for regular inspection of cars. * _____ sets shall be required.

A set of gauges shall include, but not be limited to, the following:

- a. Hook height and width
- b. Coupler throat opening
- c. Coupler height (anchorage and facing)
- d. Buffing face to pulling face GO
- e. Buffing face to pulling face NO-GO
- f. Spring Compression

*Purchaser completing detail



SECTION 13
AUXILIARY ELECTRICAL EQUIPMENT



SECTION 13

AUXILIARY ELECTRICAL EQUIPMENT

●13.1

GENERAL

The contractor shall perform for the purchaser's review a steady state, and transient stability and fault analysis under all significant load configurations on the auxiliary power supply network, including both the high and the low voltage branches. The analysis shall be based on the contact rail system steady state and transient impedance values and on the available fault current values which are as follows:*_____. The analysis shall establish that the protective device characteristics, settings, and clearing times are coordinated properly and safely throughout the auxiliary power supply systems, and that currents and voltages in all branches are satisfactory (see Figure 13-1).

13.2

HIGH VOLTAGE POWER SUPPLY

The power collector shoes convey 600 VDC power to the propulsion system and to the large auxiliary loads; such as, floor heater, overhead heater, air conditioning compressors and fans, air brake supply compressor, and the low voltage power supply.

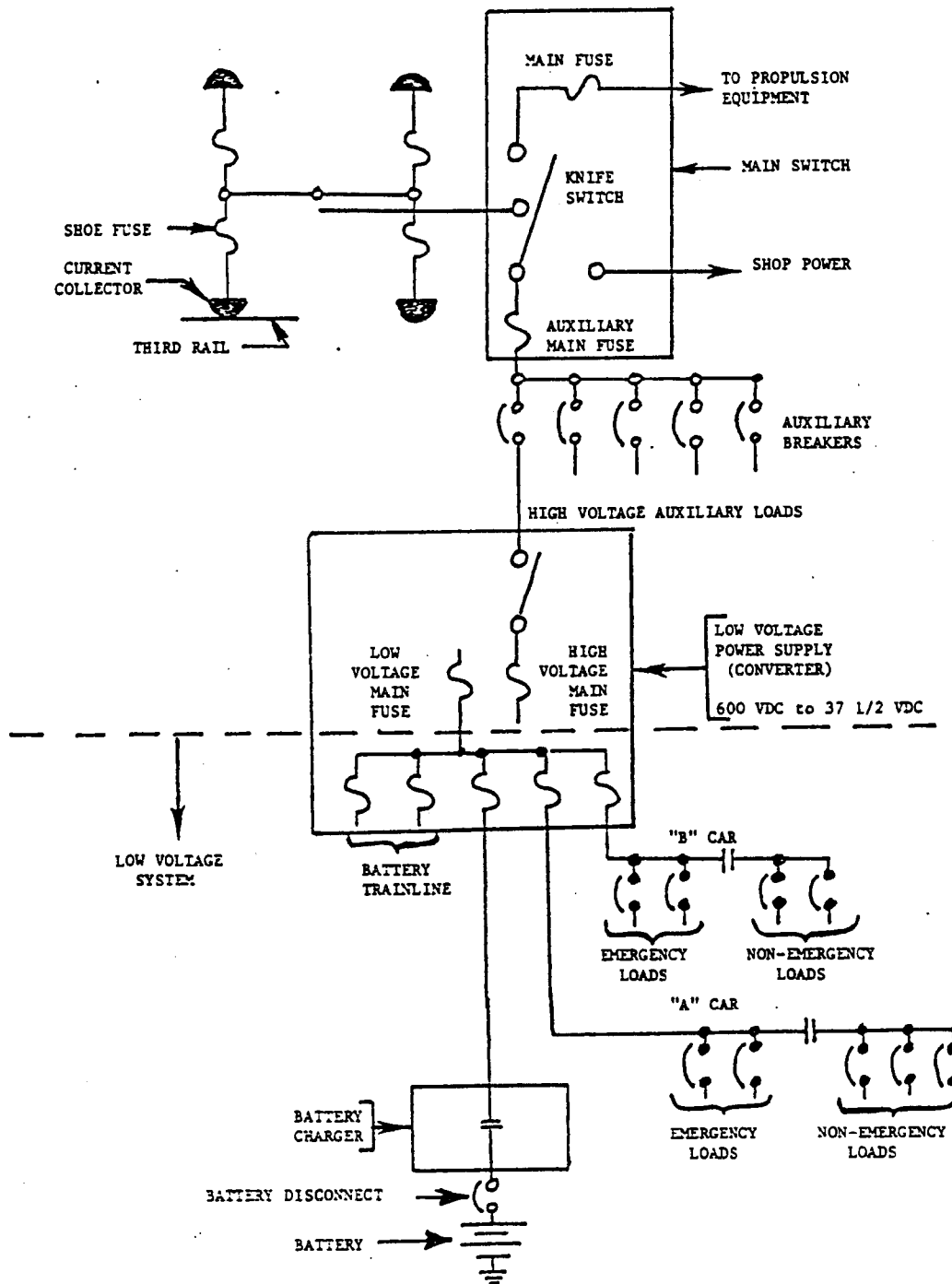
13.3

POWER COLLECTION EQUIPMENT

Power collector assembled shall be mounted to the shoe beam on each side of each truck, providing four assemblies per car.

*Purchaser completing detail

FIGURE 13-1
AUXILIARY POWER SUPPLY



Each assembly shall consist of the:

- Main body or beam
- Fuse holder and fuses
- Shoes and associated hardware

All current carrying components, including cabling, shall be electrically-sized for continuous operation without distress at the most severe performance levels in the event power collection to a car must be accomplished by a single shoe.

Shoes shall be the spring-loaded, overriding type and shall be compatible with, and sacrificial to, the contact rail. They shall be designed to encounter contact rail ramps and expansion joints as specified in Appendix A without damage at speeds up to 70 mph (112 kmh). Shoe pressure on the contact rail, the shoe downward movement stop, and nominal shoe height shall be adjustable using common tools.

The shoe beam of the assembly shall be formed of high strength, non-combustible material (when tested in accordance with ASTM D-635) dielectric material, impervious to moisture, and highly resistant to electrical tracking. It shall be designed to provide a breakaway capability and be shaped or arranged to protect the truck frame, carbody, cabling, and equipment mounted thereon from all the effects of, or involvement in, electrical arcing between the contact rail and shoe and from involvement with, or impingement of, hot ionized products discharged from a blown collector shoe fuse. Provision shall be made for adequate drainage of car wash water from fuse, fuse holder, and other collector assembly parts.

13.4

FUSES AND CIRCUIT BREAKERS

All fuses or electrical devices shall be identified and readily accessible. Circuit protection for the auxiliary power supply subsystem shall include primary fuses. The fuse holder shall contain fuse retention devices at both ends. Fuses shall not be used in heater circuits. Air gap and creepage distances shall be designed to meet the most severe operating conditions.

13.4.1

HIGH VOLTAGE FUSES

A. Collector Shoe Fuses

Collector shoe fuses shall be of the current-limiting and arc-confining type and shall be positioned by the fuse holder so that vaporized metal and ionized gases shall not be projected into the area between the collector shoe and any portion of the truck frame or carbody. The presence of a blown fuse shall be detectable visually without the removal of covers.

A plastic fuse box shall be provided on each shoe beam of the truck. The design shall facilitate removal and replacement of the fuse.

B. Low Voltage Power Supply (LVPS)

The LVPS/converter package shall be protected by current - limiting, fast clearing, static device protection installed on the load side of the LVPS contactor.

13.4.2 HIGH VOLTAGE CIRCUIT BREAKERS

A. Auxiliary Circuit Breakers

The auxiliary circuit breakers shall be located in the high voltage panel in the cab enclosure and shall contain the following high voltage circuit breakers as a minimum:

- 1 floor heater
- 2 overhead heaters (magnetic-only)
- 1 operator cab heater (magnetic-only)
- 1 air brake compressor motor (a0car only)
- 1 LVPS high voltage input (b-car only)
- 2 air conditioner compressor motors
- 2 ventilating fan motors

B. Circuit Breaker Requirements

All circuits shall be individually protected by circuit breakers. No circuit breaker shall protect more than one circuit. Circuit breaker terminals shall not be used as junction points. All circuit breakers shall be sized to protect both the equipment and the minimum wire size used for power distribution within the protected circuit. Circuit breakers, except for traction power line breakers, shall be trip-free, molded-case type, multipole with a frame size suitable for the continuous current interrupting duty. The poles shall be connected in series to achieve the stated voltages. The handle shall indicate ON, OFF, and TRIPPED positions. Each pole shall be equipped with adequate means of arc extinction to prevent flashover.

Continuous current rating shall be selected in accordance with ANSI C37.16 for the load and type of service specified.

Breaker current rating shall be clearly and permanently visible after installation. The breakers shall conform to the requirements of both ANSI C37.13 and ANSI C37.14. Electrically operated circuit breakers shall be equipped for operation from the low voltage DC supply.

13.5 LOW VOLTAGE POWER SUPPLY (LVPS) AND ENCLOSURE

The LVPS shall be installed under each B-car in a weather-proof enclosure. The LVPS shall include equipment to perform the following functions:

- Electromechanical isolation from the input power source
- Automatic discharge of the input capacitor filter
- Overload and fault protection
- Solid-state power electronics to produce nominal 37.5 VDC output power
- Automatic load-shed provisions

Enclosure access shall be interlocked to preclude entry until the high voltage input power source has been mechanically isolated from the maintenance portion of the LVPS circuits and the input high-voltage capacitors have been automatically discharged below 50 VDC. Enclosures shall provide adequate ventilation for cooling and venting of arc gases, but shall preclude entry of dirt, water, flying ballast, and other contaminants typical of the undercar environment.

13.5.1 LVPS OUTPUT OPERATING MODES AND CAPACITY

A. General

The LVPS shall supply constant low voltage power at 37.5 volts ± 0.5 VDC up to that valve required to operate a dependent pair under normal conditions (including the condition in which one of the pair controls an eight car train). This output shall supply regulated low voltage power to the low voltage loads when the battery is in the charging mode.

B. Converter Characteristics

The constant voltage output sensing and regulation devices shall maintain nominally constant voltage independent of load up to the current limit point. When input voltage falls below 70 percent of nominal, converter output voltage may begin falling off proportionately. However, the converter shall remain operational over the limits specified in IEEE 11 for the applicable nominal voltage. The converter shall have a voltage drooping characteristic in the event of current overloads in excess of nominal rated current. Available output current shall rise with falling output voltage to preclude collapse of output voltage caused by those loads which draw (approximately) constant power. When output current exceeds 105 percent of nominal current limit, the volt-amperes characteristic may "fold-back", but shall be capable of automatically recovering to normal regulation when the overload condition ceases. The fold back characteristic shall be adequate to recharge a dead battery. The output voltage shall be adjustable over a range of 1 VDC from the specified setting. The voltage adjustment shall be unaffected by vibration and temperature and shall remain stable under service conditions and ambient temperature ranges.

13.5.2 ISOLATION

The converter input and output negatives shall be isolated from one another so that the converter output negative and battery negative shall be connected to the contact rail current return only via a removable grounding strap. The grounding strap shall be in accordance with Section 13.9.

In like manner, provisions shall be made for all electrical circuit elements connected to the converter/battery system to be physically isolated from all converter electrical circuit elements connected to the contact rail and traction current return. Starting up and proper operation of the converter shall not be dependent on the voltage at the converter output terminals.

13.5.3 LVPS PROTECTION

The converter shall contain over-and-under voltage circuitry to self-protect in the event contact rail supply voltage should fall outside the design range. It shall not suffer damage because of sustained input voltages that may be impressed on it as specified in Section 13.1. In addition, sufficient protection shall be provided on the converter input and output to preclude damage to the converter from transient voltages.

13.5.4 BATTERY CHARGER

The battery charger shall provide dual rate charging of the battery. It shall be capable of constant current charging of the battery specified in Section 13.5.7, while the constant low voltage output of the converter is supplying all the low voltage loads. In the charging mode, it

shall in effect disconnect the battery from the low voltage loads and charge it at the battery manufacturer's recommended rate until the battery voltage rised to a value indicating full charge. Battery charging voltage sensing shall be temperature compensated. The final charging shall be done by trickle charging at the battery manufacturer's recommended rate.

The battery charger shall permit visual determination of the condition of the unit as follows:

- Normal output
- Malfunction

13.5.5 LOAD SHEDDING AND RECOVERY

Output sensing devices shall detect the loss or drop of constant voltage DC output from any cause. They shall measure the time duration of such conditions and shall automatically disconnect lighting, except emergency lights, from the LVPS whenever the loss persists for 10 seconds.

13.5.6 BATTERY

Each B-car shall be equipped with a nickel-cadmium battery of a type proven in rail transit revenue service. The battery shall consist of at least 25 cells. Each cell shall be steel or high strength, high temperature plastic-encased and shall provide for at least 4 inches (102 mm) of water over the top of the plates and be of such height as to make unnecessary refilling between scheduled inspections; i.e., 12,000 miles (19,200 km), ±500 miles (800 km) between inspections.

The battery shall have sufficient capacity to meet the load requirements, including that of trainline control for the maximum number of cars in a train, to permit the train to operate normally for a period of at least one hour without the charging supply and shall have a duty cycle as specified in Appendix A.

13.5.7 BATTERY PROTECTION

An over-temperature protective system shall guard against possible damage to the battery, battery enclosure, and other car components because of excessive battery charging. The protective system shall control the battery charge rate from the time when over-temperature is first detected. The protective system shall be so located as to preclude damage to the sensor during normal car operation and during all battery maintenance procedures. Protection shall be provided to limit charging current in the event of loose connections on the battery, short circuits in the battery, or dead cells.

13.5.8 BATTERY LOADS AND BATTERY POWER DISTRIBUTION

Figure 13-2 provides an example of a methodology for calculating estimated loads which the battery shall be capable of supplying under three important operating conditions. The estimated times to discharge the battery under these conditions are designated in the figure as T_1 , T_2 , and T_3 , and are the minimum acceptable values. The battery and converter capacities are shown only as illustrative examples. The contractor shall prepare a similar but more extensive analysis based on actual equipment demands and battery capacity selected by him and covering the full specified range of operating ambients. The analysis shall

FIGURE 13-2. ESTIMATED BATTERY LOADS--ONE DEPENDENT PAIR

Condition/ Load	Dead 3rd Rail	Dead Converter		Normal Running
	Train Standing No Door Operation	Train Running & Stopping to Load & Unload Passengers	Running	Battery Supplies All Low Voltage Loads During Rail Gap Transit Only
	Standing	Standing	Running	Running
Lights	0.5 KW	0.5 KW	0.5 KW	1.7 KW
ATC	0.0	0.8	0.8	0.8
Prop. Cont.	0.0	0.0	0.5	0.5
Brk Cont.	0.0	0.2	0.2	0.2
P/A	0.15	0.15	0.15	0.15
Door Cont.	0.2	0.2	0.2	0.2
Door Engines	0.0	1.5	0.0	0.0
Annunc	0.2	0.2	0.2	0.2
A/C Cont.	0.0	0.1	0.1	0.1
Horn	0.1	0.1	0.1	0.1
Misc.	<u>0.7</u>	<u>0.7</u>	<u>0.7</u>	<u>0.7</u>
A Car	1.85 KW	4.45 KW	3.45 KW	4.65 KW
B Car	<u>1.15</u>	<u>2.95</u>	<u>1.95</u>	<u>3.15</u>
A + B Car	3.00 KW	7.40 KW	5.40 KW	7.80 KW

3.0 KW = 88 amps @ 34 volts
 85% Battery Copy = 0.85×240 ah
 = 204 amp/hr.
 at the 8 hr. rate at 77 F

T_1 = time to dead battery @ 88 amps
 = $204/88 = 2.32$ hrs. = 139 min.
 @ 77F electrolyte temp.

7.4 KW = 218 amps @ 34v
 5.4 KW = 159 amps @ 34v
 30 stops @ 20 sec./stop. Requires 1/6 hr @ 218 a or 36.3 ah.
 5/6 hr. run requires 159 x 5/6 or 132.4 ah.

1 hr. run with 30 stops requires
 $132.4 + 36.3 = 169$ ampere hrs.

T_2 = time to dead battery
 = $204/169 = 1.2$ hrs.
 = 72 min.
 @ 77F electrolyte temp.

7.8 KW = 208 amps @ 37.5
 Battery supplies 230 amp for
 10 sec. or 0.61 ah per gap
 Converter capacity 267 amps
 provides 37 amps in addition to
 230 amps load which will restore
 gap drain in 61 sec. Therefore,
 battery retains charge with which
 it began and T_3 is unlimited.

13-11

form an integral part of the auxiliary system steady state and transient analysis required in Section 13.1 and shall address all "worst case" operating conditions, train consists, and dependent-pair locations within an 8-car train. This analysis shall show, for example, that voltage drops shall not exceed 1 volt on a 2-car train, nor 2 volts on a 4-car train, between any point in the battery power distribution network and the battery terminals when all normal operating loads are being supplied by that battery alone, and that conductor sizes, including especially trainline cables, are adequate.

13.5.9 BATTERY ENCLOSURE

The battery shall be mounted on a pull out, drawer-type enclosure located below the car floor to permit ease of installation and servicing accessibility. The enclosure structural frame shall be of welded steel construction. The coverings shall be electrolyte-resistant and may be reinforced fiberglass. Ventilation and drainage openings shall be provided.

The battery shall be arranged in 5 sets of 5 cells each. the separators between cells and sets, if used, shall be fire-retardant. Trays, if used, shall be fire retardant and electrolyte-resistant. The B+ and B- connections shall be readily accessible.

The complete battery shall be located in a steel, roll-out cradle. The cradle shall be arranged to roll out against stops far enough to completely expose the tops of all cells, and shall be designed to be lifted from below by a fork-lift truck. The cradle shall not require more than one person to manipulate it.

MISCELLANEOUS ELECTRICAL DEVICES

Low voltage switches shall be heavy duty and proven in electric railway service, shall have contacts rated for switching peak currents and for continuous duty at 50 VDC at the assigned loads, and shall meet the requirements of MIL-S-3930D.

The terms, RELAY and CONTACTOR, denote magnetically-operated devices for repeatedly establishing and interrupting an electric power circuit. Although the terms are often used interchangeably, the term, RELAY, shall be employed for devices below 5 KW power handling capacity, and the term, CONTACTOR, for devices controlling power at or above 5 KW. Relays and contactors:

- shall not be placed in parallel to increase the current carrying capability of the device
- shall be accessible and weatherproof
- shall have no more than two wire terminations per relay or contactor terminal
- shall be installed to preclude arc-over to adjacent equipment and damage or hazard from arc chute exhaust
- shall have been successfully demonstrated in rapid transit service
- shall meet or exceed the load and duty cycle that they shall be subjected to.

All coils shall be suppressed, except in the case where rapid switching shall be necessary, by use of suitable diodes and/or RC networks to protect contacts and reduce

transients that produce noise or electromagnetic interference in adjacent circuits.

Relays and contactors used in low energy circuits shall preclude failure due to deposits of dust or foreign matter.

13.7 CIRCUIT BREAKER PANELS

Circuit breaker panels shall be of such design that all electrical elements shall be completely concealed. The panels proper and barriers shall be of insulating composition with the height depending upon the number of circuit breakers to be mounted. A wiring gutter shall be provided at the top, bottom, and sides. The panel shall be mounted and shall be readily removable as a complete unit for repair or replacement.

13.8 GROUNDING

This section specifies the requirements for bonding and for lightning and grounding protection.

A. Truck Frame to Carbody

A grounding strap shall bond each truck frame to the carbody. When installed, all electrical and electronic unit metal enclosures shall provide a low impedance path from the equipment enclosure to the car structure. The bonding method shall produce a DC resistance of not greater than 0.0025 ohms from the enclosure to the structure, and a minimal AC impedance of less than 0.025 ohms at 150 KHz or of a comparable level at higher frequencies. The maximum DC contact impedance in traction circuit grounds and other intentional circuit grounds shall be designed not to exceed 0.0005 ohms.

The preferred bonding method shall be direct bonding of the equipment enclosure to a carbody frame member by metal-to-metal contact between the two surfaces. Where direct bonding is not feasible, conductors of sufficient cross-sectional area to carry lightning discharge current or fault current of the equipment shall be used and shall limit the voltage drop across the bond to 25 VDC.

B. Truck Mounted Components

Truck-mounted components shall be bonded to the truck frame. A set of slip rings and brushes, as specified in Section 14.2.2, shall be provided between the truck frame and each axle to provide an electrical path through the wheel rims to the running rails.

C. Propulsion System

Negative returns for the propulsion system shall be segregated from all other grounding connections. These circuits shall be installed between the ungrounded terminals of the propulsion equipment and a suitable grounding plate on a carbody frame member. The grounding plate shall be isolated from the carbody and shall pass the Isolation Resistance Test (IEEE STD 32-1972). A grounding strap with ample capacity for the service intended shall bond the grounding plate to a truck frame.

D. Steel Carbody

If the carbody structure is constructed of welded stainless or LAHT steel, the carbody shall be used for the negative return of all other primary-powered equipment. A grounding plate shall be bonded to a carbody frame

member, and two grounding straps, each with ample capacity to carry primary current, shall be provided between the carbody and each truck frame. Copper plates shall be brazed to steel plates which shall then be welded to the steel carbody structural member. Grounding leads shall then be bolted through the copper and steel plates and structural member.

E. Circuits

All load circuits connected to the low voltage DC bus shall be single wire and grounded, except those which shall be susceptible to transients and electrical noise. Susceptible circuits shall be two-wire each with a separate ground return to a common ground. The low voltage DC negative return shall be grounded to the carbody on a per-unit basis by means of a single removable ground strap through which no intentional current could flow, in accordance with this section.

13.9

SHIELDING

Wire shields used in trainline circuits shall be connected through the car coupler contacts. The wire shields shall be carried through all applicable connectors and junction boxes. Circuits shall be categorized. Shields contained in one circuit category shall not be interconnected with shields contained in another category. Shields on low-level signal leads shall not be interconnected with shields on high-level signal leads in the same category. Each group of shields shall be carried through on a connector pin or pins, or on terminal strips which shall be in the immediate proximity of the categorized group of circuits. Loops due to interconnections of shields shall not be permitted.

13.9.1

SUPPRESSION OR PROTECTION

All circuits requiring wire shielding shall have the shield terminated as specified in this subsection.

Shields used to suppress the electrical field at frequencies below 150 KHz audio frequency (AF) shall be terminated only at the low potential side of the interference circuit at the termination which exhibits maximum susceptibility.

Shields used to protect against the effect, or to exclude electrostatic voltages at frequencies below 150 KHz, shall be terminated to either the low potential side or at the balance point of the protected circuit at the termination which exhibits maximum susceptibility.

Shields used to suppress or protect against electric fields above 5 KHz shall be terminated at both ends of the low potential or balance points.

Cable shields used to exclude electromagnetic interference (EMI) at frequencies of 150 KHz and above shall be grounded to the car structure at more than one point. These shields shall be connected at the equipment cases at each end of connectors as a minimum, and at 3 foot (914 mm) intervals as a design goal. Shields shall not be carried through connectors by isolated means. The type and quality of the shields; i.e., single braid, or solid sheath, shall be determined by the attenuation requirements.

13.9.2

DOUBLE SHIELDS

Cables requiring both audio frequency (AF) and radio frequency (RF) shields shall be electrically isolated from each other.

The resistance between these circuits shall be at least 500 megohms when 1000 VDC is applied. Double shielding shall be required on circuits that are both AF-susceptible and RF-susceptible.

Coaxial cables used as constant impedance transmission lines shall be terminated as dictated by the circuit termination design and shall not be considered to be shielded conductors. Triaxial cables may be used as coaxial constant impedance transmission lines with the outer conductor employed as an RF shield.

13.10

PASSENGER AND OPERATING PERSONNEL SAFETY

The contractor shall ensure that all metal parts inside and outside the car, including equipment boxes, panels, and test receptacles in the passenger or operator areas, and which could be contacted by passengers or operating personnel, shall be at carbody potential.

SECTION 14
PROPULSION AND BRAKING



SECTION 14

PROPULSION AND BRAKING

● ● 14.1 GENERAL

This section specifies car propulsion and braking requirements. Primary power shall be supplied at a nominal

Alternate I*

600 VDC

Alternate II*

750 VDC

#

for traction equipment, auxiliaries, and control via the power collector device specified in Section 13.1. Car equipment shall meet performance requirements of IEEE Standard No. 11 for the specified nominal voltage.

14.2 PROPULSION SUBSYSTEM

14.2.1 GENERAL

A. Basic Car Unit

Each car unit of propulsion equipment shall include, but not be limited to: power conditioning equipment, four motors complete with gear units and appropriate lubricant, suspension, and flexible couplings.

*Purchaser will delete undesired alternate

B. Main Switch

A single-pole, double throw knife switch shall be located in an undercar position accessible from underneath or from the side of the car. The switch shall, in the OPEN position, disconnect collector shoe power from all carborne systems. With the switch in the OPEN position, it shall be impossible to close the enclosure cover. When switch is in the TEST position, the main switch shall permit shop primary power to be used to test the auxiliary electrical system without simultaneously energizing the main propulsion circuits.

C. Main Fuse

One main fuse per car for propulsion power shall be provided in an enclosure adjacent to the main switch enclosure which shall have a hinged captive cover to facilitate inspection and replacement. One auxiliary fuse shall be provided in the main switch enclosure.

D. Linebreaker

A linebreaker (line switch) shall be provided in the traction power circuit immediately following the main fuse. The linebreaker shall be capable of interrupting maximum fault currents to protect traction power circuits. The linebreaker shall be installed as part of its own enclosure, shall be insulated from the carbody, and shall be capable of being remotely set from the operator's console. Linebreaker reset circuitry shall be so designed that if the linebreaker is tripped three successive times, the linebreaker shall be locked out immediately following the third trip operation and shall be required to be reset

manually at the linebreaker. Should a linebreaker weld or fail to drop out, propulsion and dynamic braking shall be rendered inoperable for as long as this condition exists.

E. Propulsion Status Signal

A propulsion status signal shall be provided for each car along with an indicator either in the operator car or undercar. The signal(s) shall provide the status of the following:

- Propulsion - dead car
- Loss of dynamic braking
- Welded contactor tips of the linebreaker

14.2.2. GEARS AND GEARBOXES

A. Performance and Maintenance Provisions

1. General Gearing shall be parallel-type with the gear unit mounted on the axle and supported by a resilient mount on the truck ransom. The gear unit shall be either the single or double-reduction type. The gearcase shall have baffled or filtered orifices and plugs for lubrication and breathing. Gear ratio shall be selected to provide the car performance specified in Section 3.3.3 and shall conform to established railcar gear design practice.

The gear unit shall be arranged to provide attachment for the traction motor and shall have as a minimum a service life or 1,000,000 miles (1 609 300 km).

2. Speed Sensors Provisions shall be made for mounting two speed sensors per gear unit located to provide protection from flying objects and for replacement without requiring detrucking.

The contractor shall install one speed pick-up sensor on each axle or in each gearbox in a manner and location readily accessible for maintenance. Speed sensing circuitry shall provide a positive indication of speeds equal to or greater than 3 mph (4.83 kmh), and shall be adjustable to compensate for wheel wear. True train speed shall be measured with 0.5 mph (0.80 kmh).

3. Manufacturing Particular attention shall be given to neatness and thoroughness of welding, forming, machining, and assembling of parts. After assembly, units shall be thoroughly cleaned of loose, spattered, excess metal or metal chips, and other foreign material. Burrs shall be removed and sharp edges shall be rounded. Standard commercial parts shall be used to the maximum practicable extent. Supplier and part numbers shall be identified on drawings, bills of material, and parts lists.

4. Gears Gears shall be designed and installed for a minimum inspection and adjustment interval of 500,000 miles (804 650 km). One break-in type inspection during the first such interval shall be acceptable. Gears shall have a minimum life of 1,000,000 miles (1 609 300 km) with no degradation of performance. All main drive gears shall be fabricated from high-quality gear steel, designed and heat-treated/hardened in accordance with AGMA 240.01,

Gear Materials Manual.

5. Bearings The gearbox shall be equipped throughout with bearings which shall require a minimum inspection or adjustment interval of 500,000 miles (800 000 km). Bearings shall be manufactured from high-grade, standard commercial or vacuum-melted, bearing quality, through-hardened, or carburizing grades of steel. Seals on rotating parts shall be radial lip, face, or labyrinth-type seals. Inspection covers and gaskets shall preclude lubricant leakage.

6. Lubrication The gearbox shall be oil lubricated and shall be provided with sufficient baffles, dams, passages, and similar structures to ensure an adequate flow of lubricant to all bearings and gears under conditions specified herein of rotation, speed, load, temperature, and weather, including continuous operation in either direction at maximum speed. The unit shall be so designed that adequate lubrication shall be provided to all bearings and gears under the most severe operating conditions and shall preclude moisture infiltration into the lubricant. The gearbox shall have sufficient oil capacity for adequate cooling. All gear lubrication shall be in accordance with AGMA Standards 250.03 and 251.02.

The gearbox shall have at least one oil drain opening located at the lowest point in the case or sump. A drain plug(s) shall be installed in the opening(s) and properly secured. The filler plug may be non-magnetic, provided that a magnet shall be included in the gear unit, located for maximum contact with the lubricating oil, and readily removable for

cleaning. All fill, drain, and inspection plugs shall be safety-wired.

The quantity and grade of lubricant shall either be indicated on the filler cap or on the gearbox housing adjacent to the caps. Seasonal changes of lubricants shall not be required. The gearbox lubrication system shall be readily accessible and shall be designed to preclude overfilling.

7. Maintenance Gearbox components requiring repair or replacement shall be readily accessible without requiring removal of integral parts. Parts requiring replacement or adjustment during design life of the system components shall be individually replaceable. An adequate number of bolted and gasketed openings shall be provided for inspection and routine maintenance.

Disassembly, reassembly, servicing, and maintenance shall be possible to the maximum extent with tools and items of maintenance equipment in common usage. Special tools, where required, shall be provided by the contractor as specified in Section 21.4.

B. Grounding Brush

A ground brush assembly shall be mounted on the gear unit to shunt ground current to the axles around the anti-friction bearings. The ground brush assembly shall be electrically insulated from the gearbox and axle. One ground bush shall be provided per axle. Each brush shall be capable of carrying one-half the total electrical load, shall be held securely by suitable spring pressure against

a machined, axle-mounted, bronze or steel ring, and shall be mounted to provide an effective means for electrical connection to the ground lead. Brushes and brush holders shall be protected against injury and from the operating and storage environment by a housing with a readily removable cover.

● ● 14.2.3 TRACTION MOTORS

A. Performance and Maintenance Provisions

1. General Each axle shall be driven by a traction motor capable of producing the tractive effort level as specified in Section 3.3.3. All traction motors shall conform to IEEE Standard No. 11 (ANSI-C35.1), Rotating Electric Machinery. Traction motor rating shall be based on the performance requirements of Section 3.2.
2. Insulation Motor insulation shall be IEEE Standard No. 11, Class H insulation system or better, with Class F or better resin. After assembly, the complete motor shall be vacuum-pressure impregnated.
3. Armature The motor armature shall be dynamically balanced within the limits specified in Figure 14-1. The armature shall include all subassemblies which are rotated with and become part of the assembly when installed on the motor frame.

FIGURE 14-1. MOTOR ARMATURE LIMITS

<u>Armature Speed (RPM)</u>	<u>Maximum Unbalance (Rotating Mass)</u>	
	oz. per lb.	(g per kg)
0 to 4000	0.002	0.125
4001 to 5000	0.0015	0.0936
5001 to 6000	0.001	0.0625

Damage to the shaft assembly shall not require re-
placement of the armature, windings, or commutator.

4. Speed The motor shall meet the overspeed require-
ments of IEEE Standard No. 11. Commutator peripheral
speed shall not exceed 12,000 fpm (61 m/s) under
maximum speed conditions with fully worn wheels and
a new commutator.

5. Terminals, Bearings and Lubricants Terminals and
terminal blocks shall be protected from weather and
the operating environment and shall be clearly marked
for positive identification. Traction motors shall
be equipped with antifriction, sealed lubrication
bearings. Lubricant cavities shall have a volume
sufficient for 150,000 miles (240 000 km) of operation
without requiring relubrication. Motors shall be
provided with tapped holes closed with pipe plugs to
permit addition and purging of lubricant at 50,000
miles (80 000 km) or one year intervals, whichever
occurs first. The bearings shall have a B-10 life of
500,000 miles (804 650 km). Motor dynamic seals shall
be radial lip, face, or labyrinth-type.

6. Commutator Traction motor commutator bars shall be silver bearing and of uniform thickness and shall permit radial wear of no less than 0.25 inches (6.4 mm) without affecting the ability of the commutator to operate safely at maximum motor speed.

7. Laminations High temperature coating of coils shall be suitable for burning and chemical removal upon rewinding or replacement of coils.

8. Motor Brushes and Brush Holders The brush holders shall be secured to, and thoroughly insulated from, the motor frame. Brush holders shall be adjustable to permit 3/8 inch radial wear of the commutator. Brush holders shall be designed and located so that the brushes shall be readily accessible. Brushes shall fit in the holders closely without binding. The constant pressure springs shall be so designed as to permit regulation of the brush tension between four and eight pounds in steps of approximately two pounds. Flexible shunts for operation of all specified ratings without undue heating shall be provided on the brush holder fingers.

Operation of the brush and brush holder assembly shall not be affected by brush and spring resonant frequencies. Brushes shall have as a minimum useful life of two years or 50,000 miles (80 000 km).

9. Connections Connections between commutator risers and armature coil leads shall be welded in a manner to preclude separation under all conditions. The armature shall be capable of three rewinds.

B. Motor Field

Series-excited motors shall have their regulated field excitation coordinated with the power modulation system. Separately-excited motor field power may be effected by using either auxiliary or primary power. Motor fields shall be vacuum pressure impregnated and potted. Loss of field control shall result in immediate propulsion system shut-down. Compensating windings shall be used if the motors would otherwise have to operate with any combination of field current and armature current that could result in a reversal of flux direction under any portion of the main poles in any steady state condition of motoring or braking. Commutating poles shall be used.

C. Mounting Detail

The motors shall be designed for suspension from the truck frame and for coupling by means of gear-type couplings to the gear unit which shall be mounted on the axle and supported at the motor side by a suspension bolt.

The motors shall be equipped with safety hangers to preclude the motor from falling.

The motors shall be designed to permit each motor and gear unit to be removed from the car truck without interference with members of the truck frame.

The clearance of the lowest point of the motor frame or gear unit above the top of the track rails shall be a minimum of 3-7/8 inches (98.4 mm) when mounted on a truck having new bearings and 34 inch (864 mm) wheels and supporting the car without passenger load.

D. Vibration Limits, Traction Motors

The vibration of any traction motor, detached and supported on resilient mountings providing at least 0.25 inch (6.3 mm) static deflection, shall not exceed 0.0015 inch (.03 mm) peak-to-peak displacement at the motor bearing housings and at the motor mounting points while the motor is rotating at any speed between 50 percent and 100 percent of the maximum normal operating speed.

E. Ventilation

Alternate I*

The traction motors shall be forced ventilated by blowers. Blower motors shall be of a heavy duty design. Air ducts shall have clean-out openings.

The blowers shall be supported on vibration absorbing mounts.

In the event of motor ventilation failure, power shall be removed from the motors. However, one more stop with dynamic brake shall be possible. Upon the next request for power, a blue trouble indicator light shall be illuminated and the car shall simultaneously be cut out.

Alternate II*

Motors shall be self-ventilated. The mass rate of air flow shall be defined by the motor manufacturer.

Openings shall be provided for inspection and ventilation. The air inlet openings shall be provided with captive per -

* Purchaser will delete undesired alternate

forated covers of non-conducting material which shall be openable to permit brush inspection and replacement. Air outlet openings shall be protected from obstruction. #

F. Propulsion Cutouts

Manual controls shall make possible isolation of the propulsion system to permit a car to be cut out. Manual cut-out on a per-car basis shall be accomplished by a propulsion cutout switch located at the secondary control panel.

14.2.4 COUPLINGS

The coupling system between the traction motor and axle assembly shall be balanced to minimize noise or vibration produced at car speeds up to 70 mph (112 kmh) with fully worn wheels. Lateral, vertical, longitudinal, and angular motion of the axle relative to the motor armature bearings shall be accommodated.

● ● 14.2.5 POWER CONDITIONING

A. General

The power conditioning subsystem shall be

Alternate I*

Switched Resistance Cam Control

Alternate II*

Chopper Control #

* Purchaser will delete undesired alternate

B. Operating Parameters

Alternate I*

Cam-type propulsion control shall utilize switched resistance controlled by a camshaft containing a series of contactors and switches. The camshaft may be indexed by either an air or electric motor. The control system shall respond to signals from the automatic or manual control systems, adjust tractive effort in response to load-weight signals, interlock friction with electrical braking, and produce commanded tractive effort. Lubrication interval shall be 300,000 miles (480 000 km).

1. Acceleration Acceleration shall progress from four traction motors in series, through a transition into parallel, in which there shall be two parallel circuits of two traction motors each in series. For high speed operations, field shunting shall be used. Acceleration rates shall conform to Section 3.3.3.
2. Resistance Steps The number of switched resistance steps shall be such that the jerk limits specified in Section 3.3.3 shall not be exceeded in either acceleration or braking.
3. Cam Advance Advance of the camshaft to all power levels shall be in response to trainline commands under the restriction that motor current and acceleration rate shall be maintained at safe levels. The camshaft shall be capable of retrogressing to provide speed maintaining and motor current control.

*Purchaser will delete undesired alternate

4. Electrical Braking Cam control shall provide complete and continuous control of electrical (dynamic) braking. The electrical braking subsystem shall employ the traction motors as generators and operate in conjunction with the friction braking subsystem. The total electrical braking energy shall be dissipated by resistor grids as specified in Section 14.3.1.

5. Motor Connections Positive tractive effort shall be controlled by appropriate trainline wires providing for the motor connections specified in Figure 14.2.

FIGURE 14-2

POSITIVE TRACTIVE EFFORT

<u>SPEED COMMAND</u>			<u>MAXIMUM MOTOR CONNECTIONS</u>
3 mph (4.8 kwh) (car wash only)			Switching: full resistance
<u>NOMINAL</u>	<u>MAXIMUM</u>	<u>MINIMUM</u>	
15 mph (24 kwh)	16 mph (26 kwh)	11 mph (18 kwh)	Full field series
25 mph (42 kwh)	26 mph (44 kwh)	21 mph (36 kwh)	Intermediate field series
35 mph (56 kwh)	36 mph (58 kwh)	31 mph (50 kwh)	Full field parallel
50 mph (80 kwh)	51 mph (82 kwh)	46 mph (74 kwh)	Intermediate field parallel
70 mph (112 kwh)	71 mph (114 kwh)	66 mph (106 kwh)	Weak field parallel

Alternate II*

1. General Chopper-type propulsion control shall include either self or forced ventilation DC traction motors, of series or separately excited configuration, with associated drive gear units and a thyristor-controlled power modulation system, including reactors, reverser, protection and monitoring devices, reset capabilities, and field shunting components. Use of power contactors and resistors, excepting dynamic brake grids, shall be minimized. The control system shall respond to signals from the automatic or manual control systems, adjust tractive effort in response to load-weight signals, blend friction with electrical braking, and produce the commanded tractive effort. Torque to the four axles shall be determined by a common or multiple tractive effort control. Modulation shall be continuous over the entire speed range.

2. Chopper Modulation Primary power controlled by a thyristor modulation system shall be applied to the DC traction motors. This chopper-type modulation system, either single or polyphase, shall control car acceleration and electrical braking. The nominal chopping firing rate shall be fixed and controlled to ± 0.1 Hz per phase. The chopper shall operate between 28 Hz and the nominal chopper firing rate only when the chopper is at its minimum conduction angle. Chopper frequencies selection shall be coordinated with automatic train control cab signal frequencies to preclude EMI problems.

* Purchaser will delete undesired alternate

3. Power Semiconductors Power semiconductors shall be functionally grouped and mounted as modules to facilitate maintenance and removal. Forced air shall be used where required for heatsink temperature stabilization.
4. Thyristors Thyristors used in power and auxiliary circuits shall be assembled into units to provide mechanical support and thermal impedance stability for a minimum of 10 years without special maintenance. Heat convection passages shall be free of obstructions. Critical dynamic parameters, such as dv/dt and di/dt imposed by the circuit operating conditions, shall be controlled to ensure a minimum life of 30 years for the devices.
5. Packaging Control functions shall be grouped within the enclosures and arranged to ensure adequate heat rejection. Heat-producing components shall be compartmentalized for protection of temperature-sensitive devices. Vital circuits and critical static devices shall be located to assure thermal and vibrational stability. Internal support and mechanical protection for cables and harnesses shall be provided.
6. Location Propulsion motor control circuitry, solid state modulation devices, blowers, and brake grids shall be mounted undercar. Propulsion control logic assembly may be located in the cab.
7. Line Filter A line filter shall protect the wayside supply and car propulsion system from unwanted transients in accordance with Section 13.1. Line filter capacitors shall have a minimum life of 10 years. A bleeder resistor shall provide a discharge

path for the capacitor bank upon deenergization. The discharge time of the capacitor bank shall not exceed 30 seconds from the nominal VDC specified in Appendix A to 50 VDC. A charging resistor shall limit inrush current to the filter capacitor. Means shall be provided to automatically bypass the charging resistor when the filter capacitor is at line voltage. #

14.2.6 CONTROL LOGIC

A. General

1. Mode Changes A separate two-level (high/low) signal shall control mode changes between braking and propulsion. Another signal shall control emergency braking. The friction brake subsystem shall respond to changes greater than 4 percent of the analog signal.
2. Jerk Rate and Dead Time Specified within the jerk rate and dead time limits, the propulsion subsystem shall provide an initial acceleration rate of 2.5 mphps (4 kmhps). This rate shall be constant from zero speed to a corner point speed as specified in Section 3.3.3B, such that the performance requirements stated in Figure 3-3 shall be achieved.
3. Coast The propulsion and braking subsystems shall interpret a zero acceleration/deceleration command as a COAST command. During coasting, a minimal amount of generated current not to exceed a peak of 100 amperes and an average of 50 amperes may be maintained in the dynamic braking subsystem to reduce response time in the electrical braking circuit. Coasting shall take place with the traction motors at the weakest field strength.

B. Traction Power Interlocks

As a minimum, fail-safe traction power removal shall be provided when an emergency brake application has been commanded. While any train side door is open, or in the event of a door opening while the train is in motion, both the removable fail-safe traction power and a full-service brake application shall be provided.

D. Load-Weigh

The load-weighing compensation signals to the propulsion and braking subsystem shall be a continuous function available for car weights up to and including AW3. The load-weigh subsystem shall be designed to ensure that in the event that load-sensing should be lost, the braking subsystem shall respond as if the car weight were AW3. The load-weigh subsystem shall be damped to preclude responding to dynamic suspension motions.

E. Blending

Car retardation shall be accomplished by coordinated effort of the electrical and friction brake subsystems. Braking effort shall be equal to the commanded effort within the tolerances listed in Section 3.3.3. At a car weight greater than AW2, or under conditions which result in the electrical brakes not providing the commanded braking effort, friction brakes shall be blended on a per-car basis to maintain the commanded effort.

ELECTRICAL BRAKING SUBSYSTEMAlternate I*

Switched Resistance Cam Control

A. General

The electrical braking subsystem shall employ the traction motors as generators and dissipate energy into carborne resistors (dynamic braking).

B. Dynamic Braking

The total electrical braking energy shall be dissipated as heat by the resistor grids.

C. Propulsion Control Resistors

Propulsion and brake resistors shall be of the edge wound-type or of equal strength construction, and shall provide the braking performance specified in Section 3.3.3 without regeneration. Grids shall be isolated from their frames, and the frames shall be isolated from the carbody with high-temperature insulation. A sensor for open-circuited resistors shall be provided. Provision shall be made for grid expansion to preclude warping.

Braking resistors shall be undercar-mounted and sized for natural convection cooling. Grids shall be adequately insulated for expected voltage levels and shall be protected

* Purchaser will delete undesired alternate

from wheel splash and flying debris. Design capacity shall be based upon resistors in the used/aged condition. Heat dissipated by the resistors shall not be detrimental to any other undercar equipment or material.

Alternate II*

Chopper Control

A. General

The electrical braking subsystem shall employ the traction motors as generators and dissipate energy into carborne resistors (dynamic braking). Electric braking shall continue through contact rail gaps without causing component failure or malfunction.

B. Regenerative Braking

A selector switch shall be provided on each car to permit activation of regenerative braking on properly equipped routes. When activated, the propulsion system shall regenerate the maximum energy that the contact rail can accept, and shall dissipate unaccepted energy as heat in the grids or friction brakes. When the line is receptive, regenerative braking shall take priority over dynamic braking. Maximum voltage induced in the contact rail during regenerative braking shall not exceed that voltage specified in Appendix A.

* Purchaser will delete undesire alternate

C. Electrical (Dynamic) Braking

The total electrical braking energy shall be dissipated as heat by the resistor grids when regeneration is not in effect.

D. Electrical Brake Resistors

Electrical (Dynamic) brake resistors shall be of the edge wound ribbon type or of equal strength construction, and shall provide the braking performance specified in Section 3.3.3 without regeneration. Grids shall be isolated from their frames, and the frames shall be isolated from the carbody with high-temperature insulation. A sensor for open-circuited resistors shall be provided. Provision shall be made for grid expansion to preclude warping.

Braking resistors shall be undercar-mounted and sized for either convection or forced cooling consistent with chopper propulsion control. Resistors shall be adequately insulated for expected voltage levels and shall be protected from wheel splash and flying debris. Design capacity shall be based upon resistors in a used/aged condition. Heat dissipated by the resistors shall not be detrimental to any undercar equipment or material. #

E. Power Return To External Power Source

No equipment or device on the car shall return any power to the external power source or cause the power collector devices to be at a potential above zero when the power source is de-energized or when the car's power collector devices are not in contact with the external power source.

FRICION BRAKING SUBSYSTEMA. General

A pneumatic friction brake subsystem shall be provided on each car. The friction brake subsystem shall apply retarding force to the tread of each wheel by means of brake shoes, and shall include the following elements:

- A continuously variable service brake to supplement the electrical braking effort and to provide the total braking effort when electrical braking effort has been reduced to zero.
- A fail-safe brake to provide full service and emergency braking effort.

● 14.4.1

TRUCK-MOUNTED EQUIPMENT

The friction brake subsystem shall withstand the loads induced when meeting performance requirements with electrical braking inoperative, and shall withstand one and one-half times the main reservoir safety valve pressure. Pressurized vessels and components shall conform to the ASME boiler and Pressure Vessel Code for Unfired Pressure Vessels.

A. Tread Brake Units

A tread brake unit, mounted on the truck frame and capable of withstanding the forces and motions associated with that location, shall be provided for each wheel. Each unit shall receive air pressure under control of the electro-pneumatic

control unit and apply braking effort to the wheel tread through a brake shoe. Each unit shall provide even application of the brake shoe to the wheel to preclude sharp peaks or shoe slide-off. The tread brake unit shall automatically adjust to compensate for brake shoe wear. An integral air-over-oil, slave cylinder arrangement may be used, but there shall be no exposed oil line. Bulk wheel temperatures measured at any point shall not exceed 800 degrees F (448 degrees C).

B. Trip Cock

Two self-resetting trip cocks with adjustable mounts shall be installed on diagonally opposite corners of each car. When activated, the trip cock shall open, remain open a sufficient length of time to initiate an emergency brake application, and then shall automatically reset. The following operating requirements shall be conformed to to ensure proper interaction with wayside equipment.* _____

C. Air Line Piping

Air line piping shall be as specified in Section 6.3.1 and shall conform to the following:

1. Piping shall be clamped to preclude vibrating, rubbing, and chafing. Clamps shall be isolated to preclude noise generation.
2. Flexible connections shall be provided on all piping between the carbody and the trucks and couplers. Hoses shall conform to Specification M-618 and shall

*Purchaser completing detail

be equipped with AAR-approved reusable fittings. Air hose applications shall not be permitted in locations where visual inspection cannot be assured. Hose fittings shall comply with AAR Specification M-927. Flexible connection between air compressor unit and carbody shall not be required if such isolation is provided within the unit.

3. Piping shall be installed with a minimum number of fittings. Unions shall be used where necessary to permit replacement of apparatus and hoses.
4. All piping and fittings shall be arranged to assure moisture drainage into reservoirs installed at the lowest points in the system. Reservoirs shall be fitted with drain valves.
5. All piping, fittings, and valves shall be protected from damage caused by flying ballast and other foreign material which might be encountered in rapid rail operations.
6. The contractor shall obtain concurrence of the friction brake supplier regarding piping procedures, and the application of those procedures shall be reviewed at the undercar equipment mock-up stage.
(CDRL)
7. Fittings for test purposes shall be furnished on each car in the brake pipe, brake cylinder pipe, and in such other locations as shall be recommended by the friction brake subsystem supplier. Specific fitting locations shall be as follows:*

*Purchaser completing detail

A. Brake Control Equipment

1. Compressor In the event of compressor unit loss, the subsystem shall have sufficient storage capacity for ten consecutive full-service braking applications and releases at AW3 without initiating an emergency due to low air. It shall be assumed that the power loss shall occur when the main air reservoir is at the cut-in pressure setting of the air compressor governor.

2. Friction Brake The friction brake subsystem shall be controlled in conjunction with the propulsion subsystem, including blending, speed taper, jerk limiting, and load-weighting functions. Friction brake effort shall be controlled on a per-car basis. Friction brake subsystem control shall be fail-safe to the extent that no single failure or combination of common mode, or common cause, failures shall result in less than 50 percent emergency braking effort per car being available.

3. Train Control Signals The friction brake subsystem/ATP equipment interface shall be via train control signals. The emergency brake control signal and the response to it must be fail-safe. Emergency brakes shall be initiated and propagated by venting the pneumatic brake pipe. Propagation time for an 8-car train shall be less than 2 seconds. Pneumatic initiation and propagation of emergency braking shall not depend on electricity.

4. Blending The friction brake subsystem shall provide smooth blending with the electrical brake effort during service brake application. The propulsion subsystem shall furnish on a per-car basis, an electric brake effort signal that is an analog of the total brake effort that is actually being furnished by electrical braking. The friction brake subsystem shall furnish the necessary brake effort to make up the difference between the commanded brake effort and that braking effort supplied by electrical brakes. The electrical brake effort feedback signal shall represent a level of electrical braking equal to or less than actual.
5. Load-Weigh The load-weigh subsystem shall conform to the requirements of Section 14.2.6A.
6. Speed Taper A speed taper shall be imposed upon the service friction brakes to meet the brake rate requirements of Section 3.3.3. Speed taper shall not apply to the emergency brake.
7. Jerk Limiting The service brakes shall be jerk controlled to the requirements of Section 3.3.3. Jerk limiting shall not be applied to emergency brakes.
8. Emergency Braking Emergency braking shall be friction braking only, and shall meet the requirements of Section 3.3.3. Brake pipe recharge time shall not exceed 10 seconds for an 8-car train. Emergency brakes shall result in an irretrievable brake application that cannot be released until the train is stationary. An emergency brake application to the entire train shall be obtainable during any stage of service brake application or release and shall be initiated by at least any of the following conditions:

- a. Depressing EMERGENCY STOP pushbutton on the operator's control console and the EMERGENCY position of the manual controller
- b. Trip cock activation
- c. An unintentional uncoupling
- d. Reduction of brake pipe air pressure below the following level: * _____
- e. Deadman conditions
- f. An emergency brake valve which can be operated by a passenger or conductor and which shall be provided in each cab

B. Air Compressor Unit

The air compressor unit shall be of continuous-duty design and shall consist of: a heavy-duty compressor cooling system, safety valve, one main reservoir, and at least one supply or protected reservoir (if required for operation or maintenance), automatic drain valve with heater, governor, dessicant-type air dryer, and all other required appurtenances. The compressor shall produce the total required compressed air capacity for operation of: brakes, pneumatic suspension, horn, windshield wiper (when pneumatically operated), couplers, and others items as follows:

* _____ The air compressor unit shall be mounted under the A-car of each dependent-pair.

Compressor displacement, when driven against a pressure of 150 psi (1034 kPa) shall not be less than 30 cubic feet (0.85 cubic meters) of free air per minute. The compressor shall utilize the compressor supplier's-specified lubricating oil, shall have positive lubricating pressure, and shall have an integral sump.

*Purchaser completing detail

1. Intake Filter The compressor intake filter shall be a disposable element of sufficient size to ensure passage of the volume of air required for the maximum compressor capacity.
2. Discharge Temperature The air discharge temperature of the compressor unit shall be within 5 degrees F (2.78 degrees C) of inlet ambient temperature with the compressor running continuously under full load for one hour.
3. Subsystem Pressure Maximum pressure in the pneumatic subsystem shall be 160 psi (1102 kPa). The subsystem shall be protected by a main reservoir safety valve.
4. Leakage Rates Allowable air leakage for the total car shall not exceed 5 psi (34.5 kPa) in 10 minutes following a five-minute settlement period from the point at which the subsystem had been charged to 150 psi (1034 kPa) and the air compressor had been shut off.
5. Compressor Control Compressor control shall be automatically controlled on a per unit basis to maintain pressure at 130-150 psi (896-1034 kPa).
6. Compressor Motor The compressor motor shall conform to the following:
 - a. Type Motor shall be series-wound, interpole construction, and totally enclosed.
 - b. Efficiency Eighty percent at rated voltage and load.

- c. Time Rating The motor, when operating at the voltages, loads, and speeds specified herein, shall be classified as continuous duty as defined by IEEE Standard No. 11.
- d. Bearing The armature shaft bearing shall be of the anti-friction, ball or cylindrical roller, double width, prelubricated and sealed-type. The bearing must be capable of operating under the sustained loads and speeds encountered at an overspeed of 10 percent beyond that produced when 675 VDC is applied to the motor circuit. A grounding brush shall be incorporated in the motor between the armature shaft and frame to preclude eddy current damage to the bearing.
- e. Resistor A running resistor shall be inserted in the armature circuit.
- f. Insulation Armature and field coils shall have Class H insulation, with Class F or better resin, as defined by IEEE Standard No. 11 under, Insulation, paragraph (k). Coils shall be held securely in place and protected against mechanical damage. Coils shall be vacuum pressure impregnated with high-grade insulating varnish and baked to render them moisture-proof and to withstand the temperature and dielectric stress to which they shall be subjected.
- g. Commutator The commutator shall be well insulated in all parts. The insulating material between bars shall be undercut. Commutator design shall provide for at least two cuts during the commutator's design life.

Eccentricity of the commutator shall be within IEEE and NEMA standards for applicable motor

speeds. The motor design shall permit removal of the rotating assembly without the use of special tools.

- i. Brushes Brushes shall have a minimum wear life of one year based on an average running time of 16 hours per day. Brushes shall be accessible for replacement when the brush access cover is removed. Replacement shall not require special tools. Brush holders shall be properly mounted and accurately positioned by close machining of parts or by ring adjustment. Brush holders shall be thoroughly insulated from the frame and shall have ample creepage distance. The brush box shall be fluted or otherwise relieved to preclude brush dust packing and resultant brush jamming. The brush spring shall be of the constant force design, with springclip retainer for easy brush replacement. Provision shall be incorporated into the brush rigging design for adjustment to compensate for commutator wear. A weather-proof, sealed, readily removable, protective cover shall be provided for brush inspection and replacement, commutator inspection, internal motor maintenance, and periodic cleaning.

In accordance with the foregoing specifications for compressor motors, the following publications shall govern:

- IEEE Rotating Electric Machinery, Number 11.
- IEEE Testing Insulation Resistance of Rotating Machinery, Number 43.

- IEEE Test Code for Direct Current Machines, Number 113.
- IEEE Test Procedure for Evaluation and Classification of Insulation Systems for DC Machines, Number 304.
- NEMA Motors and Generators, Number MG-1-1972.
- MIL-STD-461A Electromagnetic Interference Characteristics, Requirements for Equipment

C. Air Dryer .

A regenerating-type air dryer shall provide a minimum of 15 degrees F (8.25 degrees C) of dew-point depression throughout the desiccant's useful life, which shall be a minimum of one year. The dew-point depression must be maintained while charging the brake reservoirs and brake lines of a dependent-pair from 0 to 150 psi (0 to 1034 kPa) under the ambient conditions specified in Appendix A. Dryer inspection shall not be required more frequently than every 60 days.

D. Air Reservoirs

Each car shall have one main reservoir and at least one supply reservoir. Each reservoir shall be supplied with witness hole provisions in accordance with the ASME Unfired Pressure Vessel Code. Brake cylinder pressure shall be controlled by means of a realy valve supplied from the supply reservoir. The air supply reservoir shall be protected by a check valve. There shall be a main reservoir equalizing pipe pneumatically separate from the brake pipe which shall equalize compressor duty cycle and shall permit borrowing of air between cars. Capacity shall

be sufficient to meet the requirements of Section 14.3.2.
Strength requirements shall conform to Section 14.3.3.

E. Cutout Cocks

Cutout cocks shall be provided for all pneumatic components and subsystems. The following vented cutout cocks shall be provided as a minimum. Others as necessary for maintenance, troubleshooting, and failure recovery shall also be provided.

1. Brake Cylinder Cutout A vented cutout cock for each car shall be provided in the brake cylinder lines. There shall be two controls for each cock. Each control shall be capable of functioning independently. One shall be located inside the car behind a locked panel, and the other under-car and visible to a person standing beside the car at the end sills.
2. Selector Cock A single, manually-operated, vented cutout valve shall be provided on the pipe bracket to cut out service brakes, but not the emergency brakes. The selector code shall be accessible from inside and from under the car.
3. Training Cutout A vented cutout cock shall be provided at each car end for the brake pipe and main reservoir pipe pneumatic trainlines.

Pressure test fittings shall be provided in the various pneumatic lines and pipe brackets. These test fittings shall permit quick connection of gauges

or transducers for testing and troubleshooting.
All test fittings shall be protected by either a
flow-limiting orifice or by an isolating cock.

14.4.3 PARKING BRAKE

Each car shall be supplied with a parking brake. The controls shall be isolated from the emergency and service brake controls and shall be provided on a per-car basis.

A. Capacity

The parking brake shall prevent a car of weight AW3 from commencing to roll from a stationary condition when standing on a 5.0 percent grade.

B. Controls

Application and release of each parking brake shall be accomplished manually. Activation of the parking brake on any car shall illuminate the PARKING BRAKE ON annunciator on the active operator's console. The PARKING BRAKE ON annunciator shall remain illuminated until all parking brakes have been released.

C. Operation

The force required to manually operate the parking brake shall not exceed 125 pounds (56.7 kg) on the hand lever.

14.5 ELECTRO-PNEUMATIC BRAKE CONTROL UNIT

The electro-pneumatic brake control unit shall consist of the pneumatic and electro-pneumatic valves and fittings

necessary to control (1) the passage of compressed air to and from the brake cylinders, and (2) the charging and venting of the brake pipe of an analog-controlled electro-pneumatic train brake system. The unit shall be suitable for bolting to the car underframe and shall contain connections for external pipe work, together with cored and drilled passages to provide interconnections necessary between the mounted valves and switches.

14.5.1 CONTROL RESPONSE

A. Friction Brake

Friction brake subsystem response to a change in the electrical brake feedback signal and tractive effort signal (jerk limiting inoperative) shall be as follows:

1. When a signal step change is from a value of 30 percent to a value of 75 percent of maximum brake effort, the time required for the brake cylinder pressure to change from a value of 25 percent to a value of 55 percent of maximum shall not exceed 0.45 seconds, including response time shall not exceed 0.2 seconds.
2. When a step change of signal is from a value of 75 percent to a value of 25 percent of maximum brake effort, the time required for the brake cylinder pressure to change from a value of 75 percent to a value of 45 percent shall not exceed 0.55 seconds, including response time shall not exceed 0.2 seconds.

B. Dynamic Braking

The response time from power shut-off (motoring current reduced to zero) to the completion of the dynamic brake

circuit shall not exceed 0.5 seconds. For modulation within the braking mode, response time should not exceed 0.25 seconds.

C. Air Dryer

A regenerating-type air dryer shall provide a minimum of 15 degrees F (8.25 degrees C) of dew-point depression throughout the desiccant's useful life, which shall be a minimum of one year. The dew-point depression must be maintained while charging the brake reservoirs and brake lines of a dependent-pair from 0 to 150 psi (0 to 1034 kPA) under the ambient conditions specified in Appendix A. Dryer inspection shall not be required more frequently than every 60 days.

D. Air Reservoirs

Each car shall have one main reservoir and at least one supply reservoir. Each reservoir shall be supplied with witness hole provisions in accordance with the ASME Unfired Pressure Vessel Code. Brake cylinder pressure shall be supplied from the supply reservoir through a relay valve. The air supply reservoir shall be protected by a check valve. There shall be a main reservoir equalizing pipe which shall perform no control function, shall equalize compressor duty cycle, and shall permit borrowing of air between cars. Capacity shall be sufficient to meet the requirements of Section 14.3.2. Strength requirements shall conform to Section 14.3.3.

E. Cutout Cocks

Cutout cocks shall be provided for all pneumatic components and subsystems. The following vented cutout cocks shall be provided as a minimum. Others as necessary for maintenance troubleshooting, and failure recovery shall also be provided.

SECTION 14A
PROPULSION AND BRAKING (OPTIONS)



SECTION 14A

PROPULSION AND BRAKING OPTIONS

14A.1 GENERAL

The following specification detail is for optional add-on reatures not incorporated in the baseline car which is described in the core specification.

14A.2 WHEEL SLIP/SLIDE PROTECTION (OPTION)

(If this option is chosen, insert the following in Section 14.)

● 14.6 SLIP/SLIDE SUBSYSTEM

A. General

Slip/slide control for friction braking shall be by means of solenoid dump valves (one per truck minimum) located near the controlled truck. The valve must be energized to exhaust air from the brake cyliners. Power to the dump valves shall be controlled such that they shall be energized for a maximum of 3 seconds per operation or as follows:* _____

B. Requirements

The wheel slip/slide protection subsystem shall detect both random and synchronous slips and slides. The subsystem shall not permit braking to be removed for more than 3 seconds or as follows:* _____. Should

* Purchaser completing detail

this limit be exceeded, the slip/slide subsystem shall be bypassed and the commanded braking effort restored. In braking, failure of the wheel slip/slide protection subsystem shall be such as to render it ineffective and permit the brakes to be fully applied.

The wheel slip/slide protection subsystem shall function properly with differences of up to 3 inches (76 mm) in diameter between wheels on different trucks of the same car. Detection of slips and slides shall be by means of evaluation of axle accelerations or axle speeds, or by a combination of the two. Axle speed differentials of 5 mph (8 kmh) at car speeds of 5 mph (8 kmh) and greater shall be detected. If required by the functional characteristics of the slip/slide protection subsystem, this differential may be increased to an axle differential of 11 mph (16.7 kmh) at a car speed of 70 mph (112 kmh).

C. Response

To ensure efficient operation of the wheel slip/slide protection system, it shall respond within 0.5 seconds after axle accelerations or axle speed differentials reach the thresholds specified above. For purposes of this requirement, response shall be defined as: Initiation of the necessary correction signals to propulsion and braking as described below.

Within 100 msec following the detection of a wheel slip, electrical tractive effort shall be less than 10 percent of the maximum effort. Within 150 msec of the pneumatic friction brake systems dump valve being energized, friction braking effort shall be reduced to less than 15 percent of the maximum effort.

D. Operation

Upon detection of a slip during acceleration, power shall be reduced on the affected truck or car until the slip has been corrected. Power shall then be reapplied automatically under the jerk limit control. Release of tractive effort shall not be jerk-limited. Slip control on a per-truck basis is preferred.

Upon detection of a slide during braking, both electrical and friction braking shall be reduced on the affected truck until the slide has been corrected. At that time, braking shall be reapplied automatically at a rate consistent with obtaining maximum performance without exceeding the specified jerk limit. This system shall function during all brake applications.

E. Failure

The slip/slide system shall be designed to fail in a manner which shall disable the slip/slide protection without impairing service brake or emergency brake applications.

(If the following option is chosen, insert the following in Section 20.)

● 14A.2.1 TESTING

A. Objective

The test objective shall be to demonstrate the performance and the efficiency of the slip/slide system for comparison with the values stated in Section 14.6.

B. Conduct

System slide efficiency and synchronous slide tests shall be conducted with the rails wetted with tap water or with lubricant-contaminated water as required to reduce adhesion levels to the design value lower limit specified in Section 3.

C. Requirements

Cars selected for these tests shall have sufficient mileage for the wheels to have developed smooth tread surfaces. The rail shall be wetted either by a spray apparatus mounted at the front of the train or by wayside sprinklers. Tests shall be conducted under conditions of minimum sunlight and at the lowest feasible ambient temperature.

Wet rail slide tests shall be performed at entry speeds, ranging in 10 mph (16 kmh) increments, from 10 mph (16kmh) to design maximum speed. Braking levels shall be those specified in Section 20.4.1.2. Braking levels too low to cause slip shall not be used.

Slip tests shall be performed with the same lubricant contaminant level used in the slide tests and at each major acceleration rate stated in Section 20.4.1.1.

D. Performance

Performance efficiency in accordance with Section 14 and the ability to detect and correct for synchronous slides shall be demonstrated in the above tests to permit comparison with the values specified in Section 3.3.3.

E. Instruments

The contractor shall instrument the consist in the following manner:* _____, to acquire the data needed to demonstrate compliance with the specified requirements. In addition to the measurements required by Figure 20-4, chart recordings shall be made of each axle of one car and of the slip/slide interface signals. Plots of system efficiency and stopping distance as functions of speed in accordance with Section 14 shall be produced for each test run.

14A.3 SNOW BRAKE (OPTION)

(if the following option is chosen, insert the following in Section 14).

Snow Brake If required by the friction brake configuration, a trainlined snow-brake function shall be provided which, during propulsion modes, shall produce a minimum brake effort to preclude ice build-up and loss of brake effort. Provision shall be made for slack adjustment during snow brake operation. The snow brake shall be operator-activated and shall remain continuously in effect until deactivated. When activated, an indicator on the operator's console shall be illuminated.

Add the following to Figure 9-1, Summary of Cab Controls and Indicators.

Control - Snow Brake Pushbutton/Indicator

Function - Applies snow brake; indicates snow brake is applied.

Nomenclature - Snow Brake

*Purchaser completing detail

Location - (1)

Normal Color Lighted - Blank

Color of Indication - Blue

Remarks - Push to apply, removal of control key release

14A.4

PARKING BRAKE (OPTIONAL ADD-ON)

(If the following option is chosen, insert the following in Section 14. If automatic trainlined actuation is chosen as an option, Sections 14.4.3B and C must be deleted and the following sections substituted.)

a. General

The specified handbrake/parking brake is manually operable only as to actuation.

b. Controls

Application and release of all parking brakes shall be accomplished by means of trainlined controls. Actuation of controls from any operator cab shall operate the individual parking brake subsystem on cars located to the rear. Activation of the parking brake on any car shall illuminate the PARKING BRAKE ON annunciator on each car as well as on the active operator's console. Release of the parking brake shall be accomplished by means of trainlined controls. The PARKING BRAKE ON annunciator shall remain illuminated until all parking brakes have been released.

c. Operation

Normal operation of the parking brake shall be via a powered means that shall apply or release all parking brakes. As a backup, a non-trainlined manual application/release method shall be provided. The force necessary to manually operate the parking brake shall not exceed 125 pounds (56.7 kg).



SECTION 15
AUTOMATIC TRAIN CONTROL (ATC)



SECTION 15

AUTOMATIC TRAIN CONTROL (ATC)

15.1 GENERAL

This section specifies the interface between car-carried automatic train control (ATC) equipment and other car-carried equipment. The purchaser will make available all information concerning the transit system required by the contractor to furnish the ATC equipment.

15.2 AUTOMATIC TRAIN CONTROL (ATC) SUBSYSTEM FUNCTION

The ATC equipment shall provide the following ATP and ATS functions:

- ATP receive and decode wayside-generated speed commands, provide overspeed protection, and indicate speed command, actual speed, and overspeed conditions;
- ATS provide for manual insertion of train identification and a train-to-wayside communication link for transmitting train identification.

The contractor shall provide all car-carried ATC equipment, as follows:

A. ATC Antennas

Separate or multi-purpose antennas shall be provided for the following ATC functions:

- The reception of wayside-generated speed command and future ATP commands (e.g., door commands).
- The transmission of vehicle-generated train ID and future ATS signals (e.g., train ready).
- Space allocation for a future antenna which shall receive wayside-generated ATS signals (e.g., train performance adjustments).
- Space allocation for a future antenna which shall receive wayside-generated ATO marker signals (e.g., automatic station stop initiation).

The carbuilder shall provide the related truck and/or car frame adapter brackets in accordance with the contractor's mounting specification.

B. Speed Decoding Subsystem

This subsystem shall decode and process information obtained from the speed command receiver antenna.

C. Overspeed Protection Subsystem

Overspeed protection shall be provided for both the manual mode and future automatic mode of train operation. Speed shall be derived from the speed sensor(s) on the car.

D. ATC Panel

ATC Panel components shall include: actual speed indicator, speed limit indicator, overspeed indicator and audible alarm, and train identification display and selector controls. These

components shall be mounted on a metal plate with associated wiring and multipin connector for installation on the operator's console.

E. ATC Subsystems

Each independent control unit or each dependent-pair shall be equipped with major ATC subsystems as follows:

1. Automatic Train Protection (ATP)
2. Automatic Train Supervision (ATS)

15.3 AUTOMATIC TRAIN PROTECTION (ATP)

The ATP equipment shall perform the following functions:

- Receive and decode speed commands
- Measure train speed and compare it with the speed limit
- Apply full service braking in the event of overspeed or system failures.

The ATP system shall be fail-safe and shall meet the reliability and fail-safe requirements set forth in Section 3.5.6.

● 15.3.1 CAB SIGNAL RECEPTION AND DECODING

The number of commands, carrier frequency, and code rates shall be as follows: * _____.

* Purchaser completing detail

A. Operation

When operating in the automatic mode, the equipment shall interpret absence of a cab signal carrier frequency and/or code rate as a STOP command. When operating in any mode of operation other than automatic, the absence of this signal shall be interpreted as a STOP AND PROCEED command, restricting speed to 15 mph (24 Kmh).

B. Requirements

ATP command reception shall be accomplished by means of two coils connected in series-aiding and mounted ahead of the lead axle or each control cab. A vital receiver shall be provided on each dependent-pair. The unit shall receive and demodulate ATP signals transmitted to the train via the running rails and/or cab signal loops.

C. Requirements

Code-rate detectors shall be fail-safe. Check circuits shall not be required to verify code-rate detector integrity. The decoders shall be such that the most restrictive command shall have priority. Command decoders shall provide information to the following subsystems:

1. Overspeed protection subsystem
2. Speed command display(s)
3. Speed regulation subsystem (future ATO)

● 15.3.2 OVERSPEED PROTECTION

A. General

Overspeed protection shall be provided by a self-checking speed measurement device which shall vitally compare the speed limit imposed by the speed command to the actual train speed. Actual speed shall be derived from a sensor or sensors monitoring a gear rotating proportional to axle wheel speed. Wheel wear adjustment shall be provided in discrete steps to compensate for wheel diameter variations on the axle monitored by the ATP sensor(s).

B. Operation

An overspeed condition detected by the protection system shall result in an audible overspeed warning which shall sound in the control cab and continue until the operator has placed the master controller into the full service brake position. The full service brake application shall continue until actual train speed is within the speed limit and the master controller is placed in the full service brake position to acknowledge the overspeed condition.

C. Zero Speed

The overspeed protection system shall also include zero speed detection circuitry. The train shall be considered at zero speed when the speed is below * _____ and a full service brake application is in effect.

* Purchaser completing detail

If the service brake fails to provide the prescribed deceleration rate, brake assurance shall initiate an open loop emergency brake application which shall not be released until zero speed is detected.

15.3.3 DOOR CONTROL

Door operation shall be manually controlled by the operator as described in Section 10.2.

● 15.3.4 SAFETY BRAKING

Safety (full service) brake application shall be initiated independently by each of the following:

- A. Loss of speed command reception
- B. Overspeed protection
- C. Automatic-manual circuits
- D. Actuation of the emergency braking system

ATP interfacing with the brake control trainline wires shall be by means of vital relay contacts.

Brake assurance shall be a part of the ATC system and shall consist of a deceleration switch and brake assurance relay. The deceleration switch shall be adjustable from * _____ mphs to * _____ mphs. A safety seal shall be provided to prevent unauthorized change of the selected rate.

Full service brake applications initiated by the ATC system shall be enforced as follows: the brake assurance unit shall detect a pre-set deceleration rate of * _____ mphs within * _____ seconds after an overspeed condition is

* Purchaser completing detail

detected. When the pre-set rate is attained, the brake assurance relay shall energize and any existing request for positive tractive effort shall be removed.

If the required rate is not attained within the required time limit, an open loop penalty emergency brake application shall be initiated.

A sealed cutout shall be provided to permit restricted train movement in the event of ATP malfunction.

● 15.4

AUTOMATIC TRAIN SUPERVISION (ATS)

A. General

The basic ATS subsystem shall provide for manual insertion of train identification on the operating console and shall also provide a train-to-wayside communication link for transmitting this data.

Train identification shall be established by the combination of the following three data elements:

- Train number
- Train destination
- Train length

The number of separate identities for each of these data elements, including future operational requirements, is as follows:* _____.

The train destination portion of the train ID shall be integrated with the motorized sign control in accordance with the following table:* _____.

* Purchaser completing detail

A sign control start switch shall be provided in close proximity to the train ID input switches to initiate sign control.

B. Operation

The operator shall manually encode train ID upon initial entry to the operating cab by actuating the respective selector switches located on the ATC panel. When the ID entry is completed, the operator shall actuate the sign control start switch to initiate motorized control of the external train destination signs. The operator shall update train ID at turn back points and under special operating conditions such as test train or out-of-service conditions.

C. Communication Link

A non-vital communication link shall be provided for transmitting train ID to compatible wayside receptors for the initial purpose of automatic train routing and/or train describer functions.

A total number of * _____ information bits shall be provided for both present and future requirements with an error security defined as follows: * _____. The communication link shall operate at a maximum train speed of * _____ mph.

A lead cab-forward direction interlock shall be provided to transmit the train ID selected in the operating control cab only.

* Purchaser completing detail

SECTION 15A
AUTOMATIC TRAIN CONTROL (ATC) OPTIONS



- Automatic Dispatch and
Berth Sequence Control

The purchaser may elect Option 1 or Option 2 level, or any intermediate level by selective use of the following optional Sections.

Option 1 and Option 2 require that specified equipments be provided complete. The purchaser may elect to rewrite portions of each option in accordance with the following format, so that the present system is arranged to accept future equipment options:

"Car shall be designed, wired, and equipped with all enclosures, mountings, wire, cable, and termination points to permit installation of* _____ equipment at a future date."

*Purchaser completing detail

ATC OPTIONS

Section 15 specifies a base type ATC system which can be readily expanded to various levels of automation.

The following sections are a rewrite of Section 15 to demonstrate expansion from a base ATC system to a minimum level Option 1 or a maximum level, Option 2 of automatic controls currently available in the heavy rail transit industry.

Option 1 Base ATC system plus:

- A. ATP
 - Mode Selection
 - Train Berth Check/Door Control
- B. ATO
 - Automatic Speed Regulation
 - Programmed Station Stop
 - Marker Recognition Data Link
- C. ATS
 - Performance Level Adjustment

Option 2 Base ATC system plus:

- A. ATP
 - Mode Selection
 - Automatic Door Control
- B. ATO
 - Automatic Speed Regulation
 - Programmed Station Stop
 - Marker Recognition Data Link
- C. ATS
 - Automatic Train Identification
 - Automatic Train Length Circuit
 - Automatic Performance Level Adjustment

OPTION 1

AUTOMATIC TRAIN CONTROL (ATC)

A. ATP FUNCTIONS

- Vital Reception and Decoding
- Overspeed Protection
- Safety Braking
- Train Berth Check/Door Control
- Mode Selection

B. ATO FUNCTIONS

- Speed Regulation
- Programmed Station Stop
- Marker Recognition Data Link

C. ATS FUNCTIONS

- Train ID
- Performance Level Adjustment

OPTION 1

AUTOMATIC TRAIN CONTROL (ATC)

15A.1 GENERAL

This section specifies the interface between car-carried automatic train control (ATC) equipment and other car-carried equipment. The purchaser will make available all information concerning the transit system required by the contractor to furnish the ATC equipment.

15A.2 AUTOMATIC TRAIN CONTROL (ATC) SUBSYSTEM FUNCTION

The ATC equipment shall provide the following ATP, ATO and ATS functions:

- ATP receive and decode wayside-generated speed commands and train berth check commands, provide overspeed protection and mode selection circuits, and indicate speed command, actual speed, and overspeed conditions;
- ATO provide for automatic speed regulation, programmed station stop, and provide a data link for the reception of wayside station stop markers;
- ATS provide for manual insertion of train identification and performance level adjustments, and a train-to-wayside communication link for transmitting train identification.

The contractor shall provide all car-carried ATC equipment, as follows:

A. ATC Antennas

Separate or multi-purpose antennas shall be provided for the following ATC functions:

- The reception of wayside-generated speed commands and train berth check command(s).
- The reception of wayside-generated ATO marker signals.
- The transmission of vehicle-generated train ID

The car builder shall provide the related truck and/or car frame adapter brackets in accordance with contractors mounting specifications.

B. ATP Reception and Decoding Subsystem

This subsystem shall receive, decode, and process information obtained from the ATP command receiver antenna.

C. Overspeed Protection Subsystem

Overspeed protection shall be provided for the manual and automatic modes of train operation. Speed shall be derived from the speed sensor(s) on the car. Brake assurance shall be provided to ensure safe braking.

D. Mode Selection Circuits

Mode selection circuits shall be provided to coordinate the prescribed sequence of automatic/manual mode transfer and related interface functions.

E. Train Berth Check

Train berth check circuits shall be provided to safely interlock manual car door controls with coincident wayside station platform side and limits.

F. Automatic Speed Regulation Subsystem

An automatic speed regulator (ASR) shall be provided to accelerate, decelerate, and maintain speed within the ATP imposed safety speed limits or within lower limits imposed by the ATS performance level adjustments.

G. Programmed Station Stop Subsystem

The programmed station stop (PSS) subsystem shall efficiently decelerate the train to a stop at designated wayside points in accordance with profile limits defined by wayside markers.

H. Automatic Train Supervision Subsystem

The ATS subsystem shall provide for manual insertion of train ID and ATO performance level modifiers including percentage reduction of speed limits and/or acceleration limits. A data link

shall be provided for transmitting train ID. from the train to the wayside.

I. ATC Panel

ATC Panel components shall include: actual speed indication, ATP and ATS speed limit indicators, mode indicators, overspeed indication and audible alarm, train ID and performance level displays and selector controls and programmed station stop and skip stop indicators. These components shall be mounted on a metal plate with associated wiring and multipin connector for installation on the operator's console.

J. ATC Subsystems

Each independent control unit or each dependent-pair shall be equipped with major ATC subsystems as follows:

1. Automatic Train Protection (ATP)
2. Automatic Train Operation (ATO)
3. Automatic Train Supervision (ATS)

15A.3

AUTOMATIC TRAIN PROTECTION (ATP)

The ATP equipment shall perform the following functions:

- Receive and decode ATP commands
- Measure train speed and compare it with speed limit
- Monitor mode selection and related subsystem interface
- Interlock car door control to verify proper operation with respect to platform alignment

- Apply full service braking in the event of overspeed or system failures.

The ATP system shall be fail-safe and shall meet the reliability and fail-safe requirements set forth in Section 3.5.6.

● 15A.3.1 CAB SIGNAL RECEPTION AND DECODING

The number of commands, carrier frequency, and code rates shall be as follows:* _____.

A. Operation

Speed commands shall be transmitted to the train in accordance with wayside signal control limits.

When operating in the automatic mode, the equipment shall interpret absence of a cab signal carrier frequency and/or code rate as a STOP command. When operating in any mode of operation other than Automatic, the absence of this signal shall be interpreted as a STOP and PROCEED Command, restricting speed to 15 mph (24 Kmh).

Train berth check signals shall be transmitted to the train at station areas to interlock car door controls with platform alignment.

B. Reception

ATP Command reception shall be accomplished by means of two coils connected in series-aiding and mounted ahead of the lead axle of each control cab. A lead-cab forward direction interlock shall be provided to select the ATP antenna in accordance with the established operating cab.

A vital receiver shall be provided on each dependent pair. The unit shall receive and demodulate ATP signals transmitted to the train via the running rails and/or cab signal loops.

C. Requirements

Code-rate detectors shall be fail-safe. Check circuits shall not be required to verify code-rate detector integrity. The decoders shall be such that the most restrictive speed command shall have priority. Command decoders shall provide information to the following subsystems:

1. Overspeed protection subsystem
2. ATP speed limit display(s)
3. Train berth check circuits
4. Speed regulation subsystem

● 15A.3.2 OVERSPEED PROTECTION

A. General

Overspeed protection shall be provided by a self-checking speed measurement device which shall vitally compare the speed limit imposed by the speed command to the actual train speed. Actual speed shall be derived from a sensor or sensors monitoring a gear rotating proportional to axle wheel speed. Wheel wear adjustment shall be provided in discrete steps to compensate for wheel diameter variations on the axle monitored by the ATP sensor(s).

B. Operation

An overspeed condition detected by the protection system shall result in an audible overspeed warning which shall sound in the control cab and continue until the operator has placed the master controller into the full service brake position. The full service brake application shall continue until actual train speed is within the speed limit and the master controller is placed in the full service brake position to acknowledge the overspeed condition.

C. Zero Speed

The overspeed protection system shall also include zero speed detection circuitry. The train shall be considered at zero speed when the speed is below * _____ MPH and a full service brake application is in effect. Zero speed shall interface with the following subsystems:

- Mode selection
- Train berth check/door control circuits
- Brake assurance
- ATO start pushbutton

15A.3.3. DOOR CONTROL

A. General

ATP interlocks shall be provided in the car door control circuits to verify that:

- train is stopped; and
- manually initiated lefthand (LH) or right hand (RH) door OPEN request is in agreement with the wayside-generated train berth check signal

B. Operation

LH or RH train berth check signal shall be transmitted in each station block in accordance with platform side and the established direction of traffic, when the train is within platform limits. Opening of side doors shall be inhibited until zero speed is detected and correspondence between LH and RH door open request and train berth check signal is established.

C. Requirements

Train berth check circuits shall be failsafe and vital relay contacts shall be provided for door control interface. A sealed bypass shall be provided to permit door operation in the event of ATP malfunction.

● 15A.3.4 SAFETY BRAKING

Safety (full service) brake application shall be initiated independently by each of the following:

- A. Loss of speed command reception
- B. Overspeed protection
- C. Automatic-manual circuits
- D. Actuation of the emergency braking system

ATP interfacing with the brake control trainline wires shall be by means of vital relay contacts with respect to full service and/or emergency brake requests.

Brake assurance shall be a part of the ATC system and shall consist of a deceleration switch and brake assurance relay. The deceleration switch shall be adjustable from * _____ MPHPS to * _____ MPHPS. A safety seal shall be provided to prevent unauthorized change of the selected rate.

Full service brake applications initiated by the ATC shall be enforced as follows: the brake assurance unit shall detect a pre-set deceleration rate of * _____ MPHPS within * _____ seconds after an overspeed condition is detected. When the preset rate is attained, the brake assurance relay shall energize and any existing request for positive tractive effort shall be removed.

If the required rate is not attained within the required time limit, and open loop, penalty, emergency brake application shall be initiated and maintained until zero speed is detected.

A sealed cutout shall be provided to permit restricted train movement in the event of ATP malfunction.

● 15A.3.5 MODE SELECTION

A. General

Mode selection circuits shall:

- Enforce prescribed sequence in the establishment of automatic and manual modes of operation.

- Transfer operator's controllers and ASR controls in accordance with the mode established.
- Maintain safety integrity with vital interface.

B. Operation

The prescribed sequence (defining the placement of the mode selector switch, master controller, and reverse switch; the related mechanical and electrical interlocks including ATP interlocks such as zero speed; and override functions including deadman control) for establishing each operating mode is defined in the following paragraphs:

1. Manual Mode

- Manual mode shall be established when all of the following conditions exist: *_____.
- Manual mode shall remain established until any of the following conditions occur: *_____.

2. Automatic Mode

- Automatic mode shall be established when all of the following conditions exist:
*_____.
- Automatic mode shall remain established until any of the following conditions occur: *_____.

E. Requirements

Mode selection circuits shall be vital with respect to maintaining safety interface with vital functions. Mode indicators on the ATC panel shall illuminate in correspondence with the established mode. When the sealed ATP cutout is actuated, trainline control shall transfer to the master controller and the cutout indicator shall illuminate. Improper operation of the mode selection circuits shall result in the initiation of full service braking.

15A.4 AUTOMATIC TRAIN SUPERVISION (ATS)

The ATS subsystem shall provide for the manual insertion of train ID and ATO performance level adjustment. A data link shall be provided for transmitting train ID from train to wayside. The ATS subsystem shall meet the reliability requirements set forth in Section 3.5.6.

● 15A.4.1 TRAIN IDENTIFICATION (ID)

A. General

The basic ATS subsystem shall provide for manual insertion of train identification on the operating console and shall also provide a train-to-wayside communication link for transmitting the train ID.

Train identification shall be established by the combination of the following three data elements:

- Train number
- Train destination
- Train length

The number of separate identities for each of these data elements, including future operational requirements, is as follows:*_____.

The train destination portion of the train ID shall be integrated with the motorized sign control in accordance with the following table:*_____.

A sign control start switch shall be provided in close proximity to the train ID input switches to initiate sign control.

C. Operation

The operator shall manually encode train ID upon initial entry to the operating cab by actuating the respective selector switches located on the ATC panel. When the ID entry is completed, the operator shall actuate the sign control start switch to initiate motorized control of the external train destination signs. The operator shall update train ID at turn back points and under special operating conditions such as test train or out-of-service conditions.

D. Communication Link

A non-vital communication link shall be provided for transmitting train ID to compatible wayside receptors for the initial purpose of automatic train routing

and/or train describer functions.

A total number of*_____information bits shall be provided for both present and future requirements with an error security defined as follows*_____. The communication link shall operate at a maximum train speed of *_____mph.

A lead cab-forward direction interlock shall be provided to transmit the train ID selected in the operating control cab only.

● 15A.4.2. PERFORMANCE LEVEL ADJUSTMENT

A. General

The ATS subsystem shall provide for the manual insertion of train performance level adjustment which shall permit prescribed percentage reduction(s) of train acceleration capability and percentage reductions of the displayed ATP speed limit for automatic and manual modes of operation.

B. Operation

Switches shall be provided on the ATS panel to permit the operator to insert performance level modifiers in accordance with general operating instructions and/or special instructions issued for abnormal or adverse operating conditions. The following percentages of ATP speed shall be provided: 100%,*_____.

The following percentage(s) of acceleration shall be

*Purchaser completing detail

provided: 100%,*_____.

C. Requirements

Performance level modifiers shall interface with the ATO subsystem. The ATO subsystem shall compare the ATP and ATS speed limits using the lower speed limit as the reference for the automatic speed regulator and drive for the ATS speed limit indicator on the ATC panel.

15A.5 AUTOMATIC TRAIN OPERATION (ATO)

The ATO equipment shall perform the following functions:

- Regulate train speed within the ATP or lower ATS speed limit
- Decelerate train efficiently within the prescribed limits of closed loop braking to a designated stop point defined by wayside markers.

The ATO system shall meet the reliability requirements set forth in Section 3.5.6.

● 15A.5.1 AUTOMATIC SPEED REGULATOR (ASR)

A. General

The automatic speed regulator (ASR) shall accelerate, decelerate and maintain train speed within the ATS speed limit or the velocity profile defined by the programmed station stop (PSS) subsystem.

The ASR equipment shall perform the following functions:

- Speed sensing, measurement, and wheel wear compensation
- Speed comparison
- Command logic for interface with the carborne positive (propulsion) and negative (braking) traction subsystems to maintain desired velocity
- Drive for ATS speed limit indicator on the ATC panel.

B. Speed Sensing, Measurement, and Wheel Wear Compensation

ATO actual speed reference shall be derived from the ATP sensor if the contractor can demonstrate, to the satisfaction of the purchaser, that the safety of the ATP subsystem is not degraded; or shall be derived from a separate, but identical type, sensor if the contractor can demonstrate close tolerance tracking between the ATP and ATO sensor outputs to ensure that control infringements will not occur. In either case, only one switch shall be provided for wheel wear compensation.

Sufficient steps shall be provided on the wheel wear adjustment switch to produce an overall speed measurement accuracy of \pm * _____ percent below * _____ MPH and \pm * _____ percent above * _____ MPH.

C. Speed Comparison

The ASR shall compare desired velocity and actual velocity producing an output proportional to the

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amount of tractive effort required to maintain desired speed, acceleration, or deceleration. Desired speed shall be derived by comparing speed limit inputs from the ATP, ATS, and PSS subsystems producing an output proportional to the lowest desired speed control range.

During constant speed running conditions, speed shall be maintained within a control band of plus zero MPH to minus * _____ MPH of N where N is defined by the ATS speed indicator which shall be coincident with the ATP speed command indicator at the 100% performance level setting. A guard band shall be provided between N and the lower limit of the ATP speed command limit to prevent competitive control between ATP and ATO during constant speed running or transition to higher ATP speed commands. The ATP speed limit shall be N plus * _____ MPH with a tolerance of \pm * _____ MPH.

Overshoot/undershoot and excessive control cycling shall be avoided. The ASR shall be based on closed loop control with sufficient dv/dt feedback and/or wayside data to anticipate control response characteristics of the traction system and wayside civil characteristics such as verticle grade transitions to maintain the control tolerance specified herein.

D. Command Logic

Logic shall be provided to command tractive effort controls in accordance with the degree of error between desired velocity and actual velocity. The interface with positive tractive effort control is defined as follows:

1. Propulsion Control

Alternate 1** - Cam Control Cars***

The digital type control interface with the propulsion control train lines shall be in the form of relay contacts. Positive tractive effort levels shall be selected by energizing trainlines in accordance with the following table: *_____.

If the control tolerances defined in this specification require additional levels of traction control and/or analysis indicates excessive cycling of the controller(s) will result, alternative control techniques such as Modulated or Advance Control methods, permitting individual cars to operate at different tractive effort stages, shall be employed subject to approval of the purchaser.

Alternate 2** - Chopper Control Cars***

Positive tractive effort shall be selected in accordance with the following "P" wire control diagram: *_____.

2. Brake Control The interface with negative tractive effort control is defined as follows:

Alternate 1** - Digital Brake Control***

The digital type control interface with the brake control trainlines shall be in the form

*Purchaser completing detail

**Purchaser shall select alternate consistent with selection in Section 14

***Purchaser shall delete undesired alternate

of relay contacts. Negative tractive effort levels shall be selected by energizing trainlines in accordance with the following table:

* _____.

Alternate 2** - Analog Brake Control***

Negative tractive effort shall be selected in accordance with the following "P" wire control diagram: * _____.

E. Operation

Upon initial entry to ATO mode, the operator shall actuate the ATO start pushbutton provided on the ATC panel. The ASR shall accelerate the train to the ATS displayed speed and then maintain that speed within prescribed limits. This operator shall continue in accordance with wayside profile speeds. Operator may reduce displayed ATS speed by manually inserting performance level adjustments provided on the ATC panel including reductions in acceleration. ATP overspeed protection shall maintain safety during ATO operation providing safety slow downs on ATP speed command reductions including stops. STOP AND PROCEED operation shall not be permitted with ATO mode in effect.

F. Requirements

ASR logic shall consist of solid state hardware using analog, digital, and/or software control techniques. Digital type trainline interface type logic shall be in the form of relay contacts.

*Purchaser completing detail

**Purchaser shall select alternate consistent with selection in Section 14

***Purchaser shall delete undesired alternate

The ASR shall not require periodic calibration except for wheel wear compensation.

● 15A.5.2 PROGRAMMED STATION STOP (PSS)

A. General

The programmed station stop equipment shall cause a train to decelerate smoothly to a stop at the desired passenger station platform location or other designated stop points. Trains shall be required to stop on alignments defined by wayside marker signals.

Station stop accuracy shall be \pm^* _____ feet (\pm^* _____ meters). Programmed station stop equipment shall have the capability of causing the train to skip any station stop when so commanded by wayside marker signals.

B. Speed-Distance Profile

Programmed station stops shall be made in accordance with speed-distance profiles defined by wayside markers. The profile shall be a function of:

1. Train length
2. Desired train/platform alignment
3. Value of deceleration prescribed for closed loop braking.

The desired train/platform alignment shall be determined by the market recognition circuits. Resolution of the profile shall be such that the overall system

*Purchaser completing detail

accuracy of * _____ feet (\pm * _____ m)
of stopping position shall be maintained with a
minimum of brake level changes.

The carborne and wayside marker system for initiation
of PSS and subsequent re-reference shall be supplied
by the ATO contractor. The marker system shall
provide the following platform alignment(s):*_____.
Average closed loop deceleration rate shall be
* _____ MPHPS.

C. Operation

Indications shall be provided in the cab to enable the
operator to monitor the programmed station stop
equipment. These indications shall be energized from
the programmed station stop equipment as follows:

1. Programmed Stop Indicator - This indicator shall
be energized upon initiation of a programmed
station stop command and shall remain energized
until the stop has been completed and the ATO
start button is actuated or until the stop has
been cancelled by activating the station stop
cancel pushbutton.
2. Skip Stop Indicator - This indicator shall be
energized upon request of a skip stop signal
and shall remain energized until the station
stop cancel button is actuated.

D. Requirements

PSS logic shall consist of solid state hardware using
analog, digital, and/or software control techniques.

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Digital type trainline interface type logic shall be in the form of relay contacts.

The PSS shall not require periodic calibration except for wheel wear compensation.

SECTION 16
COMMUNICATIONS



SECTION 16

COMMUNICATIONS

16.1 GENERAL

This section specifies functional design requirements for car-mounted communications equipment, including public address (PA), intercommunications (IC), and train-wayside radio communications (RAD), all of which shall be installed in each car.

16.2 COMMUNICATIONS CONTROL EQUIPMENT

Communications equipment shall be installed in the operator cab of each car to provide appropriate interfacing and control between elements of the communications system, including traincrew. Power shall be applied to the equipment when the master car control key switch has been placed in the ON position. The equipment shall include:

- Voice-actuated microphone with a mode selector switch
- Loudspeakers
- Transmitter receivers
- Amplifiers
- Indicator lights

A single voice-actuated microphone shall be provided through which the operator shall be able to communicate in all modes. A light located on the console shall be illuminated when the radio transmitter is energized.

16.2.1 OPERATOR CALL INDICATION

A. General

The radio receiver shall always be ON and, the indicator light on the transmitter-receiver shall also be illuminated. A selector switch arrangement shall be provided on the operator's console to permit selection of the OFF, PA (public address), IC (intercom), and RAD (radio) positions. When the operator wishes to select one of these modes, he shall place the switch in the appropriate position. It shall be possible to change the mode only by selecting a different mode.

B. Receiving

Radio call shall be received through the 4 inch (102 mm) speaker located on the secondary control panel. The operator shall respond by placing the selector switch on the operator's console to the RAD mode.

C. Audio Control

An audio level control knob shall be provided to control radio speaker output. When the control knob is set for minimum output, the sound from the speaker shall be clearly audible in the cab.

D. Intercom

An IC call shall actuate both audible and visual alarms in the operator cab. When the IC position of the selector switch is selected in another cab of the train, the IC light shall flash on the console. The call shall also

cause a steady audible alarm (buzzer) to emanate from the IC speaker located behind the operator. Selection of the IC mode shall cause the steady audible alarm to cease.

● 16.3

PUBLIC ADDRESS SYSTEM

A. General

The contractor shall design, install, and test a complete public address system on each dependent-pair. When dependent pairs are coupled, the PA systems in all cars shall be automatically interconnected to form a single operating system. The PA system shall enable authorized train operating personnel to make public address announcements to all passengers on the train from:

- any microphone station located in the operating cab, adjacent to the side windows, by depressing the push-to-talk switch located on the microphone, or from
- the voice-actuated microphone located on the operator's console by operation of the mode selector switch.

Switching shall be provided to permit patch-in transmissions from Central Control. The system shall be silent when not in use.

B. Equipment

Each A-car and B-car public address system shall consist of the following major elements:

- One solid state amplifier unit
- * _____ loudspeakers
- One voice-actuated microphone system mounted on the operator's console. The mode selector switch, when positioned to the PA mode, shall permit the microphone to be used for announcements on the public address system.
- Two microphones, each shock-mounted in a housing equipped with a push-to-talk switch and a circuit breaker.

C. Interference

The contractor shall furnish and install any additional equipment or appurtenances necessary to provide a complete PA system capable of being used from any station without interference from, or interfering with, the radio system.

D. Control

Control of the PA system shall be from the active cab in any car of the train. Communications controls shall be designed to inhibit simultaneous transmissions. Power shall be connected to the PA amplifier only when the PA system is keyed for transmission of an announcement. All component unit controls shall be internal to the unit.

E. Microphone

Each microphone shall include a built-in preamplifier. The output shall be approximately -15 dBm with 600 ohm output impedance, in a sound pressure field of 30 microbars, at a

*Purchaser completing detail

frequency of 300 Hz. The microphone/preamplifier combined response shall increase between 1,000 Hz and 3,000 Hz. Preamplifier distortion shall not exceed 2 percent total harmonic distortion (THD) within defined operating levels. The unit shall have a weatherproof diaphragm, and the case shall be constructed of high-impact strength material. The microphone shall be capable of being dropped 4 feet (12.19m) onto a solid flat surface without damage. The PUSH-TO-TALK microphone switch shall be a pushbutton capable of 1,000,000 operations without failure.

A minimum compression range of 35 dB in the microphone and associated circuitry, with a maximum output level variation of ± 2 dB and a maximum THD of 1 percent at the compressor output at nominal gain shall be provided. Under full compression, the THD shall not exceed 2 percent. The attack time of the compressor shall be a maximum of 10 milliseconds. The release time shall be factory-set at 800 milliseconds.

F. Frequency Response

Frequency response of the line amplifier section shall be ± 1 dB, in the range of 100 Hz-to-5,000 Hz, with a maximum of 1 percent THD. Preprocessing, or other techniques for altering the response curve outside the amplifier to improve the efficiency of speech, shall be permitted.

G. Amplifier

The line amplifier shall be capable of delivering a minimum of +20 dBm into an impedance range of from 200 ohms-to-600 ohms with less than 1 percent THD. Trainline level change shall not exceed 3 dB for up to eight power amplifiers across the trainline. The amplifier shall have an output

transformer with a balanced, center-tapped line winding. Amplifier inputs and outputs may be open-circuited or short-circuited, but with no damage to the amplifier. Maximum hum and noise level shall be 60 dB below the rated trainline output.

H. Inputs

Provisions shall be made for the following inputs:

1. Microphone Input Inputs shall be unbalanced 600 ohms adjustable for inputs of -20 dBm to 0 dBm. A short circuit across the microphone leads shall not damage the power source.
2. Radio Inputs The input from the radio shall be at -15 dBm to 0 dBm from a 600 ohm unbalanced line.

I. Output

The output shall be a 70.7 VDC line capable of a continuous power output of not less than 30 watts. An output level adjustment shall be provided. The power output shall not vary more than 3 dB throughout the specified temperature range. Hum and noise level of the power amplifier, measured at the output, shall not be less than 60 dB below the rated output. Total harmonic distortion of the power amplifier shall not exceed 2 percent at the output of the amplifier into rated load at full-rated power over the frequency of 300 Hz-to-3,000 Hz. Amplifier input or output may be open circuited or short circuited with no damage to the amplifier. Frequency response of the power amplifier shall be +1 dB at 200 Hz-to-5,000 Hz with a maximum total distortion of

1 percent. With the line voltage 35 percent below normal, amplifier output shall not decrease more than 6 dB from its full-rated output at normal voltage.

J. Requirements

Equipment shall be operable without damage under any combination of temperature and ambient relative humidity specified in Appendix A. The duty cycle of the system shall be continuous and the system shall manifest:

- No oscillations, acoustical feedback, or other instabilities in any combination of input level, gain, or speaker level control settings under any and all test and operational conditions.
- Low voltage power as specified in Section 13.2, and a circuit breaker located at the car tertiary control panel for overload protection.
- The capability to meet the EMC requirements specified in Section 4.3.
- A hum and noise level 40 dB below the rated output with the microphone connected and energized.
- Solid state devices throughout the design selected on the basis of compatibility with the requirements of Section 3.5.3.

K. Transformer

The line matching transformer shall be rated for 4 watts and shall have a primary winding to terminate a 70.7 VDC line with a secondary impedance of 8 ohms. Power taps shall be provided for 2.0, 1.0, and 0.5 watts. Frequency response shall be ± 2 dB from 100 Hz-to-5,000 Hz. Efficiency

shall be at least 85 percent on the 2 watt tap. Transformer windings shall withstand a 1,000 volt rms, 60 Hz test between either winding and core. Primary and secondary windings shall be phased so that all speaker cones shall simultaneously move in the same direction when the primary is connected to the distribution line according to labelling.

L. Speaker

Each speaker shall have a minimum diameter of 6 inches (152 mm). The power handling capability shall be at least 4 watts continuous and 10 watts peak. Speaker dispersion shall be at least 45 degrees with a maximum 3 dB variation of sound pressure at 400 Hz. The speaker shall be capable of operating at rated power without failing or exhibiting any rattles or cone breakup in an accelerated life test for 100 hours with a 400 Hz tone. The cone, voice coil assembly, and suspension shall be moisture resistant.

Each speaker shall be placed inside an enclosure of sufficient volume to satisfy the performance requirements for the speaker and enclosure as an assembly. Each enclosure shall be lined with sound absorbing material over at least 50 percent of the inside surface. The line matching transformer specified in Section 16.3K shall be mounted in the speaker enclosure. The speaker and grille shall be removable as a unit and shall be connected to the car speaker line by means of suitable connecting devices within the enclosure. Distortion of the installed speaker shall not exceed 5 percent. Frequency response on axis shall be within ± 5 dB between 100 Hz and 5,000 Hz. The front baffle shall be at least 25 percent (acoustically) transparent.

The baffle shall be designed to minimize the possibility of damage to the speaker cone by sharp instruments inserted through openings in the baffles. The speaker and enclosure shall be tested for temperature shock in which the assembly is alternatively soaked for at least 4 hours at -22 degrees F (-30 degrees C) and 185 degrees F (85 degrees C) for at least 10 cycles. The assembly shall be operated with a 400 Hz tone input equal to the power rating of the speaker during the last cycle.

M. Control Locations

PA system controls shall be mounted on the operator's console in each cab. The amplifier shall be mounted in the communications cabinet. The mounting rack and base plate shall be as indicated in the AAR Communications Manual, Section 12-4.

N. Electrical

Cables shall be in accordance with the requirements in Section 6.2. Each conductor shall be color-coded or otherwise identified. All wiring shall be cabled, where practicable, and clamped to the chassis. Wiring insulation shall be uniquely identified by mark-coding and shall be installed in accordance with the requirements of Section 6.2. All transformer terminals and leads shall be permanently and legibly marked to permit identification on schematic and wiring diagrams. Terminal boards shall be of nonhygroscopic insulating materials that shall not deteriorate when leads are soldered to the terminals. All components fastened to the chassis by means of machine screws and nuts shall require lock nuts or other means

to preclude their vibrating loose. Rivets or self-tapping screws shall not be used for electrical connections nor to secure components which must be removed for maintenance.

0. Mounting

Chassis, front panels, and mounting details shall be of steel, aluminum, or high-impact plastic. Steel parts shall be corrosion-resistant treated following completion of all machining operations. The front surfaces of aluminum panels shall be etched prior to finishing. Aluminum chassis shall have a minimum thickness of 0.06 inches (1.52 mm).

In those instances where fixed resistors and similar small parts cannot be incorporated into the solid state design, they shall be mounted on a components board.

Panel surfaces of each unit shall be thoroughly cleaned to remove all dirt and grease prior to their being given a durable finish in accordance with Section 6.8.

All circuit components shall be mounted in the chassis assemblies in such a manner as to permit replacement without removal of other components. Controls shall be accessible to authorized maintenance personnel and shall be secure against tampering.

16.4 INTERCOMMUNICATIONS (IC) SYSTEM

A. General

The operating cab of each car shall be equipped with a totally solid state intercommunications system. The IC

system shall be designed for maximum intelligibility to permit an operator in an operating cab to communicate privately with another crew member in any other operating cab by use of the voice-actuated microphone located on the operator's console and a separate loudspeaker mounted on the side wall of the cab, provided that the mode selector switch on the operator's console is positioned to the INTERCOM mode.

B. Buzzer Signal

A buzzer signalling system shall be provided to permit one station to signal every other station that voice communication is desired from an operating cab in the train. The system shall be powered from the nominal 32 VDC battery supply on the car.

C. Volume Control

The train IC system shall include a volume control at each IC station to permit alignment and balancing of the system. This control shall be readily accessible for servicing upon removal of the protective cover, but shall otherwise be secure from unauthorized access.

D. Equipment

Each car intercom system shall consist of the following major items:

- Voice actuated microphone system (provided for in PA System, Section 16.3)
- Power amplifier
- Speaker with volume control

- Buzzer signalling system

E. Interference

The contractor shall furnish and install any additional equipment or appurtenances necessary to provide a complete system capable of being used from any station without interference from, or with, the radio system.

Use of the 20 dBm PA line as part of the IC circuits is permitted, provided that its use reduces the number of conductors in the electrical coupler without compromising any requirements of this specification.

F. Trainlining

The contractor shall be responsible for designing, providing, and testing a complete IC system in each dependent-pair. When cars are coupled to form a train, the IC units in each car shall be automatically interconnected to form a single, integral IC system.

G. Control Panel

The communications control panel in the control cab of the consist shall be the master IC station upon energization of that cab. Power shall be applied to the IC system only when needed for communications. The IC master station equipment shall be located inside the module behind the communications panel. In non-active cabs, the equipment shall function as a slave station for cab-to-cab communications.

H. Amplifier

The IC amplifier shall be assembled from solid state components. The amplifier shall have a frequency response within 2 dB from 300 Hz to 5,000 Hz, and shall furnish sufficient power to provide the specified acoustical output at any other IC station in an 8-car train. The hum and noise level shall be at least 50 dB below the normal output. The amplifier inputs and outputs may be open circuited or short circuited without causing damage to the amplifier.

I. Circuits

The contractor shall furnish and install all interconnecting cables and wiring. All IC circuits shall be located away from, or otherwise protected from, and circuit capable of causing or inducing electromagnetic interference (EMI), as specified in Section 4.3.2.

J. Circuit Breaker, Equipment Mounting

A circuit breaker shall be provided and located with the equipment in each cab. The equipment shall operate from a power supply as specified in Section 13.5. Solid state silicon devices shall be used in all IC electronic equipment. All circuit components shall be mounted in the chassis assemblies so as to permit replacement without disturbing other components. All switches and controls shall be mounted to permit replacement without removal of other components. Controls shall be accessible to maintenance personnel and secure from unauthorized access.

K. Requirements

The system shall exhibit no oscillations, acoustical feedback, or other instabilities at any combination of input level or gain and speaker level control settings under all operational and test conditions. The hum and noise level shall be 50 dB below the rated output with the microphone connected and energized. The equipment shall be capable of being operated without damage under any combination of service conditions specified in Appendix A.

● 16.5 TRAIN-WAYSIDE RADIO COMMUNICATIONS EQUIPMENT

A. General

Radio communications equipment shall be provided to operate within either the very high frequency (VHF) or ultra high frequency (UHF) range, with the following number of channels: * _____ and in accordance with the Communications Section of the Association of American Railroads. The equipment comprising the train-to-wayside radio communication system shall consist of the following major items for each car:

- Transmitter-receiver
- Mounting bracket
- Antenna
- Set cabling
- Voice-actuated microphone system (provided for in PA system, Section 16.3)
- Loudspeaker with volume control
- Radio panel
- Mode selector switch

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The contractor shall furnish and install any additional equipment or appurtenances necessary to provide a complete system capable of being used from any station without interference from, or with, the other communication system.

B. Operation

It shall provide a two-way radio-frequency link between the radio communications system of the transit system and a train operating on any revenue service route or within the maintenance and storage areas.

C. Interference

The contractor shall be responsible only for design of the car-mounted radio communications equipment. This responsibility shall include protection against conducted, radiated, and induced interference capable of causing a malfunction or performance degradation of any car-mounted equipment.

D. Requirements

Radio communications equipment shall conform to Part 93 of the FCC requirements for Land Transportation (Urban Passenger) Service, and to the requirements and standards of the Electronic Industries Association (EIA) as follows:

RS-152-B	Land Mobile Communication Fm or PM Transmitters, 25-470 MHz
RS-159	Chassis Pickup of Vehicular Receivers
RS-160	Sound Systems
RS-186-D	Standard Test Methods for Passive Electronic Component Parts

- RS-199-A Solid and Semi-solid Dielectric Transmission Lines
- RS-204-A Land Mobile Communication FM or PM Receivers, 25-470 MHz
- RS-220 Continuous Tone-Controlled Squelch Systems (CTCSS)
- RS-278-A Mounting Dimensions for Loudspeaker
- RS-280-A Solderless Wrapped Electrical Connections
- RS-299-A Loudspeakers, Dynamic, Magnetic, and Impedance
- RS-390 Standard Test Procedure for Noise Margin Measurements for Semiconductor Logic Gating Microcircuits; Noise Margin Measurements

E. Installation

The installation and operation of all radio communications equipment shall conform to the AAR Communications Manual as follows:

- Part 12-1 This shall be considered the minimum acceptable interference-suppression.
- Part 12-10 This shall be considered applicable except as otherwise specified herein.

F. Documentation

Radio communications equipment documentation of all types shall conform to Institute of Electrical and Electronic Engineers (IEEE) Standard 100-1972, Standard Dictionary of Electrical and Electronic Terms.

G. Frequency

The form-channel radio communications transceiver shall be operated on a frequency of * _____ MHz under Part 93 of the FCC requirements for Land Transportation (Urban Passenger) Service.

H. Controls and Indication

Control and indication equipment shall be provided in various panels and operating positions as specified herein. All such control and indication circuitry and hardware shall be fully compatible with the radio communications equipment and shall include:

1. ON-OFF Control Function shall control primary power to the transceiver. This function shall be supplied through the required keylock switch contacts.
2. ON-OFF Indication Indicator lamp shall inform the operator that primary power has been applied to the radio communication transceiver.
3. ON-DISABLE Control Switch shall control the tone-coded squelch function to permit FCC-required monitoring of the radio channel before transmitting.
4. Audio Level Control Control shall vary speaker output from the minimum discernible level in the cab to maximum audio level.
5. TX on Indication Indicator lamp shall inform the operator that the transmitter is ON. Logic function shall be consistent with FCC regulations.

*Purchaser completing detail

I. Transceiver

The radio transceiver shall be a lightweight, ruggedized unit consisting of: transmitter, receiver, transient filter, and power supply assembly in a fully enclosed housing. Solid-state devices shall be used throughout.

1. Mounting The mounting rack shall be of a universal type which can accept a variety of equipment and shall be equipped with a mating pig-tail connector.
2. Squelch A continuous coded squelch system, which shall minimize reception of co-channel nuisance noise and skip-interference, shall be incorporated into the transceiver, using the standard tone frequency specified in Section 13.5 of the EIA. There shall be two modes of operation when the voice-activated microphone is not activated and is in the radio communication mode; i.e., (1) carrier squelch operation in which the receiver squelch circuit shall open for any sufficiently strong, on-frequency radio frequency (RF) carrier for use during normal two-way conversation, and (2) tone-coded squelch operation in which the transceiver shall be muted until the incoming on-frequency RF carrier is modulated by the squelch tone. Tone equipment shall comply fully with EIA standard RS-220. Squelch sensitivity shall be fixed at less than 6 dB SINAD ratio.
3. Maintainability The transceiver shall be removable from its mounting for servicing without disturbing the mounting or cabling installation and shall, without modification, be fully interchangeable with other units of the same type. All components and adjust-

ments shall lock the unit into its mounting space to preclude unauthorized access.

4. Enclosures Radio circuitry and DC power supply shall be fully encased in a ruggedly-constructed, unlouvered, single enclosure which shall plug into a permanently attached mounting rack. Interlocking sections of the enclosure shall preclude infiltration of airborne particulates and splash water. The unit shall incorporate a carrying handle. The single enclosure and mounting rack together shall not exceed an overall volume of 32,774 ccm (2,000 cubic inches). The mounting rack shall be installed as indicated on the Specification Drawings. To preclude tampering with the equipment, the radio enclosure shall be designed to permit responsible, semi-skilled personnel to replace inoperative equipment outside normal working hours.

Transmitter, receiver, and power supply circuitry shall be mounted on, and protected by, heavy gauge metal subchassis sections connected to form a mechanically integral unit.

External heat radiators shall maintain the radio equipment within the specified operating temperature range without permitting intrusion of airborne contaminants inside the radio.

5. Metering Metering of all essential circuits shall be accomplished with an external 0-to-50 microampere, 20,000 chms per volt, single-scale meter and appropriate cable.
6. Power Source The radio equipment shall be capable of operating from the power source specified in Section 13.5. The power supply shall contain a transient

filter and DC-to-DC converter. The transient filter and power supply shall form an integral part of the transceiver. Primary power input shall be adequately fused to ensure fast and positive action. The transceiver shall exhibit no failure or malfunction, nor shall it exceed component ratings when subjected to the interference levels specified in Section 4.3. Silicon solid-state devices shall be used throughout the design.

7. Marking Each equipment assembly shall bear a nameplate showing: supplier identity, equipment serial and model numbers, nominal supply voltage, and FCC-type acceptance number.

8. Antenna The radio communications antenna shall be of the rigid mobile type. The impedance of a car-mounted antenna shall maintain a VSWR of less than 2:1 over a frequency range of 3Mhz centered on an operating frequency of 161.565 MHz. The antenna shall be concealed behind the fiberglass cabend of each car and shall be of an approved, miniature type not requiring an appreciable ground plane surface. The efficiency of the antenna shall be equal to a unit dipole antenna tuned to the operating frequency of 161.565 MHz.

The antenna shall be designed for rapid railcar application, shall be impervious to damage from mechanized carwashing equipment, and shall be resistant to vandal damage. A 50 ohm coaxial transmission line used to interconnect the car and the radio communications equipment in the communications equipment rack in accordance with EIA standards.

9. Interface and Control On-board interface and control functions, as indicated on the Specification Drawings, shall be provided by the contractor for proper control of radio communications equipment operating in the radio communications system provided by others (CDRL).

●16.6

AUDIBLE SIGNALS

The public address system shall provide an audible chime signal at a frequency of * _____ Hz for the following functions* _____.

16.7

EMERGENCY

In an emergency, the communications system shall continue to operate as specified in Section 13.5.1.

*Purchaser completing detail



SECTION 17
HEATING, VENTILATION, AND AIR CONDITIONING



SECTION 17

HEATING, VENTILATING, AND AIR CONDITIONING

17.1 GENERAL

This section specifies the requirements for an air comfort subsystem to provide continuous and automatic control of floor and ceiling heating, ventilation, and air conditioning (HVAC) within each car. Each car shall be air conditioned, either by a single unit or by two separate, identical air conditioning units, each rated at one-half the required capacity. Capacities shall be determined by local climatic conditions and shall be designed for the maximum overall heat gain in the summer and heat loss in the winter under the ambient conditions specified in Appendix A. Heating and air conditioning equipment shall draw power through separate cables and fuses. All components of the subsystem shall conform to the vibration, noise, and electrical requirements of Section 3.4.

17.1.1 FUNCTIONAL DETAIL

A. Interior Conditions

1. General

As specified in Appendix A

2. Summer

5600 CFM (2.65 m³/s) total air circulation minimum

1600 CFM (.75 m³/s) fresh air minimum

- a. No passengers:
Temperature shall not fall below 70°F (21.1°C)
- b. 80 passengers:
75°F (24°C) maximum dry bulb
50 percent relative humidity
- c. 240 passenger:
80°F (26.7°C) maximum dry bulb
60 percent relative humidity

3. Winter

59°F (14.4°C)	dry bulb minimum
3750 CFM (1.77m ³ /s)	total air circulation
1070 CFM (.50m ³ /s)	fresh air minimum

B. Temperature Variations and Limits

The following point-to-point interior air temperature variation shall apply at any given time, except during pulldown and warm-up. The surface temperature limit applies at all times.

- 1. Vertical Plane Variation between any two points in any vertical plane more than 12 inches (304 mm) from the sides, ends, floor, or ceiling of the car shall not exceed 4 degrees F (2.2 degrees C).
- 2. Horizontal Plane Variations in any horizontal plane between 12 inches (304 mm) above the floor and 12 inches (304 mm) below the ceiling shall not exceed ±2 degrees F (±1.1 degrees C) longitudinally when measured at 12 inches (304 mm) from the ends or the sides of the car and ±4 degrees F (±2.2 degrees C) when measured in the same manner in an active or

or inactive cab.

3. Exposed Surfaces Surface temperature of any exposed protection device, grille, or shield shall not exceed 120 degrees F (49 degrees C) when the contact rail voltage is within the range specified in Appendix A.

C. Condensation

The air comfort subsystem shall not cause condensation to form on any car interior surface.

D. Pressurization

The ventilating system shall provide a minimum interior pressurization of 0.215 inches (3 mm) of water when the car is stationary and with all doors and windows closed.

E. Air Velocity

Air velocity within the plane 5.5 feet (1.68 m) above the floor shall not exceed 75 fpm (22 869 mm) per minute.

F. Subsystem Size

Starting from a condition with a car at stabilized interior temperature and without passengers, the air comfort subsystem shall achieve the control temperatures specified in Appendix A within one hour after layover under any ambient temperature or weather condition.

17.1.2 CONTROLS

A. General

The contractor shall install the positive, non-hunting temperature control equipment required to ensure proper operation of the air comfort subsystem. A control system employing separate temperature-sensing and control apparatus shall be provided for each air conditioning unit. The control apparatus for each system shall be mounted on separate panels. Temperature-sensing elements shall be mounted behind each recirculating air grille ahead of the filter.

B. Apparatus

1. General .Control apparatus shall incorporate components which shall be protected from harmful voltages induced by devices in related circuits or admitted on wiring connected in common with other electrical equipment. Electronic control assemblies shall be constructed as plug-in units and shall be attached with quick fasteners to preclude units from vibrating loose from fixed jacks.
2. Plug-in Cards Plug-in cards of the same part number shall be interchangeable without adjustment. Cards shall be keyed to preclude inadvertent interchangeability of unlike cards. The control point of the system shall not be affected by the normal low voltage variations specified in Section 13.5.1.

3. Temperature-sensing Devices Temperature-sensing devices shall be shock-mounted and tamperproof, shall be provided with mountings and terminals or connectors, and shall not be unduly influenced by local heat sources, sun load, or outside air. All equipment shall be removable, of industrial-quality, and suitable for rapid transit service. Precautions shall be taken to ensure maintenance-free operation under the heavy vibration operating conditions specified in Section 3.5. All parts requiring periodic cleaning, inspection, and maintenance shall be readily accessible.

4. Contractors, Relays, Panel Boards All electrical contactors, relays, and panel boards shall be protected from moisture, dust, and dirt. No controls, except temperature sensing units, shall be permitted in ducted air streams.

C. Enclosures

A common enclosure shall be provided to house each HVAC system's control equipment. This enclosure shall contain the trainline relay, heater and fan contactors, motor starting contactors, control relays, and all other required control equipment. A hinged, dirtproof, dustproof, and waterproof cover with a safety trunk arm to hold the cover open shall be provided. The cover shall provide side access to interior control equipment. All equipment boxes, covers, etc., exposed to passengers and operating personnel shall be grounded.

D. Trainline Controls

Ventilating, air conditioning, and heating equipment shall be arranged for trainline control of all units in the train from the cab of each car. Individual car temperature control shall be automatic. Trainline control on each car shall consist of a low-voltage relay which shall be energized by the auxiliaries ON/OFF switches.

17.1.3 CAB

Manually adjustable air outlets shall be provided in each cab to provide air comfort, volume, and circulation from the car's main air conditioning system. A baffle shall be provided to preclude air flow being directed at the operator. Nominal air flow shall be 90 cfm ($0.04 \text{ m}^3/\text{s}$) from each outlet. A 600 watt cab heater unit with a circuit breaker used as the ON/OFF switch shall supplement cab heat and shall also defrost the windshield. A grille shall be provided in the lower portion of the interior cab door for air circulation between the cab and the passenger compartment.

The cab heater unit shall be powered from the contact rail energy source. The unit shall be controlled by a switch with OFF and ON positions located on the secondary control panel. Nominal air flow from the unit shall be 110 cfm ($0.05 \text{ m}^3/\text{s}$).

17.1.4 LAYOVER

Layover heat of up to 50 degrees F (10 degrees C) shall be automatically provided under thermostatic control only. Floor heat only shall be used.

17.2 HEATING DETAIL

17.2.1 REQUIREMENTS

The car heating system shall provide thermostatically - controlled, fully automatic floor and ceiling heat. The heating subsystem shall be energized when the car interior temperature falls below 54 degrees F (12 degrees C).

17.2.2 EQUIPMENT

A. Floor Heaters

Heating elements shall be mounted behind stainless steel heater grilles along the side walls at the floor and shall be arranged to provide a uniform heat source throughout the passenger compartment. These elements shall be mounted to preclude resonant vibration, but shall permit expansion and contraction without contacting other components. Reinforcing structural members shall be provided in the heater cases and wear plates shall be where required for those heaters that may be used as foot rests (at cross seats). Heater strips shall be connected in series and arranged in three parallel circuits protected by one circuit breaker. The heater strip shall be precluded from attaining a temperature at which debris could be ignited. The grilles shall facilitate hot air convection but shall preclude entry of foreign matter. Heaters shall consist of a resistor embedded in a refractory insulating material of high thermal conductivity and enclosed in a rust-resistant iron sheath. Insulating material shall be compacted under pressure to ensure good heat conductivity and the absence of loose material, and shall be inserted between

the heater compartment and the outer carbody skin. Heater leads with brass tips shall be of sufficient length to permit easy replacement of the elements. Insulating bushings shall be provided for all openings and heater leads. Air gap and creepage distances shall be adequate to preclude corona discharge or other electrical failures. Heater front grilles shall be constructed to permit sections to be removed without dismantling adjacent grilles. Design of the grille lower section shall preclude accumulation of dirt and trash and also preclude splashed floor wash water from entering the heater. Heaters shall be powered from the energized contact rail and shall operate at full performance when contact rail voltage at the car is as specified in Appendix A.

B. Overhead Heaters

1. General Overhead heaters shall be located downstream from the cooling coils. With contact rail voltage at the car as specified in Appendix A, the overhead heaters shall heat incoming fresh air during the heating cycle. The heaters shall be tubular elements comprised of corrosion-resistant sheaths surrounding a uniformly-spaced, coiled, nickel-chromium resistance wire embedded in a compressed and baked refractory material. Heaters shall be accessible for replacement and cleaning through a removable ceiling panel and access door in the evaporator discharge duct.
2. Interlocks The heater circuit shall be interlocked with the blower circuit to preclude heater operation unless the blowers are in operation. The heating circuit shall not be energized unless the blowers are

operating at low speed. A circuit breaker shall be provided for each overhead heater.

If air circulation is stopped in the overhead duct and temperatures higher than 160 degrees F (71 degrees C) are detected, a thermostitch adjacent to the heating elements shall open both the overhead relay and the overhead heat circuit breaker.

C. Thermal Fuse

To protect the ceiling area from overheating and fire, a thermal fuse shall be provided in the primary power electric supply to the overhead heaters. The thermal fuse shall melt at a safe temperature, thereby opening the circuit.

17.3 VENTILATION

17.3.1 REQUIREMENTS

Ventilating fans, also known as evaporator blowers, shall operate as specified in Section 3.4.1.

17.3.2 EQUIPMENT

A. Airflow

Air movement within the car shall be accomplished by resiliently-mounted fans supplied as part of evaporator units. Fresh air shall enter through screened intakes along both sides of the car near the roof and shall be mixed with recirculated air in the plenum. Recirculated and fresh air shall then be filtered as the air exits the

plenum and enters the evaporator unit to be cooled or heated. Conditioned air shall flow from the evaporator at each end of the car into a common air distribution duct that shall be longitudinally divided by a diagonal member so that a separate duct shall be formed for each evaporator. The evaporators shall be of the push-through airflow type.

B. Blower/Motor Assembly

1. General Two-speed evaporator blowers shall force air through the cooling and heating coils. Within each evaporator unit, the fans, evaporator coils, heater units, and expansion valves shall be separately removable.
2. Motor Requirements A dual fan assembly shall be direct-coupled to a totally enclosed direct current, interpole motor rated for continuous duty. The motor shall have a nominal rating of 600 VDC and shall have ample capacity to drive the fans under any load condition.

The motor shall commutate successfully (as defined in the latest applicable IEEE standards) when operating under any load condition. It shall not flash, puncture the insulation, or be subject to any injury that would render it unsuitable for continuous service when crossing the gaps in the contact rail or at any time when a sudden change in operating conditions could cause the voltage to fall to zero and rise momentarily to 1,200 VDC. The circuit breaker used for the protection of the apparatus shall not be unduly loaded during this momentary voltage swing.

3. Fan Rating The fan assembly for each end of the car shall be rated for summer operation at 2,800 cfm (1.32 m³/s) at 1.5 inches (38.1 mm) of water static pressure. Water static pressure shall be reduced to 1,875 cfm (0.88 m³/s) for winter operation for a total of 5,600 cfm (2.64 m³/s) and 3,750 cfm (1.77 m³/s) respectively for the car.

17.4 AIR CONDITIONING

17.4.1 REQUIREMENTS

When the car's return air temperature reaches 76 degrees F (25 degrees C), one of the two air conditioning units shall be energized; and at 77 degrees F (26 degrees C) the second unit shall also be energized. As the return air cools: the unit that energized at 77 degrees F (26 degrees C) shall deenergize at 74 degrees F (23.3 degrees C), and the unit that energized at 76 degrees F (25 degrees C) shall deenergize at 73 degrees F (22.7 degrees C).

● 17.4.2 EQUIPMENT

A. Compressor-Condenser Units

Each car shall be equipped with two compressor units mounted separately under the car and in such a manner as to preclude vibrations being transmitted to the car structure. Each compressor shall reduce pumping capacity by automatically unloading in response to a preset system pressure. A Schrader valve shall be provided to permit checking lubricating pressure with a portable test gauge if lubricating pressure is required

for unloading valves in compressor. Visual means to check the lubricant shall also be protected from damage. Replacement of the compressor seal shall not require removal of the compressor from its mount nor shall it require evacuation of the system.

B. Compressor Motor

Each compressor shall be driven by a totally enclosed direct current, interpole motor rated for continuous duty. The motor shall have a nominal rating of 600 VDC and shall have ample capacity to drive the compressor under any load condition. The motor shall operate successfully over a voltage range of 425-to-675 volts. The motor shall be connected to the compressor with an approved coupling at one end and shall be connected to the condenser fan with a shaft extension at the other end.

The motor shall commute successfully (as defined in the latest IEEE standards) when operating under any load condition. It shall not flash, puncture the insulation, or be subject to any injury that would render it unsuitable for continuous service when crossing the gaps in the contact rail or at any time when a sudden change in operating conditions could cause the voltage to fall to zero and rise momentarily to 1,200 VDC.

C. Heat Exchange Medium

The heat exchange medium shall be Refrigerant 22.

D. Condenser

Each compressor shall feed its own condenser. The condenser coil shall be constructed of seamless copper tubing with copper fins. Minimum fin thickness shall be 0.008 inch (0.20 mm). Fin spacing shall be no greater than 8 fins per inch (25.4 mm). Fins shall be mechanically-bonded to the tubes. No crevices or closures shall be permitted which could hinder car cleaning. The condenser inlet shall be screened to preclude entry of debris. The enclosure from fan to condenser shall have hinged access panels to permit inspection, cleaning, and replacement of fan blades. The fan shall be dynamically balanced.

E. Receiver Tank

One receiver tank, sized to completely contain the refrigerant charge, shall be mounted on each compressor-condenser unit, and arranged so that a refrigerant level sight glass shall be visible from carside. The glass and the receiver tank shall be readily replaceable without unsoldering any fittings. For service use, a purge valve which is visible and readily accessible from carside and a shutoff valve at inlet and outlet shall be provided.

F. Filter Drier

A replaceable core drier, including a filter, moisture indicator, and inlet and outlet shutoff valves shall be mounted in the liquid line on the compressor-condenser unit.

G. Refrigeration Control Box or Portable Test Gauge
Inserted in Schrader Valves

Each system shall have a weatherproof control box containing safety pressure switches, a test switch, modulation pressure switch and *_____ portable test gauges, inserted in Schrader valves, hand valves, contactor panel, and charging connections. Different size piping or fittings shall be used for high and low pressure lines. Each box shall be mounted on or near the compressor-condenser unit and shall be readily accessible from carside. A safety trunk arm shall hold the cover of the box in the open position.

H. Refrigerant Piping

Unless otherwise specified, all refrigerant piping shall be hard-drawn type H, 1/4 hard temper copper tubing. Tubing shall be performed where possible and shall be assembled with as few fittings as practicable. Joint quality, solder, and flux material shall be as specified in Section 6.7.3. Refrigerant piping shall be insulated for protection and to preclude formation of condensate on the suction lines.

I. Supports and Connectors

Piping shall be supported by brackets and clamps located no more than 4 inches (102 mm) from joints, fittings, valves, and bends of 45 degrees or greater angles. Supports shall be spaced no more than 24 inches (610 mm) apart on straight pipe runs. All piping shall be protected from chafing and from contact with dissimilar

*Purchaser completing detail

metals. Piping runs shall create no traps or other restrictions to refrigerant flow. Flexible connectors shall be provided for each pipe at each resiliently-mounted unit.

J. Fittings

Fittings shall be refrigeration grade, wrought copper or cast brass, and shall be located at identical positions in each car. Self-sealing refrigeration fittings shall permit removal of any component without loss of refrigerant in the component or piping. Fittings and joints shall be in accessible locations for both testing and repair. Joint quality, solder, flux, and flux cleaning shall be as specified in Section 6.7.3.

K. Access Doors and Grilles

Access doors shall be provided in the low ceiling area for maintenance and removal of air conditioning equipment. Doors and grilles shall be provided with hinges, a locking arrangement, and safety catches. Doors shall be sealed to preclude air leaks. Access doors and ceiling shall not contact the evaporators. Recirculation air grilles shall be located near the air conditioning evaporation units.

L. Ducts

Flexible transition ducts shall connect the overhead air distribution duct to each overhead evaporator. These ducts shall be fireproof and withstand, without damage, the maximum temperature developed by the overhead heat unit. Air ducting shall be insulated and constructed

of fireproof materials. Ducts shall be designed to provide the specified air volume without exceeding 1,000 fpm (304.8m per minute) air velocities within the ducts.

M. Adjustments

The sample car shall be provided with adjustable diffusers and an evenly distributed pattern and velocity shall be determined in a "hot-room" test. All remaining cars then shall be equipped with diffusers manufactured or preset to the established settings.

Diffusers, grilles, and outlets shall provide evenly distributed air at surface velocities below 500 fpm (152.4m per minute). Installations shall be flush-mounted with exposed surfaces designed to complement other interior detail. In the operator cab, airflow adjustment shall be by an exposed hand control. Grilles and outlets shall be provided with safety catches and limit chains or cables.

N. Air Filters

Combined fresh and return air shall be filtered through disposable filters which shall permit adequate airflow for a minimum of 10,000 miles (16 093 km) operation between filter changes. Filters shall be mounted in dust-tight frames and shall be readily accessible through the return air grille.

O. Strainers

One strainer shall be provided for each system in a location upstream of the evaporator expansion valve. The

strainer shall be equipped with a replaceable screen and a shut-off valve at the inlet and at the outlet to isolate the strainer from the system during servicing.

P. Moisture Indicator

Two approved moisture indicators, one for each system, shall be provided in the following location:* _____.

Q. Liquid Line, Solenoid Valve

Two electrically-operated liquid line, solenoid valves, one for each system, shall be provided in the following location:* _____, in the main liquid line before the evaporator. A locking type plug connector shall be provided.

R. Evaporator

An evaporator shall be mounted in the ceiling/roof interspace at each end of the car for modulated control and shall be fed through its own expansion valve. The evaporator coil shall be copper tubing with copper fins spaced no more than 8 fins to the inch (25.4 mm). The evaporator shall be arranged for modulated control. Each section shall be fed through its own expansion valve. Expansion valves shall be readily accessible for maintenance and replacement. An insulated stainless steel drain pan shall be provided under the evaporator coil. Sufficient baffles shall be provided to preclude condensate spillage at all possible car attitudes and performance dynamics. Two drain lines with* _____ traps per drip pan shall be provided; one to each side.

*Purchaser completing detail

The lines shall be 1 inch (25.4 mm) minimum inside diameter, and shall be routed with a minimum number of bends. The radii of any required bends shall permit easy unplugging. Drain lines shall be provide with a trap and shall carry condensate to the underside of the car. Condensate shall drain clear of all undercar equipment and the running and contact rails.

S. Exterior Air Inlet

All air inlets terminating on the car exterior shall be protected to prevent ingestion of foreign particles, ice, and moisture into the ventilation system. Such protectors shall preclude blocking of the inlets by ice or snow accumulation.

SECTION 18
CAR SYSTEM ASSURANCE



SECTION 18

CAR SYSTEM ASSURANCE

18.1 GENERAL

The contractor shall assure the purchaser of the operational qualities of the car by submitting for review: the analyses, plans, and reports described in this section. To the extent possible, the data shall be provided in summary form as oral and visual presentations during the design reviews described in Section 19.

18.2 HUMAN FACTORS ENGINEERING ANALYSIS (HFE) (CDRL)

Consideration shall be given to: equipment design, passenger acceptance, maintainability, operator controls, and operational safety, and to how these elements can be demonstrated in the mock-ups.

A final report shall be submitted to the purchaser summarizing the HFE effort.

18.3 RELIABILITY ENGINEERING ANALYSIS (REA) (CDRL)

The contractor shall submit a Reliability Engineering Analysis. The analysis shall include:

- A. Subsystem definitions
- B. Functional flow and reliability block diagrams
- C. Description of data base and adjustment factors
- D. Subsystem failure modes and predicted MTBF's
- E. Definition of interfaces so that all elements in the car are identified with a particular subsystem

18.4

MAINTAINABILITY ENGINEERING ANALYSES (MEA) (CDRL)

The contractor shall submit Maintainability Engineering Analyses for the car. These analyses shall include the following:

- A. Frequency of task performance
- B. Elapsed time to perform each task
- C. Test equipment and tools required for each task
- D. Crew size and skill levels required for each task
- E. Maintenance publications and facilities required by the car being procured.

A Fault Isolation/Troubleshooting Plan shall be developed and submitted. This plan shall detail the fault isolation and troubleshooting procedures necessary for performance of the maintenance tasks identified above. This plan shall form the basis for the Car Maintenance Manuals.

18.5

SAFETY ENGINEERING ANALYSES (CDRL)

The contractor shall submit to the purchaser qualitative and quantitative analyses of safety considerations in the car design.

Qualitative analyses shall be non-mathematical evaluations of factors affecting the safety of the car operation. Probable car conditions, events, and potential consequences thereof shall be evaluated together with an assessment of potential injuries to persons and damage to property.

The contractor shall show how each identified hazard shall be controlled.

A. Subsystem Hazard Analyses (SSHA) (CDRL)

The hazard identification shall be to the vehicle line replacement unit level commensurate with system definition. The analyses shall include consideration of the: environmental conditions, human and equipment interfaces, and impact of associated failures on the safety of the vehicle system and associated equipment and facilities.

B. Operating Hazard Analyses (OHA) (CDRL)

An operating hazard analysis shall be performed to identify and evaluate the safety considerations associated with the environment, personnel, procedures and equipment involved throughout the operational phase of a given system element. The OHA shall include activities; such as, testing, installation, maintenance, support, transportation, storage, operations, emergency car evacuation, rescue, post-accident responses and training. The OHA will be used as a basis for the following:

1. Design changes, where feasible, to eliminate hazards or to provide safety devices and safeguards.
2. Special procedures for servicing, training, handling, storage and transportation.

3. The publication of warning and caution notices and special inspection and emergency procedures in the operating and maintenance instructions, including emergency action to minimize personal injury.
4. Identification of a hazardous period time span and actions required to preclude the occurrence of undesired events.

18.6

COMPLIANCE PROGRAM REPORTS (TEST REPORTS) (CDRL)

The contractor shall submit to the purchaser an overall specification compliance (test) program which shall include definition of all tests listed in Section 20, the personnel, data and facilities to be used, and a detailed testing schedule.

The contractor shall also submit to the purchaser a detailed plan for components, subsystems and systems testing. (CDRL)

The plan shall include the following information:

- A. Description of test articles
- B. Test objectives, including pass/fail criteria
- C. Test environment and the basis for establishing test criteria (e.g., location, temperature, rain, wind)
- D. Required equipment, facilities, and personnel
- E. Instrumentation
- F. Type conditions (shock, vibration, insulation, etc.)
- G. Inputs to test and outputs expected
- H. Parameters to be recorded and type of data
- I. Evaluation procedures
- J. Required reports
- K. Schedule

A detailed procedure for each test requirement shall be submitted to the purchaser. (CDRL) The basic test procedures shall be developed in accordance with the General Vehicle Test Plan for Urban Rail Transit Cars, UMTA-MA-06-0025-75-14, and shall specify the items previously outlined in the testing plan and any other pertinent information. The purchaser shall be notified of the time and location of each test at least 15 days prior to each scheduled test date. (CDRL) The purchaser will have the right to witness each test.

Test reports shall be submitted to the purchaser following completion of each test, and shall summarize results and certify conformance, as appropriate. Supporting data, including photographs, shall be made a part of the test reports. Sub-contractor test reports shall be approved by the contractor prior to submittal to the purchaser.

●18.7

SHIPPING PLAN (CDRL)

Passenger cars, at the contractor's option, may be shipped either on their own wheels or loaded on flat cars. A shipping plan shall be prepared for the purchaser's review and approval and to consist of the following as a minimum:

A. On Own Wheels

Should the contractor elect to ship the rapid railcars on their own wheels, the following procedure shall be adhered to:

After contact shoe devices, and air hose between car bodies and trucks have been installed to ensure proper fit and clearances and to permit testing of the cars, the contractor

shall remove such devices, including brushes from traction motors, but with the exception of the brake cylinder hose. Shoe beams may be left in place, with contact shoe removed, provided the contractor has first determined that no interference will be experienced during shipment. All removed material shall be shipped with the cars. This material shall have been properly marked and numbered to ensure its replacement in the location from which it was removed. The material shall be crated or blocked to preclude loss or damage to either the car or to the material. The air lines from which the hose has been removed shall be plugged, and the trip devices on trucks shall be wired in the open (upper) position. If the shoe beams are removed, the shoe beam supporting castings shall be applied to journal boxes and wired in place. Cars shall be delivered with all motors mounted and connected, complete, and ready for operation except as noted above.

Special temporary fittings; such as, drawbars and air brake details, required to permit the shipment of the cars by rail on their own wheels, shall be provided by the contractor at its expense.

Parts of the car equipment requiring lubrication, including brake bolts and pins, shall be thoroughly lubricated by the contractor before shipment of the cars, so that they will be in good operating condition at time of delivery.

Parts and equipment bearing serial numbers shall be reported in car groups as assembled for shipment.

The contractor shall provide special shear pins which conform to the following requirements: * _____
in each draft gear for the shipment of the cars.

* Purchaser completing detail

Following delivery: the contractor shall replace each shipping shear pin with a new shear pin that is designed to carry the loads specified in Section 12.3, shall reapply all removed equipment and, shall make the cars ready for operation.

B. On Flat Cars

Should the contractor elect to ship the rapid railcars on flat cars, the following procedure shall be adhered to:

The rapid railcars shall be supported on the flat cars on two cradles. The cradles shall have sufficient bearing surface and be equipped with adequate stops so that the passenger car shall be supported vertically through the truck side frame and restrained from both lateral and longitudinal motion. A sufficient number of tie-downs shall be provided.

The rapid railcar's couplers shall be restrained in the center position by use of clamps or other mechanical devices. The air connections on the coupler shall be plugged and the electric coupler pins shall be in the retracted position.

One wheel on each rapid railcar's axle shall be blocked by using the slack adjuster on the tread brake. Each motor armature shall be locked in place. All other heavy rotating equipment shall be secured to protect the bearings.

All switches and circuit breakers shall be in OFF position. The main knife switch shall be in the NORMAL position, and the battery shall be disconnected.

Prominent signs shall be displayed on both sides of the flat car reading, Do Not Hump.

Following delivery: the contractor shall reconnect the battery, remove coupler restraint and plugs and the motor armature locks, and ready the cars for operation.

18.8

IN-SERVICE SUPPORT PLAN (ISSP) (CDRL)

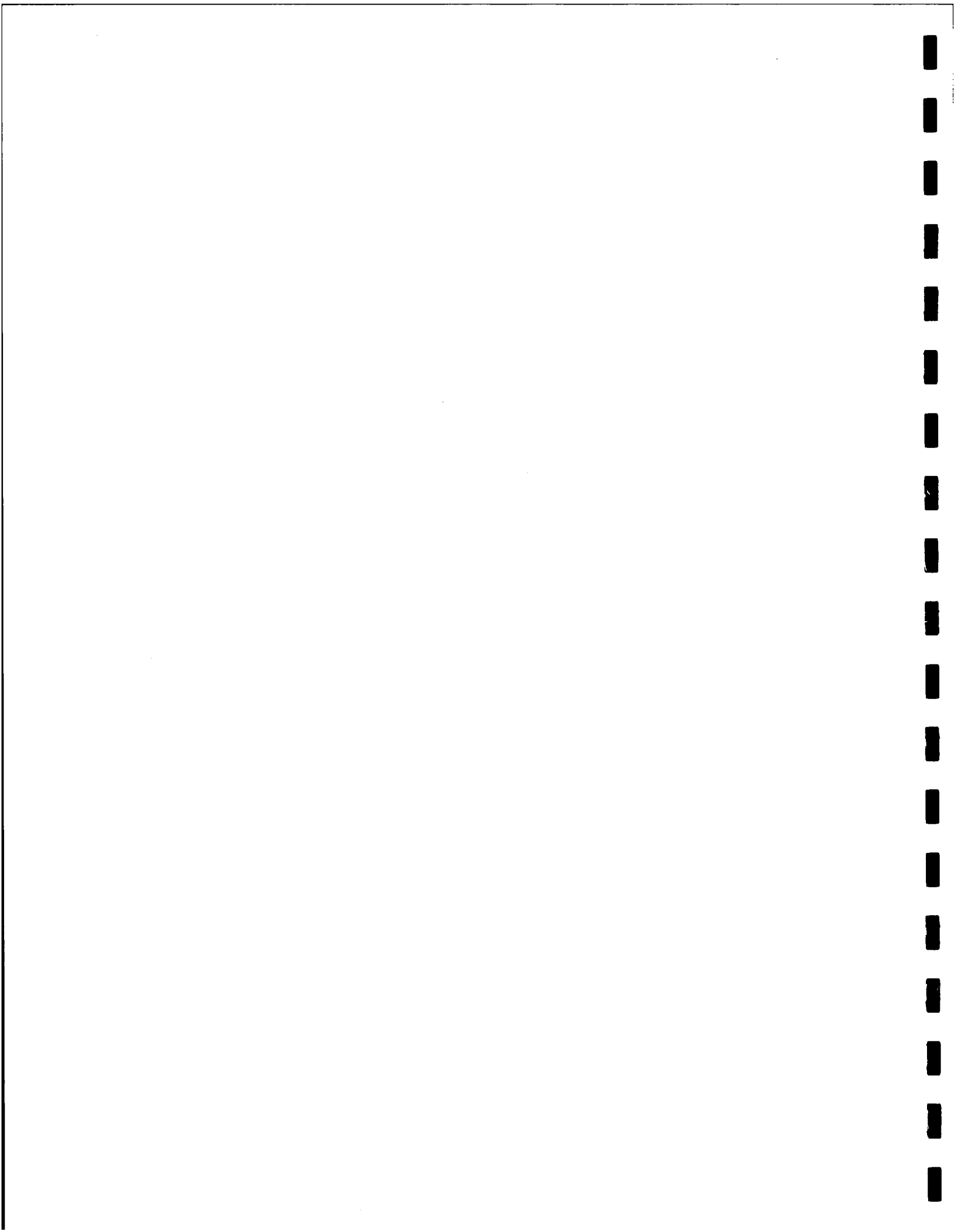
The contractor shall submit to the purchaser an In-Service Support Plan for providing the publications, training, technical assistance, spare parts, and special tools required by Section 21.

The plan shall include the following:

- A. Training program organization
- B. The content of each proposed instruction and course development, and the final achievement levels
- C. A description of the means for monitoring and evaluating individual programs and achievement
- D. Requirements for number and type of instructors
- E. A physical and functional description of the materials, training aids, and equipment required

The training program shall have as its primary objective: Developing purchaser operating and maintenance personnel to a level of competence which should ensure that work performed shall not void any warranty or guarantee in effect. Prior to commencement of revenue service operation the training program schedule shall ensure that a sufficient number of purchaser personnel shall have been trained to maintain the new cars.

The contractor shall recommend spare parts stocking levels for purchaser's future requirements based on the contractor's reliability and maintainability analyses. (CDRL)



SECTION 19
CONTRACTOR MANAGEMENT PROGRAM



SECTION 19

CONTRACTOR MANAGEMENT PROGRAM

19.1 MANAGEMENT MASTER PROGRAM (CDRL)

The contractor shall submit to the purchaser a Management Master Plan which shall include the following:

- A. An organizational chart identifying all persons assigned responsibilities for the construction of the cars and defining their relationships with each other. The organization shall include a program manager.
- B. Summary detail of the responsibilities and authority of each person on the organizational chart.
- C. The internal methods and communications to be employed to monitor, oversee, and control: program schedule, technical performance, program changes, subcontracts, materials procurement, inservice support, and reliability analysis tests and demonstrations.
- D. A master program schedule with key milestones and events emphasized.
- E. A flow chart of project task scheduling which also depicts integration of, and interactive information requirements among, all tasks.
- F. A preliminary schedule of design reviews, together with the decision-issues to be addressed at each.

- G. A schedule of items of design and manufacture which shall require purchaser approval.
- H. A schedule of all other contract deliverables.

19.2 SYSTEMS ENGINEERING PROGRAM (CDRL)

The contractor shall submit for purchaser review a Systems Engineering Plan describing the processes for:

- A. Transforming specification requirements into system and subsystem performance parameters and configurations within the developmental process of definition, analysis, design, test, and evaluation.
- B. Ensuring compatibility of interfaces to optimize car design.
- C. Integrating reliability, maintainability, safety, quality assurance, testing, and human factors considerations into a balanced, efficient engineering effort.

19.3 CONFIGURATION MANAGEMENT PROGRAM (CDRL)

19.3.1 SCOPE

The contractor shall submit for purchaser review a Configuration Management Plan. Configuration records shall be maintained by the contractor and shall be available to the purchaser throughout the term of the contract and for three years following its completion.

The Configuration Management Program shall provide for configuration oversight in the following areas:

- A. Design Reviews to provide for design evolution concurrence between purchaser and contractor.
- B. Technical Documentation Management to ensure car design integrity and documentation of each car as-built.
- C. Drawings Management to ensure car design integrity and to provide the basis for repair, overhaul, and retrofit.
- D. Production-Detail Specifications to provide a basis for purchaser/contractor concurrence regarding the manufacturing process which shall translate the car design from a paper-defined form into an operating rapid railcar.
- E. Contingency Retrofit Program to ensure purchaser-approved modification of cars produced under this contract as might be required during the warranty period.
- F. Record Drawings Program to assure that the car design in its final as-built configuration shall be documented and recorded.

19.3.2

DESIGN REVIEW PROGRAM

During the design evolution process, the purchaser will

monitor the contractor's efforts to determine the degree to which contract objectives are being achieved through periodic design reviews. The following design reviews shall be conducted jointly by the purchaser and the contractor.

A. Preliminary Design Review (PDR)

This review shall be conducted incrementally prior to detail design to evaluate the progress and technical adequacy of the selected design approach and its compatibility with the performance requirements and interfaces established by the contract. The contractor shall notify the purchaser within 21 days after Notice to Proceed (NTP) of the date when, in the contractor's opinion, a satisfactory PDR can be conducted (CDRL). The review shall be scheduled for mutually-agreeable dates at the contractor's facility.

B. Critical Design Review (CDR)

This review shall be conducted incrementally when detail design of an item is essentially complete and the associated production drawings are ready for release. The purpose of such CDR shall be to determine that the detail design of the item under review will satisfy the design requirements established in the technical specifications and to establish the interface relationships between the item under review and other items of purchaser equipment or facilities. The reviews shall be scheduled for mutually agreeable dates at the contractor's facility (CDRL).

C. Mock-up Reviews

Mock-ups shall be reviewed as detailed in Section 5.

D. First Article Inspection (FAI)

The first article inspection shall be performed on the first production dependent-pair, and shall include: shop-level test equipment, portable test units (PTU), and on-board test detail prior to shipment of the cars. Conformance of the cars to the production drawings and to test equipment requirements shall establish the production baseline. The contractor shall provide the purchaser with ample advance notice of the time and date of the first article inspection (CDRL).

The contractor shall provide the purchaser with an engineering data package in sufficient detail to permit comparison of the car's physical detail with the specification test, graphics, and mock-ups which define them. Changes resulting from the FAI shall be incorporated into the data package by the contractor (CDRL).

E. Inspections

The contractor shall schedule FAI's for the first production unit of each major equipment and subsystem prior to first shipment from the supplier's plant and shall provide the purchaser with ample advance notice (CDRL).

19.3.3 TECHNICAL DOCUMENTATION MANAGEMENT

A. Identification

The contractor's technical documentation shall define the configuration of all system equipment; i.e., test, production, or operational. Configuration shall be identified to the lowest level required to ensure repeatable performance, quality, and reliability. The contractor shall maintain release records which shall detail the relationships between identification elements. Such relationships shall be limited to configuration requirements defined by engineering data and shall not reflect manufacturing status.

Contractor's release records and documentation shall indicate the following:

1. Composition of any part number at any level in terms of subordinate part numbers
2. All next-assembly part numbers of any part
3. The specification document, specification control drawing, or source control drawing numbers associated with any sub-supplier, vendor, or contractor part numbers

The contractor's release records and documentation shall identify engineering changes, and shall retain the record of superseded configuration requirements affecting items formally released for test or production. The contractor shall employ a system of identifying numbers for specifications, drawings, and associated documents which shall

ensure that differing parts, assemblies, and installations shall be uniquely identified.

The contractor shall permanently mark-identify all hardware components as specified in Section 19.6. Such markings shall correspond with engineering data. Equipment name-plates shall provide space for several numbers to be added in accordance with Section 19.6.

B. Changes

Changes to this specification shall be controlled by the engineering change proposal (ECP) process.

An engineering change to any part, assembly, or equipment item of the car shall be designated as a Class I change when one of the following criteria shall be affected:

1. Delivered manuals
2. Delivered product (retrofit)
3. Electromagnetic interference characteristics
4. Form, fit, function, or interchangeability
5. Reliability or maintainability
6. Safety
7. Schedules or deliveries
8. Spares provisioning
9. Sources of repairable items (source control drawings)
10. Weight or balance

All other changes shall be designated as Class II changes.

All Class I ECP's, together with documentation and cost information, shall be submitted to the purchaser for review prior to implementation (CDRL). The time required

for review and schedule relief shall be considered by the purchaser in his review. Class II ECP's shall be submitted to the purchaser for information, provided that changes shall not deviate from the specification requirement (CDRL). The contractor shall maintain an Engineering Change Status Report which shall list all approved changes, their status, and completion dates. Reports shall be submitted monthly. Each purchaser-approved ECP shall be incorporated in all cars delivered under this contract.

19.3.4 STRUCTURAL STRESS ANALYSIS (SSA) (CDRL)

A structural stress plan describing the major tasks which the contractor shall perform to ensure proper stress considerations shall be submitted by the contractor.

Before structural testing shall commence, a final report shall be submitted to the purchaser summarizing the structural stress analysis. The report shall include:

- A. A delineation of the major assumptions related to stress capabilities
- B. Substantiation that safety and operational performances have been considered
- C. Complete stress analysis and design calculations of the car structure, trucks, and major equipment supports to ensure compliance with strength level requirements.
- D. Structural diagrams showing materials used, areas, section moduli, weight, etc.

19.3.5 DRAWINGS MANAGEMENT

The contractor shall submit for purchaser review prints of the following:

- A. Dynamic outline of the cars (prior to approval of carbody design) including: complete car outlines, power collectors, and space radio antenna, and reflecting all possible suspension limits and wear conditions with the clearance outline which had been provided by the purchaser to the contractor to the same scale. (CDRL)
- B. Underfloor arrangement drawings for A- and B-cars showing clearance lines and locations and outlines of all underfloor-mounted equipment. (CDRL)
- C. Subassemblies of cars and trucks. (CDRL)
- D. Single line, control schematic, and functional block diagrams for each subsystem. (CDRL)
- E. Electrical wiring diagrams and schematics for each and all electrical circuits. (CDRL)
- F. Single line piping and flow diagrams for each and all fluid circuits showing all valves, operators, and control components. (CDRL)
- G. Graphs and curves detailing response and functional characteristics for the car and for all subsystems and major components. (CDRL)

- H. Outline drawings of all major equipment components showing (CDRL):
1. Overall dimensions, orientation, center of gravity, points of normal support, and method of support during mounting and removal
 2. Location of access doors and covers showing the relation to equipment inside the enclosure
 3. Required drawout space and space required to open access doors
 4. Location and space requirements for ventilation intake and exhaust openings and cable entrances

Drawings shall be dimensioned in English units followed by equivalent SI units in parentheses. Drawings required to support design reviews shall be submitted to the purchaser prior to the scheduled review. The purchaser will have at least 15 days following receipt to advise the contractor of the findings of the purchaser's review.

Following purchaser review, one copy of each drawing shall be reviewed by the purchaser, stamped, signed by an authorized purchaser representative, dated, and returned to the contractor. Drawings stamped, NOT APPROVED, and with required corrections indicated shall be returned to the contractor for correction and resubmittal. Resubmittals shall be handled in the same manner as first submittals, but with specific attention directed to contractor responses to purchaser required corrections and to revisions not requested by the purchaser.

The review of drawings shall not be construed as permitting any departure from contract requirements, nor as relieving the contractor of the responsibility for any error, including details, dimensions, and materials.

19.3.6 CONTRACTOR PRODUCTION-DETAIL SPECIFICATION

The contractor shall submit to the purchaser a technical specification in the same format as this technical specification which amplifies the details required for production.

The contractor shall provide a draft version delineating the proposed differences from this specification. A preliminary specification marked, PRELIMINARY CONTRACTOR PRODUCTION BASELINE SPECIFICATION, shall be provided for the CDR with all differences and the reasons therefore clearly noted (CDRL). Revisions shall be provided as page replacements as changes occur. The document shall be submitted to the purchaser monthly.

Prior to completion of the contract, the contractor shall provide the final technical specification marked, FINAL CONTRACTOR PRODUCTION TECHNICAL SPECIFICATION, with all approved changes and revisions incorporated (CDRL).

19.3.7 CONTINGENCY RETROFIT PLAN (CDRL)

The contractor shall provide the purchaser with a contingency Retrofit Plan for accomplishing the following work following delivery:

- A. Correction or replacement of parts in accordance with contract warranty.

- B. Rework, replacement, or addition of parts in accordance with purchaser-approved changes

The plan shall include procedures for scheduling, assignment of work teams, and inspection of completed work as well as for maintenance of configuration records.

19.3.8 RECORD DRAWINGS PLAN

At the completion of the contract, the contractor shall provide the purchaser with a complete set of record reproducible drawings accurately representing the car in its final, as-built configuration, (CDRL) with all purchaser-authorized changes incorporated.

19.4 PERIODIC REVIEWS AND REPORTS

The contractor shall submit to the purchaser a Contract Data Requirements List (CDRL), as detailed in Section 23, which shall comprise all data to be submitted to the purchaser under this contract. Following purchaser-approval of the CDRL, the contractor shall maintain an accurate record of the status of required data for submission to the purchaser at the end of the contract (CDRL).

The general term, data, shall include the following:

- A. Administrative Reports Reports which include financial information, production status, or schedules
- B. Technical Reports Documents which record technical information, conclusions, and recommendations developed during design reviews, and engineering information activities related to this contract

- C. Other Data Information required to develop, test operate, maintain, repair, modify, support, or re-procure subsystems and equipment

19.5 QUALITY ASSURANCE PROGRAM (CDRL)

19.5.1 THE PROGRAM PLAN

The contractor shall establish and maintain a quality assurance program which shall provide objective, verifiable evidence of compliance with contract requirements and the contractor's design control procedures. A description of this system shall be included in a Quality Assurance Plan. Comments on the plan will be provided to the contractor by the purchaser within 30 days following receipt.

The plan shall include descriptions of:

- A. Equipment used to perform measurements and tests
- B. Inspection procedures
- C. Method used for selection and oversight of sub-contractors
- D. Procedures for correcting discrepancies discovered through the Quality Assurance Program
- E. Publications defining Quality Assurance procedures
- F. Systems for auditing Quality Assurance Program

The purchaser will have the right to verify the contractor's Quality Assurance operations at any time.

19.5.2 FACTORY FACILITIES INSPECTION

A. Receiving Inspection

The contractor shall provide for inspection of all incoming materials to ensure their correctness and proper condition. The purchaser will have the right to observe such inspections. Such inspections may utilize statistical sampling per MIL-STD-105. Items being inspected shall be identified to an applicable drawing, specification, or other pertinent technical document. All material certifications and test reports used as the basis for acceptance shall be retained by the contractor.

B. In-Process Inspection

The contractor shall ensure that all processing, fabricating, and other production operations shall be accomplished under an effective production control system. In-process inspection shall monitor the production control system. The purchaser will have the right to observe such inspections. The contractor shall establish and maintain a system for identifying the progressive inspection status of materials, components, subassemblies, and assemblies so that such status shall be known throughout the manufacturing, installation, and testing phases. The contractor's inspection program shall also provide for surveillance to ensure proper handling, storage, preservation, packaging and mark-identification of items during the production process.

C. Shipping Inspection

The contractor's inspection program shall provide for proper inspection, prior to shipment of the cars and of the other items deliverable to the purchaser under this contract. The purchaser will have the right to inspect each car. The

purchaser's authorization shall be secured prior to the shipment of each car.

D. Non-Conforming Material

The contractor shall establish and enforce a system for detecting non-conforming material, including procedures for its identification, segregation, and disposition. Repaired non-conforming material shall not be permitted.

19.5.3 SUPPLIER INSPECTION PROGRAM

The contractor shall examine the inspection programs of all of its first tier suppliers to ensure that the services and materials being supplied conform to contract requirements.

The contractor shall obtain from each subsystem supplier a certification that the method being used for installation and testing of that supplier's equipment or material by contractor personnel is satisfactory to the supplier. The contractor shall make such certifications available to the purchaser upon request.

19.5.4 CHANGE CONTROL INSPECTION PROGRAM

The contractor shall establish and maintain a procedure to control changes to drawings and specifications so that all inspections and tests shall be based on the latest purchaser-approved changes. The Change Control Inspection Program shall establish procedures for evaluation and purchaser review of the adequacy of each proposed change and shall ensure compliance with contractual requirements.

The contractor's responsibility for change control inspection shall extend to drawings and specifications provided by suppliers.

19.6

CAR COMPONENT SERIALIZATION PROGRAM

The contractor shall assign discrete serial numbers in sequence for the model series of each of the following:

- A. Air Compressors
- B. Air Conditioning Apparatus
- C. Axles
- D. Batteries
- E. Converters
- F. Couplers
- G. Destination Signs
- H. Door Operators and Controls
- I. Gear Units
- J. Journal Bearings
- K. Motors in any of the above
- L. Principal Units of Automatic Train Control
- M. Principal Units of Radio and Public Address Equipment (not including speakers)
- N. Principal Units of Traction and Braking Apparatus
- O. Temperature Control Apparatus
- P. Traction Motors, including Armatures
- Q. Truck Castings and Weldments
- R. Wheels
- S. Any other item of equipment customarily serially numbered

Within the period specified in the CDRL, the contractor shall submit to the purchaser a list of the items to be

serialized and a description of the serialization method to be used. The purchaser will return comments within 30 days following receipt of such information. (CDRL)

Serial numbers for equipment incorporated into each car shall be recorded in the appropriate Car History Book as specified in Section 19.7.

19.7

CAR HISTORY BOOKS (CDRL)

At time of delivery the contractor shall provide the purchaser with a Car History Book for each car. Each Car History Book shall contain the following car-specific information:

- A. Certified weight
- B. Description of modifications and completion dates of incorporation
- C. List of all defects noted and the disposition of each
- D. List of serially-numbered apparatus
- E. Provision for recording inspection, servicing, and major overhaul events
- F. Shipping documents
- G. Summary detail of each test performed on the complete car or on any part thereof
- H. Wheels, journal bearings, and gear mounting records

The contractor shall submit to the purchaser, for inclusion in the Car History Book, documentation recording changes made during the warranty period.



SECTION 20
SPECIFICATION COMPLIANCE PROGRAM AND TEST PROCEDURE



SECTION 20

SPECIFICATION COMPLIANCE PROGRAM AND TEST PROCEDURE

20.1 GENERAL

The complete passenger car, its subsystems and their components, shall be subjected to a comprehensive test program to assure conformance to the specifications.

The Contractor shall conduct the test program in accordance with the following requirements.

20.1.1 TEST PLAN AND PROCEDURES

The overall test plan and procedures shall be as specified in Section 18.7.

20.1.2 TEST COMPLETION AND STANDARDS FOR INTERPRETATION

The passenger car development and qualification tests will be considered complete when the following requirements are fulfilled.

A. Test Components

Components to be used for testing must be representative of production components. Any deviations from this requirement must be subject to approval from the purchaser. Components used for testing must be clearly identified as test components and, at the completion of testing, disposed of in accordance with the directions of the purchaser.

B. Final Test Report

A final test report shall be prepared documenting the results obtained and submitted for approval. The report shall be identified by a Contractor document number and shall refer to the Contractor part number and serial number of the test hardware. All pertinent test results (as well as a discussion of any deviations from the approved test procedure) shall be included. The test report shall also include any photographs and any additional data necessary to support the test results. Supplier test reports shall be approved by the Contractor prior to submittal to the purchaser. Three (3) copies of the report shall be submitted for approval to the purchaser within 15 days after completion of testing.

Test reports for test classified as commercial tests shall not be submitted for approval but shall be made available to the purchaser upon request.

C. Test Failure and Discrepancy Analysis

In the event that failures occur during any testing, a failure report shall be submitted to the purchaser. This report shall identify the unit being tested, identify the cause(s) of failure, indicate what corrective action is necessary, and the extent of such action. Where no change is determined necessary justification for the decision shall be provided. Where a failure occurs during testing, the testing shall be suspended pending evaluation by the purchaser as to the effect on testing completed and the need to conduct additional tests using new or reworked parts.

20.2 COMPONENT QUALIFICATION TESTS

20.2.1 GENERAL

A. Required Tests

Component level testing shall demonstrate that the design, construction and performance of the various components are valid and in compliance with the requirements of this specification.

Figure 20-1 lists the required component level testing to be conducted.

FIGURE 20-1. COMPONENT QUALIFICATION TESTS

- 20.2.2 Propulsion System
- 20.2.3 Electrical System Components
- 20.2.4 Truck System
- 20.2.5 Coupler and Drawbar System
- 20.2.6 Automatic Train Control (ATC)
- 20.2.7 Auxiliary Equipment Noise Tests
- 20.2.8 Door Systems
- 20.2.9 Seats
- 20.2.10 Friction Brake System
- 20.2.11 Signs
- 20.2.12 Air Conditioning
- 20.2.13 Communications

B. Waiver of Component Qualification Test

If the component to be tested has demonstrated through prior revenue service in the environment as specified in Appendix A that it meets the requirements as contained in this spe-

cification, the purchaser may waive the applicable qualification test. The purchaser will ensure that the component presented for waiver is representative of the production element in service.

20.2.2. PROPULSION SYSTEM

The following tests shall be performed on propulsion system components.

20.2.2.1 Motor Tests

Unless otherwise specified, all tests shall be made at the works of the motor manufacturer in accordance with the latest standards of the IEEE and under the supervision of the purchaser or his representative. The manufacturer shall furnish all necessary power, labor and equipment for the tests required. If any motor fails to meet the requirements of any test and it is found necessary to change to design or construction of any part or parts, the change or changes shall be incorporated in all of the motors furnished under these specifications.

In the event of such changes, repeat engineering tests shall be performed to verify that modified motors meet test requirements.

A. High Potential Insulation Tests

All motors shall be given high potential insulation tests in accordance with IEEE Standard No. 11.

B. Commercial Tests

Each motor shall receive commercial tests in accordance with IEEE Standard No. 11.

C. Engineering Tests

The motor selected by the purchaser's Inspector from the first lot of 50 commercially tested motors shall be subjected to the complete engineering tests in accordance with IEEE Standard No. 11.

20.2.2.2 Motor Control Tests

All control apparatus shall be tested at the manufacturer's plant.

The manufacturer shall furnish all necessary power, labor and equipment for the tests and inspections required. One of each of the components comprising the propulsion system including but not limited to the cam controller resistors, master controller and knife-switch fuse box shall be subjected to an approved engineering test. The engineering test shall include tests for shock, vibration and environmental considerations.

A. Commercial tests

Before shipment, each completed component shall be given an operating sequence test, including the calibration of all relays and the following dielectric tests:

The 32 volts conducting parts shall withstand an alternating current potential of 1000 volts continuously for one minute applied between conducting parts and ground and between switch and other contacts. The maximum leakage shall be 1 ma (resistive).

Diodes and/or transistors shall not be subjected to the high potential test.

B. Pneumatic Tests

Before leaving the manufacturer's plant, valves, cocks and air piping shall withstand an air pressure test of 100 psi (689 kPa). Switch groups shall withstand an air pressure test of 70 psi (48 2 kPa), after installation on the cars.

20.2.3 ELECTRICAL SYSTEM COMPONENTS

The following tests shall be performed on the electrical system components:

20.2.3.1 Converter and Inverter

A. Commercial Test

Each converter and inverter shall be subject to an approved commercial test.

The commercial test shall include a high potential test to verify that the insulation system is adequate. The high voltage circuits shall be subjected to 3,500 volts, 60 Hz for 1 minute without failure and the leakage current shall

not exceed 2.0 ma (resistive). The low voltage circuits shall be subjected to 1,000 volts, 60 Hz for 1 minute without failure and the leakage current shall not exceed 1.0 ma (resistive).

B. Engineering Test

One converter and inverter in each lot of 100, or less, shall be subject to an approved engineering test.

The engineering test shall include a test or tests to verify that: wave forms at all critical locations are in accordance with the manufacturer's design; the output voltage is maintained with the supply voltage varying between 450 and 650 volts; sufficient protective devices have been included to protect against transient voltage conditions; it has ample capacity; the variation of temperatures, vibration and load variations encountered in operation do not affect the operation or output; it does not generate voltage spikes on start, stop and on third rail gaps; and that the electrical interference does not adversely affect any other system.

20.2.3.2 Battery Charger

The battery chargers shall be subject to tests as detailed by the purchaser.

20.2.3.3 Battery

The battery shall be subject to tests as detailed by the purchaser.

20.2.3.4 Circuit Breaker Panels and Arc Chutes

Each circuit breaker panel and arc chute shall be given a surface high potential test of 3500 volts A.C. Any panel failing under this test shall be rejected. After the circuit breaker panels are assembled, they shall be given a one minute high potential test of 3000 volts A.C. for 600 volt parts and A.C. powered circuits (except that electronic solid state devices shall not be hi-potted), and of 1000 volts A.C. for battery voltage parts, the voltage being applied to conducting parts of opposite polarity.

20.2.4 TRUCK FUNCTION AND QUALITY ASSURANCE

20.2.4.1 General

A sample truck shall be tested over a major portion of the purchaser's operating lines at speeds up to the maximum design speed. The tests shall demonstrate the ride performance, confirm the primary and secondary suspension parameters, and verify the dynamic loads specified in Section 11.3.2.

The following tests shall be performed on all cast steel trucks.

Some of the quality control tests specified in this section may be omitted or other tests required, depending on the design and method of fabrication used. All testing shall be done in the presence of the purchaser. The contractor shall provide all testing instruments, materials, and labor necessary to the proper conduct of these tests. The cost of all such testing shall be borne by the contractor.

All truck frames in which defects are found during any of the following tests which, in the judgment of the purchaser, can be successfully repaired shall be deemed acceptable to the purchaser after such repairs have been made to the satisfaction of the purchaser. All defects shall be carefully monitored and corrective action taken as required.

Radiograph Inspection - Radiographs will be evaluated in accordance with ASTM Specification E446 and E142. The maximum permissible severity level of defect will be as follows:

<u>Category</u>	<u>Stress Level</u>	
	<u>Critical</u>	<u>Non-Critical</u>
A (gas porosity)	2	3
B (inclusions)	2	3
C (shrinkage)	2	3
D (crack)	None Permitted	
E (hot tear)	None Permitted	

20.2.4.2 Radiography Requirements

To demonstrate a satisfactory production, the following procedure shall be followed:

- a. Obtain five 100 percent radiographed production side-frames in a row without any unacceptable internal defects. These same five castings are to be 100 percent checked for wall thickness measurements and overall dimensioning.

The Manufacturer shall provide the purchaser with a detailed sketch of wall thickness measurement locations and required thicknesses. The purchaser will have the right to review and approve measurement locations.

b. After the successful production of five defect free truckframes (castings or weldments), the radiographic and wall thickness program will provide that, 1 in 25 of the successive production frames or bolsters (castings or weldments) will be 100 percent radiographed and 100 percent measured for wall thickness as indicated on purchaser approved sketches of same.

c. If the 1 in 25 production sideframe and bolster (casting or weldment) displays unacceptable (greater than Class II in critical and/or greater than Class III in non-critical areas, ASTM E-446) defects, then the production (castings or weldments) of the prior 2 sideframes or bolsters and the subsequent 2 sideframes or bolsters of the defect laden sideframe or bolster shall be 100% radiographed and evaluated. If no objectionable defects are found then the 1 in 25 program continues similarly.

d. If within the 2 prior and/or 2 subsequent sideframes or bolsters similar or other defects outside of acceptable class levels are detected, then a partial (area of defect) radiography evaluation shall be made on 4 additional prior and 4 additional subsequent side frames or bolsters (castings or weldments) using the original 1 in 25 sideframe or bolster as the central focus of the numbers of sideframes or bolsters to be radiographically evaluated.

After the contractor has demonstrated a satisfactory production process, one frame representing each lot of 35 frames produced shall be selected by the purchaser. This frame

shall be 100 percent radiograph inspected in the "as-cast" condition. If the radiographic quality specified is not attained, additional frames, as required by the purchaser, from the lot represented shall be similarly tested. The defects shall be repaired or the frames will be rejected. Repaired defects shall be radiograph inspected again.

20.2.4.3 Stress Test Procedure B

The following test shall be designated as "Stress Test Procedure B". Successive truck frames shall be subjected to a determination of residual stresses by strain gauges in which only the straight end rail shall be cut. This test shall be continued until four successive truck frames in addition to the two tested under "Test Procedure A" have met the stress specifications of 10,000 psi (68 950 kPa) maximum in tension or compression.

Thereafter one truck frame representing the first lot of 50 frames, one truck frame representing the second lot of 50 frames, and one truck frame representing each succeeding lot of 100 frames shall be subjected to "Stress Test Procedure B". In the event that the truck frame selected to represent any lot of frames fails to meet the residual stress specifications of 10,000 psi (68 950 kPa) maximum, an additional frame from the same stress relief heat treatment batch shall be selected for test. Should this second test frame fail to meet the specification of 10,000 psi (68 950 kPa) maximum residual stress, the entire stress relief heat treatment batch shall again be stress relieved and the test repeated.

Strain gauges for all tests shall be applied as directed by the purchaser.

Truck frames which have had only the end rail cut shall be acceptable to the authority after the end rail is welded and the truck frame has had additional stress relief heat treatment. Any cold pressing shall be followed by stress relief heat treatment. A record shall be kept of all truck frame serial numbers in each stress relief heat treatment. Recording pyrometer charts for all heat treating operations shall be furnished to the authority's representative. In the event that the charts show any departure from the approved procedure, for any stress relief heat treatment batch, the purchaser may require a specimen truck frame from that batch to be subjected to "Stress Test Procedure B" or the entire batch to be heat treated again.

After examination by the purchaser, a complete set of radiographs shall be delivered for final approval and storage. Densities of radiographic film shall be between 1.5 and 3.5.

20.2.4.4 Magnetic Particle Inspection

Magnetic particle inspection shall take place after all heat treating applications have been performed on castings or weldments. This is to include furnace heat treatments and/or local heat treatments of weld repairs.

Criteria for accept/reject for surface indications on castings or weldments shall conform to ASTM E-125.

<u>Type of Defect</u>	<u>Severity of Defect Permitted As Per Photo Number From ASTM E-125</u>
Cracks	None
Shrinkage	None
Inclusions	None
Porosity	None
Defective Welds	None

In the event the magnetic particle inspection indicates that the truck frame has injurious defects, the contractor shall take such corrective measures in its production methods as he deems necessary or desirable to eliminate those defects.

20.2.4.5 Residual Stress Test

This test is required for a one-piece cast truck frame only.

The following test shall be designated as "Stress Test Procedure A". Immediately following final stress relief heat treatment, the first truck frame produced shall have both end rails cut, the center transom nearest the dropped end rail cut, and the residual stresses in the frame determined by strain gauges. Residual stresses shall not exceed 10,000 psi (68 950 kPa) in tension or compression.

In the event that this truck frame indicates stresses above 10,000 psi (68 950 kPa) in tension or compression at any test point, the contractor shall take such corrective measures as he deems necessary or desirable. Thereafter, the next truck frame offered for inspection shall be similarly tested. This test shall be repeated on two successive truck frames until satisfactory procedures have been established to meet the above requirements.

20.2.4.6 Ultrasonic Testing

Prior to stress relief heat treatment, any portion of each frame that requires further examination due to defects found by the above methods of inspection shall be ultrasonic tested as per ASTM recommended practice for "Ultrasonic Testing By The Resonance Method", ASTM-E113. Defects revealed by this inspection shall be repaired only if a satisfactory

repair can be made. Such repaired defects shall be again ultrasonic tested, if required by the purchaser.

20.2.5 COUPLER AND DRAWBAR LOADING

20.2.5.1 General

A sample coupler and drawbar assembly shall be subjected to the load tests specified in this section. This test assembly shall be deemed acceptable to the purchaser as a production assembly if no defects are found during the testing and the test assembly is otherwise acceptable. Any revisions to the assembly affecting its capability to withstand the loads specified shall require additional testing.

20.2.5.2 Load Tests

Load tests shall be performed by the contractor with the following requirements:

- Apply the static design loads specified in Section 12.3 to the various components of the drawbar and coupler assembly by the contractor in the presence of the purchaser to demonstrate that the shear mechanism satisfies the strength requirements specified in Section 12.3.
- There shall be no visual permanent deformation, fractures, or cracks in any component.

A compression test shall be performed on a complete drawbar assembly by the contractor in the presence of the purchaser to demonstrate that the shear mechanism satisfies the strength requirements specified in Section 12.3.

20.2.5.3 Quality Control

Coupler and drawbar load tests identical to the tests specified in this section shall be performed on 1 in 200 coupler and drawbar assemblies. The test assemblies will be selected by the purchaser.

20.2.5.4 Radiographic Inspection

One casting representing each lot of twenty-five castings produced shall be selected by the Inspector for radiographic inspection at location selected by the purchaser to determine that the quality of the castings are of Class III or better according to ASTM Specifications E-446.

20.2.5.5 Coupler Head Functional Tests

A. Gathering Range

Two completely assembled drawbars including the coupler heads, but excluding the electric couplers, shall be mounted in a fixture designed for the purpose of establishing conformance with the approved profile diagram established from the gathering range specified in Section 12.2.1. One drawbar assembly shall be held rigidly except that provision shall be made for simulating vertical misalignment. The other drawbar assembly shall be a simulating vertical misalignment and allow forward movement of the car to be simulated. In addition, 5 degrees of rotation of each of the coupler heads shall be incorporated in the tests.

B. Lateral Force

Tests shall be made on the fixture described above to determine that the lateral forces required to move the coupler are within the limits specified in Section 12.2.1

C. Compatibility

Tests shall be performed in the fixture described above to determine that coupling and uncoupling can be made with air and manually with two couplers being provided under this Contract, and with one coupler being supplied under this Contract and one coupler head considered standard on the purchaser's property. A standard coupler head will be supplied to the Contractor for this purpose without cost to the Contractor.

D. Centering Device

Tests shall be conducted on the moving unit of the test fixture described above to determine that the automatic centering device functions properly and centers the drawbar to within 0.3" (0.8 cm) of the center line.

E. Shear Pin Removal

A Test shall be performed wherein the release mechanism is intentionally activated to determine that it functions as intended and required replacement elements can be installed readily. The test shall include both partially sheared pins and completely sheared pins, if shear pins are used in the release mechanism.

F. Manual Uncoupling Test

A test shall be performed to verify that the force necessary to manually uncouple two mated couplers in the buff condition using only one coupler lever does not exceed 110 pounds (49.9 kg) as measured on the end of the manual lever.

20.2.5.6 Functional Tests Electric Coupler

A. Functional Test

One end of a car set of electrical couplers shall be rigidly mounted in a fixture to be mated to a similar set of movable electrical couplers to establish that the equipment will function as specified.

Any component necessary to demonstrate that the equipment does function as specified shall be included in the test set-up.

B. Manual Operation Test

A test shall be performed to verify that the force necessary to manually retrieve the contacts of one electric coupler does not exceed 30 pounds (13.6 kg) in the uncoupled condition and 80 pounds (36.3 kg) in the coupled condition both as measured on the end of the manual lever.

20.2.6 AUTOMATIC TRAIN CONTROL (ATC)

The following tests shall be performed on the components comprising the ATC system:

20.2.6.1 Commercial Test

Each component comprising the ATC system shall be subjected to an approved commercial test.

20.2.6.2 Engineering Test

One component in each lot of 100 units shall be subjected to an approved engineering test.

20.2.7 AUXILIARY EQUIPMENT NOISE TESTS

Approved noise tests shall be conducted to meet the requirements of Section 3.4.2. Components to be tested prior to installation on the car shall include the following:

- a. Traction Motor
- b. Gear Unit
- c. Air Compressor
- d. Air Conditioning Compressor-Condenser Unit
- e. Air Conditioning Evaporator Unit
- f. Door Operator Assembly
- g. Converter
- h. Inverter
- i. Fluorescent Lamps and Ballasts

20.2.8 DOOR SYSTEMS

20.2.8.1 Side Door Performance Test

The Contractor shall provide, at the point of manufacture, a test rack duplicating the actual car's door pockets and containing one pair of side doors of the same size, weight, and type of mounting as specified for the passenger cars, the rack being arranged to permit the following tests to be made:

Before shipment of the first set of equipment, it shall be mounted upon the test rack together with the door operating light signals, accessory switches and other features, and tested as directed by the purchaser, to determine whether the equipment will function as specified. The connections between parts of the equipment shall be equivalent to the connections of the completed car.

All motors, magnet coils, relays and other parts of the equipment shall be tested for proper functioning before shipment.

20.2.8.2 Side Door Life Cycle Test

The door operating equipment mounted on the test rack specified in Section 20.2.8.1 shall be given a life cycle test consisting of one million operations of door opening and one million operations of door closing.

20.2.8.3 Electrical Tests

Each completed piece of electrical door operating and signal apparatus shall be subjected to the following dielectric test, to be made by the manufacturer at his plant, in accordance with the latest I.E.E.E. standards. The conducting parts shall withstand a potential of 1,000 volts, alternating current, applied for one minute between conducting parts and ground, and between switch or other contacts. Leakage current shall not exceed 1.0 ma (resistive).

20.2.8.3 Door Deflection Test

One side door, sliding end door, swinging end door and cab door shall be tested to determine that they are capable of sustaining a concentrated load of 200 pounds (90.8 kg) applied perpendicularly to the plane of the door at the center of the front edge of a single leaf on the passenger side of the doors. The deflection shall not exceed 0.25 inch (6.4mm). The door shall be supported in a horizontal plane on blocks having a top surface one inch wide and of sufficient length to support the entire door width. The blocks shall be placed at the ends of the door. The load may be applied in suitable increments, either by weights or pressure over a maximum area of 6 square inches (38.7 cm²).

The maximum load shall be applied for a minimum period of five minutes. Upon removal of the load, the door shall not show a permanent set.

20.9.2 SEATS .

The following tests shall be performed in the presence of and to the satisfaction of the purchaser on a sample cross and longitudinal seat to be selected by the purchaser completely assembled and fastened to fixtures simulating car interface and attachment.

20.2.9.1 Vertical Drop

Vertical drop impact to the seat with a 40 pound (18.2 kg) weight from heights of 6, 8, 10 and 12 inches (15.2, 20.3, 25.4 and 30.5 cm), 1000 drops for each height without failure.

20.2.9.2 Swinging Impact

Swinging impact with a 40 pound weight applied to the back from one direction for the longitudinal seat and from both directions for the cross seat. Test shall include impact through distances of 6, 8, 10 and 12 inches (15.2, 20.3, 25.4 and 30.5 cm), 10,000 strokes for each distance without failure.

20.2.9.3 Scratch Resistance

Scratch resistance of fiberglass surface shall be tested with a "Hoffman Scratch Tester". An acceptable surface shall require a minimum of 1000 gram load on the tester to cause appreciable scratching.

20.2.9.4 Vertical Load

Vertical load test on a longitudinal seat. A fixed load of 200 pounds (90.8 kg) shall be applied to the center of each

outboard seat position. A variable vertical load of 800 pounds (363 kg) shall be applied to the center of the front edge of the opposite aisle seat position. After removal of the load, the permanent set or deformation shall not exceed 1/16 inch (1.6 mm).

20.2.9.5 Horizontal Load

Horizontal load test on a cross seat assembly of a four passenger seat. A horizontal load of 500 pounds (227 kg) shall be applied to the stanchion base at the tope of the seat back. The test shall be made for the four (4) positions corresponding to the longitudinal and lateral axes of the car. After removal of the load at each position, the permanent set or deformation shall not exceed 1/16 inch (1.6 mm) at the point of load application

20.2.10 FRICTION BRAKE SYSTEM

20.2.10.1 Electrical Tests

Current carrying parts of each complete set of air brake apparatus shall be given the following dielectric tests by the manufacturer, at his plant, in the presence of the purchaser's Inspector, the method conforming to the latest Standards of the I.E.E.E. The 32 volt conduction parts shall withstand 1000 volts A.C. continuously for one minute between conductors, and between conductors, and between conductors and ground. Leakage current shall not exceed 1.0 ma (resistive). The 600 volt conducting parts shall withstand 3500 volts A.C. applied continuously for one minute between conductors and between conductors and ground. Leakage current shall not exceed 2.0 ma (resistive).

20.2.10.2 Compressor Unit

A. Commercial Tests

Each compressor unit shall be subjected to an approved commercial test.

B. Engineering Test

One compressor unit from each lot of 50 or less shall be subjected to an approved engineering test.

20.2.10.3 Reservoirs

One reservoir of each type from each lot of 100 or less shall be subjected to a hydrostatic test of 280 psi (1929 kPa) and an air test of 160 psi (1102 kPa) without leakage.

20.2.10.4 Miscellaneous Parts

All electrical and pneumatical components of the friction brake system shall be subjected to an approved commercial test.

20.2.11 SIGNS

20.2.11.1 Commercial Tests

Each side and end sign shall be subjected to an approved commercial test.

20.2.11.2 Engineering Test

One side and one end sign shall be subjected to an approved engineering test.

20.2.12 AIR CONDITIONING

20.2.12.1 Commercial Tests

Each compressor-condenser unit and its components and each evaporator-blower unit and its components shall be subjected to an approved commercial test at their manufacturer's plants. Each motor for compressor-condenser and evaporator-blower unit shall be subjected to the most thorough and minute inspection including an approved high potential test.

20.2.12.2 Engineering Tests

One unit of each of the major components of the air conditioning system shall be subjected to an approved engineering test.

20.2.13 COMMUNICATIONS

20.2.13.1 Public Address System

A. Amplifier

Each amplifier shall be subjected to an approved commercial test. The amplifiers shall be tested 24 hours of continuous operation at 44 volts d.c. power source, 1 KHz sine wave input, and 5 watts output. No component in the amplifier shall exceed its rated capacity during the 24 hour test period.

The amplifiers shall be tested at 20 watts power output for 15 minutes.

A certified test report shall be submitted by the Contractor of five samples covering all items of this specification.

These test reports shall follow as to form, RETMA Standard SE-104. The purchaser reserves the right to require the contractor to submit a certified test report of five samples from an independent testing laboratory.

B. Microphone

Each microphone plate shall be subjected to an approved commercial test.

One microphone plate assembly shall be tested to confirm that the microphone protective dome can withstand a drop test of a one pound steel ball from a height of 6 feet (18.3 cm) for a duration of ten repetitive blows without cracking or permitting any damage to the microphone element, or any other element mounted on the plate.

Each voice operated microphone and relay shall be subjected to an approved commercial test.

C. Loudspeakers

Each loudspeaker shall be subjected to an approved commercial test. This requirement shall also include the loudspeaker located on the operator's console.

20.2.13.2 Intercom System

A. Engineering Test

One intercom system shall be subjected to an approved engineering test.

B. Commercial Test

Each component comprising the intercom system shall be subjected to an approved commercial test.

20.2.13.3 Train to Wayside Radio

A. Commercial Test

Each radio transmitter-receiver shall be subjected to an approved commercial test.

B. Engineering Test

The Contractor shall submit a detailed test report from an approved accredited Radio-electronics test laboratory certifying that the Radio-Transmitter-Receiver supplied under this Contract meets every requirement of this specification.

20.3 SUBSYSTEM QUALIFICATION TESTS

20.3.1 GENERAL

A. Required Tests

Subsystem level testing shall demonstrate compliance with the requirements of this Specification.

Figure 20-2 lists the required subsystems qualification tests.

FIGURE 20-2. SUBSYSTEM QUALIFICATION TESTS

- 20.3.2 Propulsion System
- 20.3.3 Friction Brake System
- 20.3.4 Car Body System
- 20.3.5 Air Conditioning System
- 20.3.6 Heating System
- 20.3.7 Safety
- 20.3.8 Truck System
- 20.3.9 ATC System

B. Waiver of Subsystem Qualification Test

If the component to be tested has demonstrated through prior revenue service in the environment as specified in Appendix A that it meets the requirements as contained in this specification, the purchaser may waive the applicable qualification test. The purchaser will ensure that the subsystem presented for waiver is representative of the production element in service.

20.3.2 PROPULSION SYSTEM

One complete propulsion system shall be subject to an approved engineering test to ascertain that the equipment performs all of the specified functions within permitted tolerances.

The manufacturer shall furnish all necessary power, labor and equipment for the tests and inspections required.

At the conclusion of the engineering test, the equipment shall be returned to the shop, put in first class condition and given the regular commercial test before shipment. In

the event that the engineering test results are not satisfactory, the purchaser may direct that any additional equipment be tested or that the entire lot represented by the test be rejected.

The equipment testing shall be arranged with the traction motors coupled to a flywheel representing the kinetic energy of the car.

Electrical parameters shall be tested at values 10% higher than the maximum encountered in normal operation.

20.3.2.1 Operation

All acceleration and braking sequences and functions shall be demonstrated on the test floor. Complete operating results shall be taken by instruments and recorded according to the approved engineering test code.

20.3.2.2 Temperature Test

One line switch and control box shall be connected in the full speed running position and temperature readings taken until all apparatus reaches a constant temperature. Observed temperatures shall not exceed those allowed by I.E.E.E. standards.

The line switch and those switches in the control box which carry two-motor current during the power-on period only shall be tested at 70 percent of double the continuous rating of each motor. Other main circuit switches in the control box shall be tested at the continuous rated motor current.

20.3.3 FRICTION BRAKE SYSTEM

Upon the completion of each car at the Contractor's plant, air brake apparatus, including piping, shall be thoroughly tested for leakage and general workability, including the adjustment of the variable load valve to empty and loaded conditions.

The allowable leakage for the complete air system including the air dryer and air suspension shall not exceed 5 psi (34 kPa) in 10 minutes from a pressure of 150 psi (1034 kPa).

20.3.4 CAR BODY SYSTEM

20.3.4.1 Rivet Test

If used, every rivet shall be hammer and edge tested and if found loose, or with heads not concentric or improperly formed shall be cut out and replaced.

20.3.4.2 Weld Test

A. General

Each weld shall be carefully inspected and all exposed welds shall be ground and smooth and polished. No more than 10 percent of thickness of parent material shall be ground. Relief from any polishing shall be granted only by the purchaser.

B. Spot Weld Test

Sample specimens of materials used in structural spot welding applications shall be subjected to the following tests prior to each day's production and at periodic random samplings

each day to ascertain that the integrity of the spot welding is being maintained. The specimens shall be identical to that used on the car (composition and thickness) and shall be welded under conditions duplicating regular production spot welding machine settings, cleaning preparation, use of sealers.

C. Tension Shear Test

Two specimens shall be lapped and spot welded together with a single spot. The specimen shall be subjected to tension loading in a standard tension testing machine to destruction. The strength and ductility of the weld shall be approved.

D. Peel Test

Two specimens shall be lapped and spot welded together using three spot welds. The specimens shall be peeled apart to destruction. Weld penetration and shunting effect (weld size) shall be approved.

20.3.4.3 Water Test

The completed car shall be watertight. The car shall be subject to water tests on roof, side frame complete, windows, doors and car ends, to simulate as closely as practicable, the condition of the car body being struck by heavy rainfall and the condition of car washing operation.

Insulation shall be omitted from the carbody except where structure interferes with installation after sheathing is applied. The car body shall contain all parts which assist in making it water tight. It shall be permissible to sub-

stitute plates for doors and windows provided they are properly sealed and that a retest of the completed car with windows and doors installed is performed.

Water Operating Pressure shall be 45 psi + 10 -5 psi (310 kPa, + 69 -34 kPa) at each nozzle. The nozzles shall have an orifice of 1/4 inch + 1/16 -0 inch (.63 cm+.15 -0 cm) to provide semi-automation in a conical pattern having approximately 65 degrees included angle. The nozzles shall be held 46 to 84 inches (117 to 213 cm) from the work. The nozzles shall be spaced so as to provide overlap of the spray cones sufficient to cover all of the are being sprayed.

The initial spray application shall be uninterrupted for not less than 10 minutes before inspection for leaks is started. The spray shall be in operation during inspection.

Each subsequent spray application shall be uninterrupted for not less than 10 minutes if the shutdown period has been in excess of 2 hours.

The water test area shall be suitably heated in cold weather and testing shall be of duration to demonstrate water tightness of the carbody to the satisfaction of the purchaser.

20.3.4.4 Loading Tests

A. General

A sample car carbody structure shall be subjected to the load tests specified in this section. This test car shall be deemed acceptable to the purchaser as a production car if any defects found during the testing are repaired to the satisfaction of the purchaser and the test car is otherwise acceptable.

Additional tests may be specified by the purchaser to verify the results of structural calculations, as required. Any revisions to the structure affecting its capability to withstand the loads specified shall require additional testing.

During the load tests, the floor plan shall be omitted in selected areas designated by the purchaser.

B. Vertical Load Test

A carbody vertical load test shall be performed by the contractor with the following requirements:

1. The car shall be subjected to 1.6 times the total static vertical load consisting of the following:
 - a. AWO load between bolsters at actual locations, plus,
 - b. AW3 - AWO load distributed uniformly over the length of the car, plus
 - c. An allowance for vertical impact of 30 percent of loadings described above.
2. Loads shall be applied in at least five (5) increments and removed in reverse order.
3. Maximum stress in any material, except the carbody bolsters, under the maximum above loading shall not exceed 80 percent of the specified yield stress. For the carbody bolsters, the stress shall not exceed 64 percent of the yield stress.

4. Strain gauges shall be located as per drawing of car structure and readings of each gauge at each load level shall be recorded. Approximately 150 strain gauges shall be used.
5. There shall be no visual permanent deformation, fractures, cracks, or separations in car structure.
 - a. Any broken welds shall be jointly examined by the contractor and the purchaser to determine if failure is the result of weld quality or stress.
 - b. Any elastic buckling of roof skin or side skin shall not be considered a failure of this load.
6. Vertical deflections at each side of centerline of car shall be recorded for each level of vertical load and shall not exceed the requirements of Section 7.1.2.

C. Compression Test at the Anticlimber

A carbody compression test at the anticlimber shall be performed by the contractor with the following requirements:

1. The car shall be subject to a static compression as specified in Section 7.2.1.
2. Strain gauges shall be located as per drawing car structure and readings of each gauge at each load level shall be recorded. It is anticipated that approximately 100 of these gauges will be located in the same position as the gauges required under the carbody vertical load test.

3. There shall be no visual permanent deformation, fractures, cracks, or separations in car structure.
4. Any broken welds shall be jointly examined by the contractor and the purchaser to determine if failure is the result of weld quality or stress.
5. Vertical deflections at each side of centerline of car shall be recorded for each level of compression load and shall not be greater than 0.33 inches (8.38 mm) between body bolsters.

D. Compression Test at the Coupler

A carbody compression test at the coupler shall be performed by the contractor with the following requirements:

1. The car shall be subjected to a static compression as specified in Section 12.3.
2. The compression load shall be applied in at least five (5) increments and removed in reverse order.
3. Strain gauges shall be located as per no. 2 of the carbody compression test at anticlimber described above, and readings of each gauge at each load level shall be recorded.
4. There shall be no visual permanent deformation, fractures, cracks, or separations in car structure.
5. Any broken welds shall be jointly examined by the contractor and the purchaser to determine if failure is the result of weld quality or stress.

6. Vertical deflections at each side of centerline of car shall be recorded for each level of compression load and shall not be greater than 0.33 inches (8.38 mm) between body bolsters.

E. Load Test of Forward Collision Post and Corner Posts

A loading test of the forward collision post and corner post structures at the cab end shall be performed by the contractor with the following requirements:

1. The car shall be subjected to static loads as specified in Section 7.2.4.
2. Each load shall be applied in at least five (5) increments and removed in reverse order.
3. Maximum stress in any material under the maximum above load shall not exceed 80 percent of the specified yield stress.
4. Strain gauges shall be located as per drawing of car structure, and readings of each gauge at each load shall be recorded. Approximately 50 strain gauges shall be used. In addition, approximately 50 gauges of those required under the carbody compression test at the anticlimber will be utilized.
5. There shall be no visual permanent deformation, fractures, cracks, or separations in car structure.
6. Any broken welds shall be jointly examined by the contractor and the purchaser to determine if failure is the result of weld quality or stress.

F. Load Test of End of Car

A loading test of the end of car structure at the cab end shall be performed by the contractor with the following requirements:

1. The car shall be subjected to a static vertical upward load of 80,000 pounds (36 287 kg), applied on the centerline of the car at the anticlimber. This loading test may be combined with the carbody vertical load test described above, to provide resistance to the applied load.
2. Loads shall be applied in at least five (5) increments and removed in reverse order.
3. Maximum stress in any material under the maximum above load shall not exceed 80 percent of the specified yield stress.
4. Approximately 50 strain gauges of those required under the carbody vertical load test will be utilized, and readings of each gauge at each load level shall be recorded.
5. There shall be no visual permanent deformation, fractures, cracks, or separations in car structure.
6. Any broken welds shall be jointly examined by the contractor and the purchaser to determine if failure is the result of weld quality or stress.

G. Torsion Load Test

A torsion load test shall be performed on a sample car structure in the presence of the purchaser with the following requirements. End frames and bulk head may be applied with all auxiliary structure and stiffeners in place.

1. Apply jacks to each of the four jacking pads at body bolsters and load car on jacks with the car off the trucks. Car shall have simulated equipment load between bolsters at actual location.
2. Raise one jack until car raises from any of the other three jacks.
3. Strain gauges shall be located as per Item 3 of the body compression test specified in Section 20.3.4.4E.
4. Maximum recorded stress of any material under any of the above requirements shall not exceed 50 percent yield as specified in Section 7.2.7.
5. The distance jack is raised for car to clear a second jack shall be recorded.
6. There shall be no visual permanent deformation, fractures, cracks or separations in car structure.
 - a. Any broken welds shall be jointly examined by the Contractor and the Authority to determine if failure is the result of weld quality or stress.
7. Test shall be repeated by using the opposite jack on the same end of car.

H. Quality Control

Carbody load tests identical to the tests specified in this Section shall be performed on one car from the first lot of 50 cars, one car from the next lot of 50 cars and one car from each succeeding lot of 100 cars. The test cars shall be selected by the purchaser.

I. Door Operation Test

A door operation test of a fully equipped A Car shall be performed by the Contractor in the presence of the purchaser with the following requirements:

1. Apply a load of 45,000 pounds (20385 kg) uniformly distributed over the length of car and a load of 10,000 pounds (4530 kg) uniformly distributed between bolsters.
2. Open and close all doors 5 times.
3. There shall be no interference with the operation of any door.

20.3.5 AIR CONDITIONING SYSTEM TESTS

20.3.5.1 Air Distribution

The air distributors in one A car and one B car shall be adjusted in a hot room test. The hot room shall be maintained at 105°F (41°C) ± 2° dry bulb and 80°F (26°C) ± 2° wet bulb. The car shall be pre-soaked in this environment for approximately 8 hours prior to turning on the air conditioning system. After the thermostat has been satisfied for its low cooling requirement, the air distribution shall be adjusted to meet the following criteria:

1. The air velocity throughout the car at a height of 66 inches (168 cm) above the floor shall not exceed 75 feet (22,9 m) per minute.
2. The temperature throughout the car shall be uniform within a tolerance of 2°F.
3. The air pattern shall be in a lateral direction where the outer louvers "wash" the car's ceiling and windows and the center louvers distribute air approximately 45 degrees from the vertical centerline.

The louvers of the distributors of the remaining cars shall be permanently fixed as determined above before installation on the cars.

20.3.5.2 Air Rate Test

A test shall be performed on one A car and one B car to verify that the rate of fresh air delivered to and the rate of recirculated in the car is as specified in Section 17.1.1A. During this test, the windows and doors shall remain open.

20.3.5.3 Pressurization Test

A test shall be performed on one A car and one B car in a hot room described in Section 20.3.5.1 to determine that with all windows and doors closed there is positive pressurization of the car while one air conditioning system in the car is operating in the high cooling mode and positive pressurization of the car while two air conditioning systems in the car are operating in the high cooling mode as specified.

20.3.5.4 Pulldown Test

A test shall be performed on one A car and one B car in a hot room described in Section 20.3.5.1 to determine that the time required for initial pulldown of temperature from hot room environment to thermostat setting is no more than 20 minutes.

20.3.5.5 Capacity Test

A test shall be performed on one A car in a hot room maintained at 105°F (41°C) ± 2°F dry bulb and 80°F (26°C) ± 2°F wet bulb to verify and demonstrate that the air conditioning system causes the temperature within the car to fall and be maintained as specified.

The test shall be run on a car that: has been pre-soaked in the hot room environment for approximately 8 hours; has all windows and doors closed; has the cab air diffuser closed; and has floor heat units evenly distributed throughout the car to simulate passenger load.

For a 240 passenger load (twenty-eight floor heat units at 1 KW per unit) the temperature shall not exceed 75°F (24°C) dry bulb and 62.6°F (17°C) wet bulb.

20.3.6 HEATING SYSTEM TEST

A test shall be performed in one A car in a cold room maintained at 0° F (-19°C) to demonstrate that the heating system meets the following criteria. The car shall be soaked in the environment for approximately 8 hours prior to the start of the test.

1. The time required for initial raising the temperature of the interior of the car from cold room environment to the thermostat setting of 59°F (15°C) shall be determined.
2. Verify that blower fans are operating at their reduced capacity during the entire heating cycle.
3. The temperature within the car shall be maintained at 59°F (15°C).
4. The temperature throughout the car shall be uniform within a tolerance of 2°F (-17°C),
5. The car temperature shall be so maintained at 50°F (10°C) during the "lay-up" cycle.
6. The rate of fresh air and recirculated air moved in the car shall be verified to be as specified.

20.3.7 SAFETY TESTS

Tests shall be conducted in accordance with the Contractor's system safety plan as specified in Section 18.5.2.

20.3.8 TRUCK SYSTEM TEST

Each completed truck shall be subjected to an approved commercial test.

20.3.9 ATC SYSTEM TEST

Each set of ATC equipment shall be subjected to an approved commercial test. In addition each set of ATC equipment shall be functionally tested using input signals identical to that existing on the purchaser's property.

20.4

CAR-LEVEL TESTING

20.4.1

GENERAL

Car-level qualification testing shall demonstrate that the design of the consist and the individual subsystems comprising it are valid and in compliance with the requirements of this Specification. Unless otherwise specified, the consist for qualification testing shall be a minimum consist as defined by the purchaser in the procurement documentation.

Car-level testing shall demonstrate that printed circuit boards are interchangeable without affecting car performance.

Figure 20-3 lists the required car-level qualification tests and indicates the appropriate location for each test. The instrumentation requirements for each test are listed in Figure 20-4.

20.4.1.1

Acceleration Performance Test

A. Objective

The test objective shall be to demonstrate that the acceleration performance requirements specified in Section 3 have been met.

B. Requirements

The consist shall be accelerated to traction motor base speed. If discrete acceleration commands are employed, the consist shall be accelerated at each value in turn.

C. Conduct

Accuracy of propulsion system response to command level and excursion from nominal rate shall be measured for comparison with the requirements of Section 3.3.3.

The consist shall then be accelerated at maximum rate to design maximum speed to acquire data needed for comparison with time-to-speed and continuous speed specification requirements.

The above tests shall be performed with each car weight at no less than AW2 weight specified in Figure 3-2 and shall be performed in both directions over the same track section to equalize grade and wind effects.

The consist shall also undergo a series of tests during which trainline propulsion commands are modulated in all manners permitted by Sections 3 and 14. Modulation and manipulation shall not be restricted to "normal" operation so that the ability of the propulsion subsystem to protect itself and maintain passenger comfort under conditions of "abnormal" automatic or manual operation can be demonstrated. In addition to the requirements of Figure 20-4, subsystem interface signals shall be recorded as a function of time. The tests shall demonstrate proper jerk-limit operation (except under specifically exempted conditions) and shall show that equipment dead time for propulsion and friction brake systems is within specified limits. Tests shall also be conducted to acquire data to demonstrate that interface signals between the propulsion/dynamic brake and friction brake subsystems are within the accuracy requirements needed to produce subsystem and car system performance within the tolerances specified in Section 3. Motor voltages and currents shall be recorded for each propulsion subsystem.

FIGURE 20-3
CAR-LEVEL QUALIFICATION TESTS

Type of Test		Test Locations		
		Contractor	Authority	TTC
20.4.1.1	Acceleration Performance	-	0	X
20.4.1.2	Braking	-	0	X
20.4.1.3	Duty Cycle and Regeneration*	-	X	0
20.4.1.4	Radio Frequency Interference	-	X	0
20.4.1.5	Emergency Systems	-	0	X
20.4.1.6	Ride Quality	-	X	0
20.4.1.7	Noise	-	X	-
20.4.1.8	Vibration	-	X	-
20.4.1.9	Inter-Car Interference	X	0	-
20.4.1.10	Loaded Car Door System	X	-	0
20.4.1.11	Parking Brake	X	0	-
20.4.1.12	Weight Distribution	X	0	-
20.4.1.13	Maintainability Demonstration	-	X	-

Key: 0 indicates Authority or TTC may require test to be performed on their trackage. X indicates mandatory test sites for car.

Note: For new major subsystem design, refer to Figure 20-7.

* Chopper option

FIGURE 20-4

INSTRUMENTATION REQUIREMENTS FOR QUALIFICATION TESTS

Test No.	Title	Traction Motor		Acceleration	Brake Cylinder Pressures	Rate Commands	Mode Commands	Axle Speed	Line	
		Current	Voltage						Voltage	Current
20.4.1.1	Acceleration Performance (1)	X	X	X	X	X	X	X	X	X
20.4.1.2	Braking Performance (1)	X	X	X	X	X	X	X	-	-
20.4.1.3	Duty Cycle	X	X	X	X	X	X	X	X	X
20.4.1.4	Radio Frequency Interference (RFI) (1)	X	-	X	X	X	X	X	X	X
20.4.1.5	Emergency Systems (2)	-	-	-	-	-	-	-	-	-
20.4.1.6	Ride Quality (1)	X	-	X	X	-	X	X	-	-
20.4.1.7	Noise (1,2)	-	-	X	-	-	-	X	-	-
20.4.1.8	Vibration (1,2)	-	-	-	-	-	-	-	-	-
20.4.1.9	Inter-Car Interference (2)	-	-	-	-	-	-	-	-	-
20.4.1.10	Parking Brake (1)	-	-	-	-	-	-	-	-	-
20.4.1.11	Weight Distribution (2)	-	-	-	-	-	-	-	-	-
20.4.1.12	Maintainability Demonstration (2)	-	-	-	-	-	-	-	-	-

(1) Additional test-specific instrumentation requirements are noted in test text.

(2) Instrumentation is hardware-specific or site-specific and shall be supplied as needed to meet the test requirements.

20.4.1.2 Braking Performance Test

A. Objective

The test objective shall be to demonstrate that the braking performance requirements specified in Section 3 have been met.

B. Requirements

A consist, with each car weight at no less than the AW3 weight and with each car at the AWO weight specified in Figure 3-2, shall be operated at each discrete braking level command, or if a continuously variable trainline command is employed:

1. at the minimum
2. 80 percent
3. 100 percent command levels
4. plus any additional command levels defined in Section 15 as critical to automatic train control

C. Conduct

Blended braking tests shall be conducted from design maximum motor speed at each braking command noted above. Regeneration shall not be employed. Friction braking tests shall also be conducted at each command level, including emergency. Each test group shall be performed with brake initiation at speed increments of 20 mph (32 kmh) from a speed of 20 mph (32 kmh) to design maximum car speed. In addition to the requirements of Figure 20-4, subsystem interface signals shall be recorded as a function of time. The instrumentation shall permit demonstration that blended and friction braking have the required accuracy of trainline response, that excursions

outside the normal specified values are within specified limits, that blending functions maintain the command rate within specified limits throughout the transition from one brake system to another, and that jerk-limit requirements are met.

20.4.1.3 Duty Cycle Test

A. Objectives

The test objectives shall be:

1. To verify that motor amperes experienced are within traction equipment design limits, and that braking resistors, friction brake equipment, and traction power conditioning equipment are not stressed thermally beyond specification limits.

Chopper Option

2. To demonstrate safe and proper operation of the regenerative system when a power system gap is encountered and when a grounded or deenergized section of the power system is encountered, as required by Section 14.
3. To establish regenerative system energy consumption.

B. Conduct

The consist shall be operated over a simulated or actual average route profile as specified in Section 3.3.4 and Appendix A while loaded to the car weight values specified in Section 3. The profile run shall be performed on a fully loaded receptive power system. In addition to the requirements of

Figure 20-4, instrumentation shall record as a function of time: rms amperes, kilowatt-hours consumed, friction braking surface temperatures, and underfloor temperatures at those points identified as significant with regard to conducted and radiated heat.

C. Instrumentation

Temperature measuring devices shall be augmented by temperature-sensitive chemical or physical indicators. The measuring devices shall have the thermal inertia appropriate for the individual application.

D. Regeneration (Chopper Option)

A regenerative energy consumption test shall be performed. The test parameters shall be as follows:

1. Level tangent track or duty cycle as specified in Section 3.3.2.
2. Initial speeds of 50 and 80 mph (80 and 130 kmh)
3. Contact rail voltages without regeneration of 620 VDC, 675 VDC and maximum level.
4. Braking rates of 2 and 3 mphps (3.22 and 4.83 kmhps)
5. Dependent-pair
6. Empty car weight (AWO)
7. On level tangent track and in still air, the traction resistance of the car(s) shall be calculated based on the modified Davis equation as specified in A.4, Appendix A.

●20.4.1.4 Radio Frequency Interference (RFI) Test

A. Objectives

The test objective shall be to verify that the vehicle does not produce radiated emissions beyond those permitted in Section 4.

B. Location

Measurements shall be taken on the purchaser's property at the speeds and modes of operation and with the car loads specified in the acceleration performance test of Section 20.4.1.1 and the braking performance test of Section 20.4.1.2. Alternatively, and only as a last resort, adjustments may be made to traction motor currents to simulate the loaded car conditions.

C. Conduct

The test procedures shall be those established in MIL-STD-461R for measurement of vehicle radio interference for Class IIIC and Class IIID equipment in the frequency range as follows:

* _____ The tests shall be performed with dipole antennas mounted at a distance of 50 feet (15.2 m) from centerline of track perpendicular to the direction of consist motion. Dipole antennas shall be polarized both vertically and horizontally to define the plane of maximum interference. Loop antennas mounted on the moving consist shall also be used for measurements in the frequency range of 0.014 MHz to 30 MHz.

Each test run shall be performed at least twice to determine average values. In addition to pass-by runs, measurements shall be made under all accelerating, braking, and mode

* Purchaser completing detail

change conditions of which the car and its subsystems are capable. Auxiliary systems shall be tested for Class IIIB conditions measured at the speed and load conditions stated in the second paragraph of this test. The sources of the greatest emissions shall be identified to the extent possible.

20.4.1.5 Emergency System Test

A. Objective

The test objective shall be to demonstrate that the emergency systems, as designed, constructed and integrated with other car subsystems, are in compliance with Section 3.

B. Conduct

Tests shall be conducted in accordance with approved test procedures, Section 18.7, which subject all emergency system features to all identified emergency conditions. These shall include emergency brakes, emergency communications, emergency lights, emergency door features, and any other defined emergency features.

C. Requirement

Tests shall assure that emergency system functions cannot be defeated by improper actions on the part of train personnel or the public within the limits of the physical protection possible in each specific area. Instrumentation shall be provided to measure emergency system response so that comparison of operation with specified limits can be made.

20.4.1.6 Ride Quality Test

A. Objective

The test objective shall be to demonstrate that the g forces seen within the car and/or the natural suspension frequencies are in accordance with Sections 3 and 11. The consist shall be operated on the purchaser's property or, if a new property without sufficient trackage, on an existing property that most readily duplicates the conditions of the new property.

B. Conduct

Operation shall be at speeds from 10 mph (16 kmh) to design maximum speed at 10 mph (16 kmh) increments and at speeds which are calculated or determined to produce the natural frequencies of trucks, car structures, and suspension systems. Operation at identified critical speeds shall be with all conditions of passenger loading specified in Section 3.

C. Instrumentation

The consist shall be instrumented to record: velocity; and acceleration in three axes on the car floor, at the car center, and over the forward truck center pivot. Accelerometers shall have scales proper for the specific application and shall be damped to minimize response above 20 Hz. Chart recordings shall become the permanent record. The contractor shall also tape record data for computer analysis to demonstrate specification compliance. The output shall be in the form of a spectral band analysis for each plane of motion.

20.4.1.7 Noise Test

A. Objective

The test objective shall be to demonstrate compliance with Section 3.4.2.

B. Conduct

1. Exterior Tests shall be performed in the reproducible Standard Test environment at a site to be designated by Transit Industry consensus. With the consist stationary, measurement shall be made of the sound pressure levels of all auxiliary power devices simultaneously energized. Wayside sound pressure levels shall be measured with the minimum consist passing at the speeds and distances specified in Section 3.4.2. Results shall be analyzed to determine the critical speed areas. Additional tests shall be conducted at the critical speeds for compliance with the values stated in Section 3.4.2.
2. Interior-Stationary With the consist stationary, car interior noise measurements shall be made 4 feet (1219.2 mm) above floor level at least 1 foot (305 mm) from any wall, and directly above the outline of each undercar noise source. For interior noise sources, measurements shall be made in a horizontal plane 5.5 feet (1676.4 mm) above the floor both along the car centerline and under noise sources. At all points in these planes more than 1 foot (305 mm) from a wall, the sound pressure levels shall not exceed those stated in Section 3.4.2. Measurements of sound pressure levels shall be made as specified above for all noise sources operating simultaneously.

3. Interior-Moving With the consist in motion and with all interior noise sources operating, car interior noise measurements shall also be taken. The consist shall be operated at the previously specified speeds and at identified critical speeds. Measurements shall be made at the above-specified distances and locations within the car, and performed with a contractor-provided, purchaser-approved, sound level meter using the fast response, A-scale setting.

20.4.1.8 Vibration Test.

A. Objective

The test objective shall be to demonstrate compliance with Section 3.4.3.

B. Conduct

Interior vibration shall be measured on the purchaser's property at the interior surface which is in contact with the passenger space and nearest the vibration source. Measurements shall also be made at points within the car which respond audibly or visibly to the vibrations.

Vibration from components mounted on the body, on the truck frame, or on the axle shall be measured at the specified points or within the specified region.

C. Requirements

Vibration readings shall be taken, first, with the consist stationary and, again, with the consist in operation at the speeds at which wayside sound measurements were taken and at speeds which are found to be critical for initiating vibration in the passenger space. Vibration levels shall be accelerometer-measured in three axes and chart recorded.

The body-mounted equipment shall be given the following number of applications and shall produce the maximum peak g levels as measured by a device mounted near the center of gravity of the equipment.

<u>Direction</u>	<u>g Level (Max Peak)</u>	<u>Time Base (Seconds)-</u>	<u>No. of Applications</u>
Horizontal	+ 3.0	10 msc	10,000
Vertical	+ 1.5	10 msc	10,000
Any	+ 0.5	10 msc	1,000,000
Longitudinal	+ 2.0	250 msc	5,000
Lateral	+ 1.5	250 msc	5,000
Vertical	+ 2.5	250 msc	5,000

20.4.1.9 Inter-Car Interference Test

The test objective shall be to demonstrate that the completed cars have no physical deficiency which would preclude operation on the fixed facilities described in Appendix A, as may be modified by the purchaser.

Tests of car designs with significant dimensional differences between the front and rear ends of the cars shall involve two minimum consists.

The minimum consists shall be places on a curved section of track, or have one end translated with the truck properly swiveled so that the angle between the two units of the consist, or alternately, the angle between a pair of single-unit consist cars, is equal to the value required by the specified minimum radius track curve. The contractor shall demonstrate that under the extreme conditions specified in Section 3.2.2 for draftgear deflection, carbody level difference and carbody roll, there shall be no physical interference between car-

bodies. This shall be demonstrated for all possible front and rearend pairings of similar and dissimilar ends. The contractor shall further demonstrate that, under the same conditions, coupling and uncoupling operations can be performed with full performance of all required train configuration changes.

20.4.1.10 Loaded Car Door System Test

The test objective shall be to demonstrate compliance with the basic requirements for door subsystem operation with the car empty and with the car at AW3 weight as specified in Figure 3-2.

At each load value, a door test shall be made to check for function as specified in Section 10 and to detect any deterioration in performance due to carbody sag. A chart recorder shall record the elapsed times between initiation of door opening and closing commands and the fully open/closed responses. No adjustments to the door system shall be permitted during testing.

20.4.1.11 Parking Brake

A. Objective

The test objective shall be to demonstrate compliance with Section 14.4.3.

B. Conduct

The consist shall be stationary on level, tangent track with the hand parking brakes applied. A strain gauge-type load cell or other approved device shall be rigged in a cable line

to the consist coupler. With all hand parking brakes applied on the consist at the handle force limit specified in Section 14 cable tension shall be increased to the value equivalent to the force tending to roll the consist, each car at AW1 weight, on a 5 percent grade. The test shall be repeated with 75, 60, and 50 percent of handbrakes applied, and with the consist at AW3 for all percentages. The consist shall not move, as evidenced by lack of motion at the wheel/rail interface. The cycle at each percentage of handbrakes applied shall be repeated once. Following achievement at the specified force, the cable tension shall be gradually increased beyond that point to determine the force level at which the consist shall move.

20.4.1.11 Weight Distribution Test

A. Objective

The test objective shall be to demonstrate that distribution weight among the wheels and trucks of the consist is within the requirements and limits of Section 3.2.4.

B. Conduct

The completed, ready-to-run consist shall be weighted at each wheel and at each truck. The test plan shall provide for the test to be run at least twice to disclose any defects which might exist within the instrumentation or the procedure.

Each car shall be weighted, fully equipped at each truck, and the weights summed. The sample car, described in Section 5, less trucks, shall be weighed laterally and end-to-end to determine car balance. The fully equipped sample car shall then be weighed to demonstrate that wheel loads at every wheel are within the maximum permitted in Section 3.2.4.

20.4.1.13 Maintainability Demonstration

A. Objective

The test objective shall be to verify that the delivered cars comply with the maintainability requirements specified in Section 3.6.7.

B. Conduct

A maintainability demonstration shall be conducted in accordance with the approved Maintainability Demonstration Test Plan, Section 18. The demonstration shall be conducted in two phases. The first phase shall be a demonstration of a representative sample of maintenance tasks selected by the purchaser from those listed in the contractor's maintenance analysis. The performance of these tasks shall be demonstrated by contractor personnel.

A second phase shall be conducted to verify maintainability characteristics of the equipment in an operating environment.

20.4.2 TRAIN-LEVEL TESTING

Train-level qualification testing shall demonstrate proper operation of those functions which might be affected by consist length. Tests shall be conducted on consists of intermediate or maximum design length as specified in Section 3.3.2. Figure 20-5 lists the train-level qualification tests. For new car design or new major subsystem design, refer also to Section 20.4.4.

FIGURE 20-5. TRAIN-LEVEL QUALIFICATION TESTS

<u>Test No.</u>	<u>Test Title</u>
20.4.2.1	Trainline Function
20.4.2.2	Emergency Brake Propagation
20.4.2.3	Low Voltage Supply
20.4.2.4	Intermediate-Cab Operation
20.4.2.5	Jerk-Limit Verification
20.4.2.6	Remotely Controlled Features

20.4.2.1 Trainline Function Test

A. Objective

The test objective shall be to demonstrate satisfactory trainline operation in a maximum design consist of subsystems not specifically covered in the remaining train-level qualification tests.

B. Conduct

Those responses which are visible or audible may be verified by observation. Those which require instrumentation to detect shall be verified on contractor-provided instrumentation.

20.4.2.2 Emergency Brake Propagation Test

A. Objective

The test objective shall be to verify compliance with the requirements of Section 14.

B. Conduct

The maximum consist shall be instrumented to record the elapsed time between initiation of an emergency brake application at one end of the train and achievement of a complete emergency brake application at the other end of the train for comparison with the requirements of Section 14.4.2. All methods of emergency brake initiation provided on the car shall be independently tested.

In like manner, the time required to recharge the emergency brake system and restore normal service braking shall be measured.

20.4.2.3 Low Voltage Supply Test

A. Objective

The test objective shall be to demonstrate compliance with Section 13 design criteria.

B. Conduct

A minimum consist shall have its low voltage supply source de-energized and its battery discharged below the minimum operating level, as evidenced by refusal of the brakes to release and the propulsion system to apply power. A second, fully operational minimum consist shall then be coupled to the first with the low voltage supply positioned at the rear of the train. Transfer of low voltage power to the lead (simulated-disabled) consist shall enable the train to be operated from the first cab without degraded performance and within the time permitted by Section 13. This test shall also monitor control voltage in the first cab, and the con-

tractor shall show that it is above the minimum required to permit charging and release of brakes on the entire two train consist.

A second test shall be made with the battery of the first consist again discharged (as above) and with the low voltage supply de-energized. This simulated-disabled consist shall be coupled to a sufficient number of cars to form a maximum consist. Within the time specified in Section 13, the first consist shall completely control the train in a normal manner.

C. Requirements

Both tests shall be accomplished without incorrect operation of protective devices on the cars or within auxiliary subsystems.

To verify that voltages remain within specification requirements, chart recordings shall be made of the low voltage control line in the cab of the first consist throughout the tests.

20.4.2.4 Intermediate-Cab Operation Test

A. Objective

The test objective shall be to demonstrate proper operation of all control, communications and other functions essential to safe train operation as may be prescribed by the purchaser.

B. Conduct

A maximum consist shall be operated from a trailing cab or as prescribed by the purchaser.

20.4.2.5 Jerk-Limit Verification Test

A. Objective

The test objective shall be to demonstrate that all cars operate synchronously such that jerk-limits specified are not exceeded in any car of the train at any time, except as permitted by Sections 3.3.3.F.

B. Conduct

Trains consisting of multiples of the minimum consists up to the design maximum shall be assembled and tested. For each train size, complete exercise of all propulsion and braking commands and mode changes shall be carried out.

C. Requirements

Instrumentation in the form of a portable accelerometer and chart recorder shall be used to take measurements in the end cars of the train. Measurements in intermediate cars shall also be performed if measurements made on the end cars indicate that jerk-levels beyond specification limits exist within the train.

20.4.2.6 Remotely Controlled Features Test

A. Objective

The test objective shall be to demonstrate performance of remotely controlled features in accordance with the appropriate sections of the specification.

B. Conduct

If the car contains remotely controlled features such as hostling and uncoupling, these features shall be exercised at each train length up to the design service maximum.

20.4.3 INTEGRATED TESTING

Integrated qualification testing shall demonstrate that the interface and fit requirements of integrated functions have been met.

Tests shall be conducted on trains of varying length on the purchaser's property and at the U.S Transportation Test Center. Figure 20-6 lists the basic tests required. For new car design or new major subsystem design, refer also to Section 20.4.4.

FIGURE 20-6. INTEGRATED QUALIFICATION TESTS

<u>Test No.</u>	<u>Test Title</u>
20.4.3.1	Communications
20.4.3.2	Power System Noise
20.4.3.3	Mixed Consist Compatibility
20.4.3.4	Automatic Train Control
20.4.3.5	Power Collector
20.4.3.6 (14D)	Power Gap

20.4.3.1 Communications Test

A. Objective

The test objective shall be to demonstrate compatibility of the vehicle-to-wayside communication system with the system on purchaser's property and to verify conformance with Section 16.

B. Conduct

Measurements shall be made of transmitter power output, modulation level, harmonic generation, and antenna radiation pattern. All specified system features shall be demonstrated and monitored throughout the trainline and shall include initiation from the wayside.

20.4.3.2 Power System Noise Test (Static Power Conditioning System Cars Only)

A. Objective

The test objective shall be to demonstrate that the level of electrical noise inserted into the power system is in conformance with Section 4.

B. Conduct

The cars shall be loaded to produce maximum design accelerating and braking current and shall be operated in trains of design service maximum and non-revenue maximum lengths.

C. Requirements

The trains shall be operated over an instrumented section of track at those speeds which produce maximum motor power output in motoring and braking. The track shall contain insulated sections of sufficient length to interrupt the power supply to the car propulsion system filter so that its natural frequency and the noise produced by its discharge/charge cycle can be determined.

20.4.3.3 Mixed Consist Compatibility Test

A. Objective

The test objective shall be to demonstrate proper operation of the new cars in train with the purchaser's existing cars.

B. Conduct

A maximum revenue sized consist shall be formed of any combination of new cars and existing cars of a given design. This consist shall be operated in a simulated revenue profile to demonstrate operation in accordance with Contract Terms and Conditions.

20.4.3.4 Automatic Train Control (ATC) Test

A. Objective

The test objective shall be to demonstrate proper system functioning and absence of interference by the propulsion system in compliance with Sections 4 and 15. Minimum and maximum consists shall be instrumented and operated.

B. Requirements

Critical areas of the ATC system shall be monitored while the consist is operated in accordance with Sections 20.4.3.2 and 20.4.3.3 to demonstrate the sensitivity and noise rejection capability of the ATC system and the suitability of car construction in the area of EMI control. Continuous oscillograph chart recordings shall be made during these tests. Signals shall be injected into the running rails at the wayside system design level limits.

C. Conduct

The train shall be operated on a special track section containing a sufficient number of track codes for system exercise, alternatively, a device shall be applied to the car to simulate wayside inputs. The normal system wayside interface (for example, electromagnetic coupling) shall be used for signal injection.

The ATC system shall be provided inputs to completely exercise all its functions. Chart recordings shall be made of subsystem responses and output commands with sufficient accuracy to permit measurement of delay and response times for comparison with Section 15 requirements. Consist speed, distance, mode trainline commands, motor currents, and consist acceleration shall be recorded as a function of time. Recording accuracy and response shall be adequate to show trainline noise or instability and vehicle dead time and response time. Recording shall be analyzed for ATC system function as specified in Section 15 with respect to: stability, accuracy of speed limit control, and avoidance of excessive control cycling.

The consist shall be accelerated and decelerated between all possible ATC speed commands, including zero. Tests requiring complete stops with a zero speed command shall be made to determine stop distances from each ATC-authorized speed. This shall be carried out in manual and any other modes of which the subsystem is capable. Complete stops shall be made for maximum and minimum service consists to establish the effects of train resistance on stop distance.

Additional features peculiar to the ATC systems and their interfaces with other subsystems shall be tested.

● 20.4.3.5 Power Collector Test

A. Objective

The test objective shall be to verify satisfactory power collector operation on the purchaser's system in conformance with Section 13.

B. Conduct

For third-rail systems, the minimum consist shall be operated at all speeds up to design maximum speed through power collected with all collector shoes and then only one power collector shoe per vehicle. The test section shall contain typical third-rail gaps, expansion joints, and such other collecting surface discontinuities as follow:*_____.

The traction power voltage shall be oscillograph-recorded so that the dynamic characteristics of the power collector assembly can be compared with the values specified in Section 13 from the standpoint of response to discontinuities, degree of damping, resonance points, and evidence of flutter.

20.4.3.6 Power Gap Test

The test objective shall be to demonstrate the ability of a minimum consist to: traverse a power system gap in braking while producing tractive effort variations within the limits specified in Section 3.3.3, detect the gap while accelerating across it, and produce the power system response specified in Section 14.2.5B Alternate I (and inhibit regenerative braking and regeneration into a grounded or deenergized section as specified in Section 14.3E Alternate II.

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A minimum consist shall be accelerated and braked through a power system gap at speeds and tractive effort commands as specified in Section 20.4.1.2.

Regenerative braking mode tests shall be made (first) with the far section of the power system gap grounded, and (a second time) with the section de-energized, but not grounded (14.3B, Alternate II).

Instrumentation shall be provided to chart-record the following as a function of time: individual power collector voltage and current, traction motor voltages and currents, tractive effort commands, and any other signals appropriate for the subsystem provided.

20.4.4

TESTING AT TRANSPORTATION TEST CENTER (TTC)

The objective is to test new rapid railcar designs and new major subsystem designs at the U.S. Transportation Test Center (TTC), Pueblo, Colorado, to provide pre-revenue service certification under the auspices of the Federal Government.

Particular tests of the qualification tests specified under Section 20.4.1 shall be performed in whole or in part at the TTC, as summarized in Figure 20-7.

The TTC test schedule shall be incorporated into the contractor's proposal and may be incorporated in the purchaser's contract delivery schedule subject to UMTA concurrence. If the test schedule and TTC availability permit, the contractor and/or purchaser may at their discretion conduct additional testing at TTC beyond that described herein. The contractor shall monitor schedule adherence and, with 24 hours of first knowledge of an actual or potential schedule conflict or delay,

FIGURE 20-7
TESTING AT TRANSPORTATION TEST CENTER (TTC)

Test No.	Test Title	Performed Completely at TTC	Performed in Part at TTC
20.4.1.1	Acceleration Performance	X	-
20.4.1.2	Braking Performance	X	-
20.4.1.3	Duty Cycle	X	-
20.4.1.4	Radio Frequency Interference(RFI)	X	-
20.4.1.5	Emergency Systems	X	-
20.4.1.6	Ride Quality	X	-
20.4.1.7	Noise	-	X
20.4.1.10	Loaded Car Door System	X	-
20.4.1.11	Parking Brake	-	X
20.4.2.1	Trainline Functions	-	X
20.4.2.2	Emergency Brake Propagation	-	X
20.4.2.3	Low Voltage Supply	-	X
20.4.2.4	Intermediate Cab Operation	-	X
20.4.2.5	Jerk-Limit Verification	-	X
20.4.2.6	Remotely-Controlled Features	-	X
20.4.3.1	Communications	-	X
20.4.3.2	Power Gap	X	-
20.4.3.3	Power System Noise	-	X
20.4.3.5	Automatic Train Control (ATC)	-	X

All relevant portions of the tests utilizing simulation equipment shall be performed using simulators and devices approved by the purchaser subject to UMTA concurrence.

20.4.4.1 TTC-Furnished Items

The TTC site manager will arrange for the Federal government to provide the following supplies and services at no cost to the purchaser, its representatives, or the contractor:

- a. Test package, reliable and adequate power, maintenance buildings, and all general purpose maintenance equipment and shops. Sufficient track switches, frogs, etc., will be added to the test track to simulate purchaser's track conditions.
- b. Office space, furniture, and equipment.
- c. Car unloading cranes and jacks. (No railed roll-off ramp is available at TTC.)
- d. Instrumentation and data processing equipment, including sensors, signal conditioning, and onboard recorders

(as needed to satisfy the requirements that test data shall be recorded in analog form and digitized off the car for data analysis and report generation). As many as 30 sensor locations within the consist undergoing TTC testing may be continuously monitored/recorded.

e. The following personnel:

1. Test control/support engineer to oversee and coordinate scheduling, maintenance, logistics, instrumentation, and data support function at the TTC.
2. Chief test engineer to act as single point of contact with the contractor and purchaser and to ensure that the capability and resources of the TTC are made available.
3. Instrumentation engineers and technicians.
4. Data acquisition, analysis, reduction, and reporting specialists.
5. Maintenance building supervision and car/equipment maintenance personnel.
6. Operators and enginemen to effect movements of cars and other steel-wheeled equipment.
7. Security, safety, fire, and paramedical personnel on duty at all time.

20.4.4.2 Contractor-Furnished Items

The contractor shall provide the following supplies and services:

- a. A number of dependent-pairs of cars as specified in the Contract Terms and Conditions.
- b. Arrangements and costs for shipment of cars and adequate spares to and from TTC.
- c. Appropriate "all-inclusive" insurance coverage of the cars.
- d. Warranty coverage on cars, subsystems, and equipment during the TTC test period.
- e. Designation (with purchaser assistance) of up to 30 sensor locations for continuous monitoring/recording. These are locations of the consist which shall provide a high probability of fault diagnosis if car problems or failures are encountered. UMTA/TTC concurrence shall be prerequisite to designation of more than 20 such sensor locations.
- f. Special tools or test equipment unique to the car design.
- g. Coupler adapters between transit car couplers and standard AAR couplers for logistical moves at TTC.
- h. Documentation of test requirements, car technical descriptions, and operating manuals no later than 30 days prior to commencement of TTC testing. Preliminary but complete version of test documents will be considered acceptable.

- i. Final contractor reports for all tests. TTC shall provide supportive efforts, including formatting assistance.
- j. Qualified personnel to perform the following tasks during the TTC test program:
 1. Supervise and oversee overall contractor activity, including personnel, equipment, safety, and industrial security matters.
 2. Provide test leadership, direction, and engineering support to assure attainment of established test program goals and adequate data acquisition. Engineering representatives shall be thoroughly familiar with both car and purchaser's operational environment and shall interface with TTC test personnel.
 3. Provide maintenance leadership for the car and associated equipment. (TTC on-site car maintenance capability will require the direction of contractor personnel.)

20.4.4.3 Purchaser-Furnished Items

The purchaser will normally provide the following supplies and services:

- a. Preparation of test plans and procedures for any special tests that may be specified by the purchaser.
- b. Assistance in selecting up to 30 sensor locations to assure a high probability of fault diagnosis.

- c. Special wayside/track signaling or control equipment for the conduct of contractor or purchaser tests.
- d. Final test reports of any special tests that may be specified by the purchaser. TTC will assist in formatting and provide other site-specific support.
- e. On site;
 - 1. Supervision of overall purchaser activity.
 - 2. Test engineering support to achieve purchaser-requested test program goals and assure adequate data acquisition for all tests. Purchaser engineers, familiar with both the car design and the purchaser's operational environment, will interface with the TTC test team and assist in proper placement of instrumentation sensors and installation of any special wayside/track signaling or control equipment.
 - 3. Maintenance support as determined by the purchaser after consultation with TTC and the contractor.

20.5 QUALITY ASSURANCE TESTING

A. General

The contractor shall complete quality assurance testing to demonstrate that the minimum consist has been completely and correctly manufactured for scheduled revenue service. Quality assurance tests shall be performed in accordance with the approved test procedures, as specified in Section 18.

B. Location

Following completion of manufacture, each minimum consist shall be operated on a test track designated in the Contract Terms and Conditions. (The acceptance tests described in Section 20-6, if performed on the contractor's property shall be substituted for these car-level quality assurance tests.)

C. Requirements

The minimum consist shall be operated at minimum, 50 percent, and 100 percent of maximum tractive effort levels corresponding to each discrete setting of the master or automatic train controller, or at some combination as approved by the purchaser.

The consist shall be operated at up to the maximum speed which is safe on the test track and which, as a minimum, shall be the start of field weakening at maximum rate.

Trainline mode and tractive effort commands shall be modulated to fully exercise the traction and friction brake equipment so that responses and dead times can be determined for comparison with Section 14.5.1 requirements.

All cab and trainline functions shall be tested to verify satisfactory functional operation of the car as a complete system.

ACCEPTANCE TESTINGA. General

The contractor shall complete acceptance testing to demonstrate that the minimum consist has been completely and correctly constructed and calibrated in accordance with relevant specification requirements and can be placed into scheduled revenue service. Each acceptance test shall be performed in accordance with the approved applicable test procedure, as specified in Section 18.

B. Requirements

All minimum consists shall be subjected to acceptance testing. These tests shall be performed on the purchaser's property in accordance with the Contract Terms and Conditions. Instrumentation requirements are listed in Figure 20-8. If testing is performed on the contractor's property, these tests shall be used in place of those of Section 20.5 above.

C. Final Acceptance

Contractor access to the cars following successful performance of these tests shall be defined in the Contract Terms and Conditions. Purchaser approval sign-off forms shall accompany the test plans submitted by the contractor to the purchaser. Purchaser personnel may witness and sign-off at test completion, but final acceptance of cars shall be in accordance with the Contract Terms and Conditions.

Figure 20-8

Instrumentation Requirements for Acceptance Tests

INSTRUMENTATION REQUIREMENTS FOR ACCEPTANCE TESTS

Test		Traction Currents	Motor Voltages	Acceleration	Brake Cycle Pressures	Rate Commands	Mode Commands	Axle Speed
No.	Title							
20.6.1	Acceleration	X	X	X	-	X	X	X
20.6.2	Braking	X	X	X	X	X	X	X
20.6.3	Automatic Train Control (1,2)	X	-	-	-	-	-	X
20.6.4	Low Voltage System (1)	-	-	-	-	-	-	-
20.6.5	Trainline (2)	-	-	-	-	-	-	-
20.6.6	Subsystem (2)	-	-	-	-	-	-	-
20.6.7	Cab Gage (2)	-	-	-	-	-	-	-
20.6.8	Quality Assurance	-	-	-	-	-	-	-

- (1) Additional test-specific Instrumentation requirements are included in test text.
- (2) Instrumentation is hardware-specific or site-specific and shall be supplied as needed to meet the test requirements

20.6.1 ACCELERATION TEST

A. Objective

The test objective shall be to demonstrate compliance with values derived for minimum consist acceleration as a result of qualification testing.

B. Conduct

The AW0 weight consist shall be accelerated at each discrete propulsion tractive effort level or, if the subsystem provided does not employ discrete levels, at minimum, 50 percent and 100 percent of the maximum value and at any value defined in Section 15 as critical to ATC subsystem performance. At the maximum rate, the consist shall operate to design maximum speed or to the maximum permitted by test track design to demonstrate field weakening and time-to-speed capability. Chart recordings shall be made in accordance with Figure 20-8.

20.6.2 BRAKING TEST

A. Objective

The test objective shall be to demonstrate compliance with values derived for minimum consist braking as a result of qualification testing.

B. Conduct

A minimum consist at the AW1 weight and at the AW3 weight shall each be operated to test the blended electric and fric-

tion braking subsystem and the friction braking subsystem alone at each discrete braking effort level or, if a continuously variable command method is employed, at minimum, 50 percent and 100 percent of the maximum level, and at any level which is defined in Section 15 as critical to ATC subsystem performance. Stops shall be made from design maximum speed or at the maximum speed permitted by the test track using the braking effort commands listed above. An emergency stop shall also be made from each specified speed.

The test sequence shall be performed in its entirety for blended brake and friction brake independently. Chart records shall be made in accordance with Figure 20-8.

20.6.3 AUTOMATIC TRAIN CONTROL (ATC) TEST

A. Objective

The test objective shall be to demonstrate that all parts of the ATC subsystem are functioning properly and safely and that cars so equipped can be placed into scheduled revenue service.

B. Location

The instrument consist shall be operated over the purchaser's revenue track or on an especially equipped track section.

C. Requirement

The test shall exercise all functions of the ATC subsystem, paying special attention to safety-related functions.

Testing shall be conducted for manual and other required modes of operation.

D. Conduct

Entrance into a stop command zone shall be made at all ATC-authorized speed commands in manual modes. Stop distances shall be measured and recorded for all reaction distances.

Convenience functions, as provided, shall be tested fully. Door control/ATC subsystem interfaces, particularly those which are safety-related, shall be tested. Interfaces with other subsystems on the car, such as destination signs and communications, shall be functionally tested.

In addition to the requirements of Figure 20-8, chart recordings shall be made of ATC subsystem key inputs and outputs so that wayside response, as evidenced by trainline commands, can be recorded. Critical system voltages which indicate system sensitivity and noise rejection shall also be recorded.

20.6.4 LOW VOLTAGE SYSTEM TEST

A. Objective

The test objective shall be to verify that voltage bus readings are within the range specified in Section 13.

B. Conduct

The consist shall be operated in (1) an operative or laid-up state, and (2) with all subsystems operative; bus voltages shall be tested for specification compliance.

20.6.5 TRAINLINE TEST

A. Objective

The test objective shall be to demonstrate proper coupler operation in uncoupling and coupling modes as specified in Section 12.

B. Conduct

Each end of the minimum consist shall be coupled to another consist. When coupled, proper cab control and trainlining of all coupler functions shall be demonstrated. The proper operation of all emergency system functions and features, e.g., propagation and recharge and pneumatic and electrical isolation provisions, shall also be demonstrated, if appropriate.

20.6.6 SUBSYSTEM FUNCTIONAL TEST

A. Objective

The test objective shall be to demonstrate that each subsystem functions in compliance with specified criteria.

B. Conduct

Each car subsystem shall be tested for proper functioning, as evidenced qualitatively by the proper response of each subsystem to cab and trainline commands, to the degree that the responses would be perceived by passengers or operating personnel.

The door subsystem shall be tested for proper mechanical operation, ability to detect at each opening the specified

minimum obstruction, and interlocking with propulsion, brake, and train control subsystems. All cab controls, cab indicators, lights, and indicators appurtenant to each subsystem shall be checked for proper functioning.

20.6.7 CAR HEIGHT, CAB GAUGES, COUPLER, AND TRIPCOCK TESTS

A. Objective

The tests objectives shall be to demonstrate compliance with design criteria specified in appropriate sections.

B. Conduct

A light consist shall be spotted on a level tangent track section. Measurements shall be made from the railhead at the four corners of each car to an agreed-upon carbody surface. All third-rail shoe heights shall also be measured.

Fluid system compressors and pumps shall have cut-in and cut-out points checked against standard gauges to demonstrate proper adjustment. Cab gauges shall be compared against standard gauges. Coupler and tripcock heights shall be measured and/or gauged to demonstrate conformance with Section 3.

20.6.8 QUALITY ASSURANCE (QA) TEST

A. Objective

The test objective shall be to confirm that the contractor's quality assurance program objectives have been fully attained.

B. Conduct

All areas of the car shall be inspected as a final check of the contractor's QA function. Cars shall be visually inspected for evidence of shipping damage, damage resulting from retrofit or calibration work, or improper QA procedures at plant, and for cleanliness. All deficiencies shall be corrected by the contractor in accordance with the Contract Terms and Conditions.

20.7 RELIABILITY DEMONSTRATION

A. Objective

The objective shall be to demonstrate attainment of specified subsystem reliability requirements.

B. Conduct

The reliability demonstration plan, as specified in Section 18 shall include such detail as may be required to implement and administer the program and to determine that an acceptable level of reliability has been demonstrated. Under the plan, the cars shall be operated on the purchaser's property and the contractor shall monitor subsystem reliability. The reliability demonstration shall be performed in accordance with the approved reliability demonstration procedure, as specified in Section 18. The reliability demonstration period shall commence when the first car commences operation on the purchaser's property and shall extend to the end of the warranty period of the final car, or until the specified reliability is met, whichever occurs first.

For each of the cars for which an MBTF is specified, the log of cumulative subsystem MTBF shall be plotted on the ordinate against the log of the cumulative subsystem operating hours. Acceptable car reliability shall be demonstrated when subsystem MTBF has equaled or exceeded the respective specified MTBF for a duration of one reliability accounting period. In the event that cumulative car operating hours are not, or will not be, attained by particular subsystems during the reliability demonstration period, the contractor shall advise the purchaser when such is first determined and propose an alternative duration of cumulative operating hours or an appropriate extension to the demonstration period of the particular subsystems.

C. Requirements

The purchaser will provide assistance to the contractor in obtaining and reviewing the data required for the reliability demonstration. Reliability accounting shall include the following considerations:

1. Reliability Accounting Period Quarterly. Data shall be collected continuously but calculations shall be made for, and results plotted at, quarterly time intervals.
2. Operating Hours Subsystem operating hours shall be based on the car in which the respective subsystem is installed. Operating hours shall include all time during which the car is energized and in which the respective subsystem is installed. Provision shall be made to equate hours of operation to miles traveled and cycles of operation per subsystem where miles and cycles are a more commonly used reliability measure for those component subsystems. Complete details

regarding operating hours applicable to reliability demonstration shall be included in the reliability demonstration plan.

3. Failures For reliability demonstration, only primary failures having the following characteristics shall apply:
 - a. Occurs in contractor-supplied equipment or results from the contractor-supplied car equipment,
 - b. Cannot be considered wearout,
 - c. Was not caused by outside and unrelated events, such as negligence, deliberate abuse, or collision or derailment due to external causes,
 - d. Was unscheduled in nature,
 - e. Requires repair, replacement, or adjustment of components or equipment.
 - f. In the event of a redesign, the failure count shall be returned to one.

20.8 SPECIAL TESTING

A. Objective

The objective shall be to conduct testing of the cars separate from that which is the contractual responsibility of the contractor; e.g., to verify critical interface parameters between on-car and off-car equipment, to exercise more fully certain car components, or to demonstrate reliability.

B. Conduct

The contractor shall support the purchaser in such tests with instrumentation and/or personnel.

When the results of such tests disclose deficiencies or inadequacies in the design, fabrication, assembly, or testing processes of the cars, the contractor shall correct the deficiencies or inadequacies.



SECTION 21
IN-SERVICE SUPPORT REQUIREMENTS



SECTION 21

IN-SERVICE SUPPORT REQUIREMENTS

21.1 TECHNICAL SUPPORT

21.1.1 CONTRACTOR

The contractor shall provide technical support to the purchaser in the form of a mutually agreeable number of: field service engineers, technicians, and repair personnel for each shift of operation. These personnel shall be fully qualified in all aspects of maintenance and operation of the car, and shall assist the purchaser in promptly responding to and expeditiously resolving any difficulties experienced in the operation and maintenance of the cars. They shall further serve as on-site representatives of the contractor with the primary responsibility of responding to any and all warranty claims which might arise. These personnel shall be available at the purchaser's facilities at the time of delivery of the first revenue car and shall continue in attendance for the entire guarantee period.

(CDRL)

21.1.2 SUPPLIER

The contractor shall require all subsystem suppliers to have competent personnel on the property of the purchaser within 24 hours following receipt by the contractor of a request from the purchaser for technical assistance and warranty and guarantee-related repairs. The number of personnel and the length of their assignments shall be established by mutual agreement between the purchaser and the contractor. This requirement shall continue on an

on-call basis throughout the warranty and guarantee period.

21.2 TRAINING

21.2.1 TRAINING CLASS

As part of the in-service support plan required by Section 18.8, the contractor shall develop and present a formal instruction program to purchaser operating, maintenance, and supervisory personnel. This program shall commence upon delivery of equipment, and shall continue while acceptance testing is in progress. The contractor shall recommend proficiency and education entry levels for purchaser personnel to be trained. It shall be assumed that the purchaser personnel to be trained shall have no prior knowledge of, nor familiarity with, the features of the new cars and with their support equipment.

The schedule, size and location of instruction program classes shall be as specified in Figure 21-1.

On completion of training, the contractor shall provide the purchaser with one updated set of all instructional material and training aids used to provide such training, together with instructors' notes and lesson plans, to permit purchaser instruction of employees on a sustaining basis. (CDRL)

● FIGURE 21-1. OPERATION TRAINING PROGRAM

<u>Personnel Classification</u>	<u>Classroom Instruction</u>		<u>Equipment Instruction</u>		<u>Location*</u>
	<u>Number of Sessions</u>	<u>Approximate Number of Hours/Session</u>	<u>Number of Sessions</u>	<u>Approximate Number of Hours/Session</u>	
Supervisory					
Operational	5	4	5	4	
Maintenance	5	4	5	4	
Car Operators	10	8	5	8	
Maintenance					
Car Mechanics	30	4	30	4	
Electrical Technicians	30	4	30	4	
Electronic Technicians	30	4	30	4	
Brake Specialists**	15	4	15	4	
Truck and Suspension Specialists***	3	4	3	4	
HVAC Technicians **	30	6	30	2	
Communications Specialists (Inc. Class A Operator's License)	5	2	5	6	
<u>Class Size Limit</u>					
Classroom	30 (15-20 desirable)				
Equipment	5-6				

*Purchaser completing detail

**Specialists Courses are in addition to the Car Mechanics Course.

● 21.2.2

INSTRUCTION BOOKS

A. General

The contractor shall prepare: (1) an Operator's Instructional Manual, (2) a Running and Servicing Manual, and (3) a Heavy Repair Maintenance Manual. In the organization of these manuals, the car shall be treated as an integrated system and not as a grouping of disassociated parts. The material shall be indexed with a standard numbering system. Revisions required by changes to equipment and procedures shall be maintained by the contractor throughout the warranty period.

B. Manual Topics

To the extent necessary, the manuals shall be subdivided into the following topics:

1. General subsystem description and operation
2. Block diagrams
3. Signal flow diagrams
4. Functional schematics
5. Functional wiring and piping diagrams
6. Troubleshooting techniques
7. Lubrication and cleaning, including frequency, methods, and trade identification of recommended materials, component locations, and description
8. Inspection and maintenance standards, including wear limits, settings, and tolerances
9. Installation and removal procedures
10. Test and evaluation procedures

C. Operator's Instructional Manual (CDRL)

The Operator's Instructional Manual shall contain all information needed for optimal operation of the car. It shall include:

1. General car familiarization material
2. Location, function, and operation of all controls, gauges, indicators, and switches
3. Emergency procedures
4. Trouble symptoms and diagnosis methods

D. Heavy Repair Maintenance Manual (CDRL)

The Heavy Repair Maintenance Manual shall contain a detailed analysis of each component of the car so that maintainers shall be able to effectively service, inspect, maintain, adjust, troubleshoot, repair, replace, and overhaul each and every major component and subsystem.

E. Running Maintenance and Servicing Manual (CDRL)

The Running Maintenance and Servicing Manual shall provide the maintainer, in convenient form, with all information needed for on-board servicing, including: lubrication, inspection, running maintenance and adjustment, and on-line trouble diagnosis.

F. Format (CDRL)

MIL-M-38784A shall be used as the standard for the format of the manuals and MIL-M-15071H for technical content guidelines. The contractor shall submit the Table of Contents and Sample Formats for each manual.

The size of each manual, the method of binding, the type of cover, and the number of copies to be furnished shall conform to the following requirements: *_____. Completed manuals shall be submitted first in draft form for use and correction during initial training and operational testing. The final printed copy shall incorporate all corrections made during initial training and operational testing.

21.3 DIAGNOSTIC TEST EQUIPMENT

The contractor shall provide all equipment specified in this section to properly perform all in-service testing of cars. The contractor shall perform all necessary modifications to test equipment resulting from modifications in car design.

21.3.1 SHOP LEVEL TEST EQUIPMENT

Bench test equipment test devices shall be supplied by the contractor for the purposes of: testing, troubleshooting, and calibrating electric, electronic, mechanical, and electromechanical components of each car subsystem as specified by the purchaser. Test units shall be for use in, and shall be compatible with the purchaser's maintenance and repair facility which the purchaser shall specify. Bench test units shall contain provisions for rapid testing, troubleshooting, and calibration of the electronic circuit boards, plug-in relays, sensors, transducers, etc., used in car-mounted systems. Capabilities shall be provided for internal connection of meters, oscilloscopes, signal generators, and other response-indicators to simplify and expedite the required work. External connection of

*Purchaser completing detail

such apparatus shall not be permitted. Bench test units may use shop-supplied compressed air and electric power. Design of the tester shall be such that input signals or supplies such as compressed air can be varied over the full working range of the device. The bench test device, when used in accordance with instructions supplied by the contractor, shall test and calibrate the car equipment equal in quality to that performed by the original supplier, with the exception of tests of an environmental nature.

Performance of the tests shall not be automatically accomplished by the test device. Instead, they shall be performed by manual manipulation of dials, levers, buttons, and other appropriate controls by test technicians who shall establish input levels and provide internal connections between the equipment under test and appropriate power supplies, input signal generating devices, and output signal, and response measuring devices. Bench test devices shall be of a higher technical quality than the equipment being tested. Instrument accuracy shall be such that equipment calibrated on the bench test device may be placed in service on any car without need for further calibration.

21.3.2 PORTABLE TEST EQUIPMENT

A. General

The contractor shall provide portable test units (PTU) designed to perform subsystem tests as specified by the purchaser and to provide a 95 percent confidence level that the subsystems shall function properly in revenue service.

B. Propulsion Subsystem

PTU's to simulate dynamic system operation of the propulsion system by dry sequencing shall be provided. These plug-in type units shall contain all control logic, sequencers, generators, indicators, switches, and coupling devices necessary to ensure a thorough check of the propulsion subsystem. Test units shall use low voltage DC and logic control power available from the propulsion control equipment. Under no circumstances shall the car be capable of movement during the time that the PTU is connected to the car propulsion equipment. The test circuits shall permit critical control and power circuit simulation and readout so that subsystem status can be measured.

The PTU shall be designed with the following guidelines considered as a minimum:

1. The connection to the subsystem under test shall be by a single multi-pin connector.
2. Use of the test device shall not require removal or disconnection of any component, printed circuit board, wire chassis, terminal, or cable except for high voltage leakage checks.
3. The PTU shall produce the operating commands and other input signals necessary to fully exercise all functions and components of the subsystem under test, including electrical leakage checks, for both high and low voltage systems.
4. The PTU shall measure or indicate all signals, responses, and outputs of a properly functioning subsystem.

5. The PTU, when used in accordance with instructions supplied by the contractor, shall enable the purchaser to fully check out and calibrate the subsystem under test and to locate and replace any removable component which shall have failed.
6. Indicators and input signal generators shall be built into the PTU to the maximum extent possible.
7. The PTU shall have an accuracy commensurate with the tolerance specified.
8. Power for PTU operation shall be derived from car power.

The test device shall be housed in an enclosure with a removable cover suitable for use in the maintenance and repair facilities environment. The weight of the portable test device shall not exceed 25 pounds (11.3 kg). Provisions to connect any external apparatus to the device shall not be made.

21.3.3 ON-BOARD TEST SUPPORT DETAIL

The contractor shall provide test receptacles and additional portable test equipment located in the cab, including multi-channel recorders which shall permit monitoring of system performance and control logic during actual operation and during simulation by the PTU. Since this equipment shall add wiring and weight which could act to reduce car reliability, a detailed analysis of equipment requirements shall be made by the contractor.

Test receptacles shall neither interfere with nor alter the safety requirements of normal operation. At least 50 strategic test points shall be supplied. Ten spare test points for possible future use shall also be provided. Selection of test points as well as physical receptacle design and wiring shall be coordinated with the purchaser.

The test receptacle and portable test units combined shall be capable of isolating faults to the replaceable assembly level.

21.4

MAINTENANCE SPARES AND REPLACEMENT PARTS AVAILABILITY

The contractor shall submit to the purchaser a Parts Catalog which shall enumerate and describe: every component with its constituent parts, the vendor's number, the contractor's number, and the commercial equivalents (CDRL). Cutaway and exploded-detail drawings shall permit identification of all parts not readily identified by description. Parts common to different components (for example, bolts and nuts) shall bear the same contractor's number with a reference to the other components in which they shall be found. Each part or component shall be identified as being part of the next larger assembly.

The contractor shall submit a sample format of the Parts Catalog to the purchaser for approval (CDRL).

Prior to printing, the approved draft of the Parts Catalog in final form shall be supplied to the purchaser to permit the purchaser to ensure that the order or control numbers

for each part meet the purchaser's requirements. (CDRL)

21.5

GAUGES AND SPECIAL TOOLS

The contractor shall provide those gauges and special tools to effectively maintain and repair the cars.



SECTION 22
APPLICABLE DOCUMENTS



SECTION 22

APPLICABLE DOCUMENTS

22.1 GENERAL

22.1.1 APPLICATION

This section specifies the documents referenced in this specification. Each document forms a part of this specification to the extent specified in the respective paragraph wherein it is referenced.

22.1.2 EFFECTIVE DATE OF DOCUMENTS

Applicable documents shall be of the issue in effect on the date of the invitation for bids, unless otherwise specified herein.

22.1.3 SUBSTITUTE DOCUMENTS

Use of a later revision of a specified document or use of a comparable document prepared by the contractor or his subcontractors in lieu of a specified document shall require approval by the purchaser.

22.2 STANDARDS

22.2.1 INDUSTRIAL

ACRI	680	Standard for Air Filter Equipment	3.4.6
AGMA	240.01	Gear Materials Manual	14.2.2
AGMA	250.03	Lubrication of Industrial Enclosed Gear Drive	14.2.2

AGMA	251.02	Lubrication of Industrial Open Gearing	14.2.2
AIEE (IEEE)	11	Rotating Electric Machinery	14.2.3 14.4.2 20.2.2.1
Aluminum Ind. Assoc.		Aluminum Standards and Data	6.4.4 6.5.1
ANSI	B16.18	Cast Bronze Solder-Joint Pressure Fittings	6.3.1 6.7.3
ANSI	B16.22	Wrought Copper and Bronze Solder-Pressure Fittings	6.3.1 6.7.3
ANSI	B31.1	Power Piping (1980 update coming out)	6.3.2
ANSI	C37.13	Low Voltage AC Power Circuit Breakers Used in Enclosures	13.4.2
ANSI	C37.14	Low Voltage DC Power Circuit Breakers and Anode Circuit Breakers	13.4.2
ANSI	C37.16	Low Voltage Power Circuit Breakers and AC Power Circuit Breakers, Ratings, Requirements, and Recommendations	13.4.2
ANSI	S1.2-1962	Physical Measure of Sound, Method for	3.4.2
ANSI	S1.13-1971	Sound Pressure Levels, Methods for the Measurement of	3.4.2
ANSI	Y32.16	Reference Designations for Electrical and Electronic Parts and Equipment	6.2.4
ANSI	Z26.1	Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways, Safety Code for, including Addenda	7.4.1 7.4.1 7.4.4
ASHRAE	52-68	Method for Testing Air Cleaning Devices	3.4.6

EIA	RS-152-B	Land Mobile Communications FM or PM Transmitters, 25-470 MHz	16.5
EIA	RS-159	Chassis Pickup of Vehicular Receivers	16.5
EIA	RS-160	Sound Systems	16.5
EIA	RS-186-D	Standard Test Methods for Pas- sive Electronic Component Parts	16.5
EIA	RS-199-A	Solid and Semi-Solid Trans- mission Lines	16.5
EIA	RS-204-A	Land Mobile Communications FM or PM Receivers 25-470 MHz	16.5
EIA	RS-220	Continuous Tone-Controlled Squelch Systems (CTCSS)	16.5
EIA	RS-278-A	Mounting Dimensions for Loud- speakers	16.5
EIA	RS-280-A	Solderless Wrapped Electrical Connections	16.5
EIA	RS-299-A	Loudspeakers, Dynamic, Magnetic, and Impedance	16.5
EIA	RS-390	Semiconductor Logic Gating Microcircuits; Noise Margin Measurements	16.5
IEEE	STD-383- 1974	Test for Wire Extended Life Characteristics	6.2.2
IEEE (AIEE)	11	Rotating Electric Machinery	3.2.2 14.2.3 14.4.2 20.2.2.1
IEEE	32-1972	Isolation Resistance Test	13.9
IEEE	43	Testing Insulation Resistance of Rotating Machinery	14.4.2
IEEE	100-1972	Dictionary of Electrical and Electronic Terms	16.5

IEEE	113	Test Code for Direct Current Machines	14.4.2
IEEE	304	Test Procedure for Evaluation and Classification of Insulation Systems for DC Machines	14.4.2
NEMA	LD3	High Pressure Decorative Laminates (1975)	6.4.13
NEMA	MG1	Motors and Generators	14.4.2
NEMA *IPCEA	WC5 S-61-402	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy	6.2.2.
NFPA	258-76	Standard Test Method for Measuring the Smoke Genera- ted by Solid Materials	App. C
UL E	44-1975	Rubber-Insulated Wires and Cables	6.2.2
22.2.2	GOVERNMENTAL		
FED-STD-501A		Floor Covering, Resilient, Nontextile, Sampling and Testing	6.4.14
FED-STD 595a		Colors	6.8.1
MIL-STD-105		Sampling Procedures and Tables for Inspection by Variables for Percent Defectives	19.5.2
MIL-STD-454F		General Requirements for Elec- tronic Equipment	6.5.2
MIL-STD-461A		Electromagnetic Interference Characteristics Requirements for Equipment	14.4.2 20.1.1.4
MIL-STD-471		Maintainability Verification/ Demonstration/Evaluation	18.4.1
MIL-STD-889B		Dissimilar Metals	6.5.2
MIL-STD-1472B		Human Engineering Design Criteria for Military Systems Equipment and Facilities	3.6.4

22.3 SPECIFICATIONS

AAR	M-101-A	Ultrasonic Inspection of New Axles, Heat Treated and Non-Heat Treated, for Freight Cars, Passenger Cars and Locomotives	11.4.2
AAR	M-107	Wheels, Wrought Carbon Steel	6.4.2 11.4.4
AAR	M-201	Steel Castings	6.4.2
AAR	M-618	Hose, Air, Wire Reinforced	6.3.2 14.4.1
AAR	M-927	Hose Fittings and Hose Assemblies, Air, Wire Reinforced	14.4.1
AAR		Specifications for the Construction of New Passenger Equipment Cars	7.2.4
AISI	C-1020	Hot-Rolled Bar Steel	6.2.4
AISI	C-1045	Steel Forgings	6.4.2
ALCOA	TR 254	Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles	6.4.4 6.5.1 6.5.3
ANSI	SI.4-1971	Sound Level Meters, Specifications for	3.4.2
ASTM	A-25	Wrought Steel Wheels for Electric Railway Service	6.4.2
ASTM	A-27	Mild to Medium-Strength, Carbon Steel Castings for General Application	6.4.2
ASTM	A-31	Boiler Rivet Steel and Rivets	6.4.2 6.6.2
ASTM	A-47	Malleable Iron Castings, Spec. for	6.4.2
ASTM D	A-689	Carbon Steel Bar for Springs	6.4.2

ASTM	A-123-73	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip	6.5.1
ASTM	A-131	Structural Steel for Ships	6.4.2 6.6.2
ASTM	A-148	High Strength Steel Castings for Structural Purposes	6.4.2
ASTM	A-166-61T	(Superceded by B-456-71)	6.6
ASTM	A-194	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High Temperature Service	6.6.1
ASTM	A-325	Specification for High Strength Bolts for Structural Steel Joints Including Suitable Nuts, Plain Hardened Washers	6.4.2 6.6.1
ASTM	A-383-77	Axles, Railway, Carbon Steel, Untreated for Export and General Industrial Use	6.5.1
ASTM	A-490	Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints	6.6.1
ASTM	A-502	Steel Structural Rivets	6.6.2
ASTM	A-514	High-Yield Strength, Quenched and Tempered Alloy Steel Plastics, Suitable for Welding	6.4.2
ASTM	A-536	Ductile Iron Castings, Specification for	6.4.2
ASTM	A-563-76a	Carbon Steel Nuts	6.6.1
ASTM	A-606	Steel Sheet and Strip, Hot-Rolled and Cold-Rolled, High-Strength, Low Alloy with Improved Corrosion Resistance	6.4.2
ASTM	A-729	Alloy Steel Axles, Heat-Treated for Mass Transit and Electric Railway Service	6.4.2 11.4.2

ASTM	B-26	Aluminum-Alloy Sand Castings	6.4.4
ASTM	B-33	Tinned Soft or Annealed Copper Wire for Electrical Purposes	6.2.1
ASTM	B-85	Aluminum-Alloy Die Castings	6.4.4
ASTM	B-108	Aluminum-Alloy Permanent Mold Castings	6.4.4
ASTM	B-177	Chromium Plating on Steel for Engineering Use	6.5.1
ASTM	C-542-76	Specification for Lock-Strip Gaskets	6.9.2.F
ASTM	D-256	Impact Resistance of Plastics and Electrical Insulating Materials	Figure 6-2
ASTM	D-395	Compression Set of Vulcanized Rubber	Figure 6-1
ASTM	D-412	Tension Testing of Vulcanized Rubber	Figure 6-1 6.4.14
ASTM	D-470	Thermosetting Insulated and Jacketed Wire and Cable Testing	6.2.2
ASTM	D-471	Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids	Figure 6-1
ASTM	D-523	Test Procedure to Determine Gloss Value	Figure 6-1
ASTM	D-573	Accelerated Aging of Vulcanized Rubber by the Oven Method	6.2.2 Figure 6-1
ASTM	D-624	Rubber Property-Tear Resistance, Test for	Figure 6-1
ASTM	D-635		13.3
ASTM	D-638	Tensile Properties of Plastics, Test for	6.2.2 Figure 6-2

ASTM	D-695	Compression Properties of Rigid Plastics, Test for	Figure 6-2
ASTM	D-790	Flexural Properties of Plastics, Test for	Figure 6-2
ASTM	D-1149	Accelerated Ozone Cracking of Vulcanized Rubber, Test for	Figure 6-1
ASTM	D-1204	Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting of Film at Elevated Temperatures, Test for	6.4.14
ASTM	D-1360	Test for Fire Retardancy of Paints (Cabinet Method)	6.8.1
ASTM D	D-1361	Test for Fire Retardancy of Paints (Stick and Wick Method)	6.8.1
ASTM	D-2200	Pictorial Surface Preparation Standards for Painting Steel Surfaces	6.8.1
ASTM	D-2240	Indentation Hardness of Rubber and Plastics by Means of a Durometer, Test for	Figure 6-1
ASTM	E-113	Ultrasonic Testing by the Resonance Method	20.2.4.6
ASTM	E-119	Fire Tests of Building Construction and Materials	6.9.2 App. C
ASTM	E-125	Magnetic Particle Indications on Ferrous Castings	20.2.4.4
ASTM	E-142	Controlling Quality of Radiographic Testing	20.2.4.1
ASTM	E-162-76	Test for Surface Flammability of Materials Using a Radiant Heat Energy Source	6.9.2 7.3.8B
ASTM	E-446	Reference Radiograph for Steel Castings Up to 51 mm (2") Thickness	11.3.2 12.3 20.2.4.1
23.3.2	GOVERNMENTAL		
DOD-P-21035A		Paint, High Zinc Dust Content, Galvanizing Repair (Metric)	6.5.1

Federal TT-P-38D	Paint, Aluminum, Ready-Mixed	6.5.3
Federal TT-P-664C	Primer Coating, Synthetic, Rust-Inhibiting Lacquer-Resisting	6.8.1
Federal WW-T-799E	Tube, Copper, Seamless, Water and Refrigeration (For Use With Solder-Flared-Or Compression Type Fittings)	6.3.1
MIL-C-005015	Connectors, Electrical	6.2.4 12.5.1 12.5.2
MIL-P-8053 MIL-P-8053C	Plywood Core Sandwich Panels	6.4.7
MIL-P-13949E	Plastic Sheet, Laminated, Copper Clad	6.2.6
MIL-M-15071H	Manuals, Technical: Equip- ment and Systems, Contents Requirements for	21.2.2
MIL-C-22750C	Epoxy, Polyimide	6.5.1
MIL-M-38784A	Manuals Technical: General Requirements for Preparation of	21.2.2
MIL-I-46058C	Insulating Compound, Electrical	6.2.6
MIL-S-3930D	Low Voltage Switches	13.6
MS-25036L	Wire Terminations, Crimp- Style Terminal Lugs	6.2.4
UMTA-MA-06-0025- 79-1 (PB#294-840/4WT)	Flammability Tests, Electrical Insulation Fire Characteristics, December, 1978	6.9.4
UMTA-MA-06-0025- 79-2 (PB#294-841/2WT)	Toxicity, December, 1978	6.9.4

22.4	<u>MANUALS, PRACTICES, CODES AND GUIDELINES</u>		
22.4.1	INDUSTRIAL		
AAR	Communications Manual		16.3 16.5
AAR	Wheel and Axle Manual		11.4.1 11.4.2
APTA	Guidelines for Design of Rapid Transit Facilities		3.4.2
APTA	Rapid Transit Systems Glossary of Reliability, Availability, and Maintainability Terminology for Rail Rapid Transit		3.6.6.
ASME	Boiler and Pressure Vessel Code for Unfired Pressure Vessels (1977) (A 1980 update is coming out)		6.7.2 11.3.2 14.4.1 14.4.2
AWS	American Welding Society Structural Welding Code		7.2.2
AWS	Welding Aluminum		6.7.2
AWS	Brazing Manual		6.7.2
22.4.2	GOVERNMENTAL		
AFSC	Handbook DH-1-3		3.6.4
DOT	UMTA-MA-06-0025-79-1	Flammability Tests	6.9.5
DOT	UMTA-MA-06-002507902	Toxicity	6.9.5
FCC	Rules and Regulations, Part 93		16.5

SECTION 23
CONTRACT DATA REQUIREMENTS LIST (CDRL)



SECTION 23

CONTRACT DATA REQUIREMENTS LIST (CDRL)

23.1 GENERAL

The CDRL shall be prepared as specified in Section 19.4 and shall be as illustrated by example shown in Figure 23.1.

CDRL items are designated throughout the specification by the following: (CDRL).

23.1.1 PURCHASER REQUIREMENTS

The purchaser shall complete the following columns of Figure 23-1:

- a. Item No. Indicates the sequence the CDRL item appears in the specification.
- b. Sequence No. Indicates the sequence of submittal desired by the purchaser.
- c. Title CDRL item
- d. Reference Paragraph Where the CDRL item appears in the specification.
- e. Format/Quantity Format and quantity in which the CDRL item is required.

23.1.2 JOINT REQUIREMENT

f. Schedule Dates:

1. Submittal number of days after the
 notice to proceed (NIP)
2. Frequency one time, monthly, etc.
3. Approval if required

The purchaser will supply the information received where indicated by an asterisk (*). Where left blank, the contractor will provide required information.

23.1.3 CONTRACTOR REQUIREMENTS

The contractor shall complete the following columns of Figure 23-1 as part of the bid:

g. Received Date:

Column 1	date received
Column 2 (calendar)	number of days after the NTP
Column 3 (Ltr. no.)	contractor letter number

h. Resp. Contractor's responsible person or section.

i. Status:

1. ER Date Engineering Review date
2. OTA Date Official Transmittal Approval Date

j. Action/Remarks self-explanatory

FIGURE 23-1. CONTRACT DATA REQUIREMENTS LIST

CONTRACT DATA REQUIREMENTS LIST												
					REV _____	DATA _____	PAGE _____	OF _____				
CONTRACT NO. _____		CONTRACT/SUPPLIER _____			SYSTEM _____			CATEGORY _____				
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/Approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- (2)	LER No. (3)		E R/Date (1)	OTA/Date (2)	
001		Car Weight Record	3.2.4D		Prior to first PDR							
002		Thermal Characteristics Data and Test Results	3.3.2B									
003		Design Critique Reports	3.6.2A									
004		Master Car Design Plan	3.6.2B									
005		Industrial Design Plan	3.6.3									
006		Reliability Verification and Comparison Analysis	3.6.6									

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
			REV _____ DATA _____ PAGE _____ OF _____									
CONTRACT NO. _____		CONTRACT/SUPPLIER _____			SYSTEM _____			CATEGORY _____				
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/Approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- - (2)	Ltr No. (3)		E R/Date (1)	OTA/Date (2)	
007		Electromagnetic Compatability (EMC) Control Methods	4.3.1		*							
008		Review of Mock-ups	5.1.1C 5.1.2F 19.3.2D									
009		Mock-ups and/or Models	5.1.1C									
010		Notice of Car Readiness for Inspection	5.2									
011		Description of Commercial Material not covered by a Specification	6.4.1									
012		Crashworthiness Analysis	7.2.6									

*Purchaser completing detail

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
						REV _____	DATA _____	PAGE _____	OF _____			
CONTRACT NO. _____			CONTRACT/SUPPLIER _____			SYSTEM _____			CATEGORY _____			
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- (2)	Ltr No. (3)		E R/Date (1)	OTA/Date (2)	
013		Man-Machine Interface Analysis	9.2									
014		Record of Wheel Serial Numbers	11.4.1B									
015		Axle Serial and Heat Numbers	11.4.2C									
016		Mounting Charts and Inspection Sheets	11.4.4B									
017		Certified Spring Guarantee	11.5.1									
018		Friction Brake Piping Procedure	14.4.1C1									

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
REV _____ DATA _____ PAGE _____ OF _____												
CONTRACT NO. _____ CONTRACT/SUPPLIER _____ SYSTEM _____ CATEGORY _____												
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- dar (2)	Ltr No. (3)		E R/Date (1)	OTA/Date (2)	
025		Subsystem Hazards Analyses	18.5.1									
026		Operating Hazard Analysis	18.5.1									
027		Compliance Testing Program Plan, Including Schedule	18.6									
028		Compliance Testing Detailed Test Procedure	18.6									
029		Notification of Time and Location of Compliance Test	18.6									
030		Compliance Test Report	18.6									

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
CONTRACT NO. _____						CONTRACT/SUPPLIER _____			SYSTEM _____		PAGE _____ OF _____	
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/Approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- (2)	Ltr No. (3)		E R/Date (1)	OTA/Date (2)	
031		Shipping Plan	18.7									
032		In-Service Support Plan	18.8									
033		Recommended Parts Stocking Levels	18.8									
034		Management Master Program	19.1		*							
035		Systems Engineering Plan	14.2		*							
036		Configuration Management Plan	19.3.1		*							

*Purchaser Completing detail

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
			REV _____ DATA _____			PAGE _____ OF _____						
CONTRACT NO. _____		CONTRACT/SUPPLIER _____			SYSTEM _____			CATEGORY _____				
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/Approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- (2)	Ltr No. (3)		F R/Date (1)	OTA/Date (2)	
017		Notification of Preliminary Design Review Date(s)	19.3.2									
038		Notification of CDR Date(s)	19.3.2									
039		Notification of System FAI Date(s)	19.3.2									
040		Engineering Data Package for System FAI	19.3.2									
041		Notification of Subsystem FAI Date(s)	19.3.2									
042		Engineering Change Proposals, Class 1 (ECP-1)	19.3.3									

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
CONTRACT NO. _____ CONTRACT/SUPPLIER _____											REV _____ DATA _____	PAGE _____ OF _____
SYSTEM _____											CATEGORY _____	
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- dgr (2)	LT No. (3)		E R/Date (1)	OTA/Date (2)	
049		Electric Wiring Diagram	19.3.5e									
050		Piping and Flow Diagram	19.3.5f									
051		Graphs and Curves	19.3.5g									
052		Outline Drawings of Major Components	19.3.5h									
053		Technical Specifications Preliminary	19.3.1		*							
054		Technical Specifications, Final	19.3.6									

*Purchaser completing detail

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
						REV _____	DATA _____	PAGE _____	OF _____			
CONTRACT NO. _____			CONTRACT/SUPPLIER _____			SYSTEM _____			CATEGORY _____			
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- {2}	LEF No. (3)		E R/Date (1)	OTA/Date (2)	
055		Contingency Retrofit Plan	19.3.7		*							
056		Record Drawings	19.3.8									
057		Contract Data Requirements List	19.4		*							
058		Quality Assurance Plan	19.5.1		*							
059		List of Serialized Equipment Items and Description of Each Serial Number	19.6		*							
060		Car History Book	19.7									

*Purchaser completing detail

FIGURE 23-1, continued

CONTRACT DATA REQUIREMENTS LIST												
					REV _____	DATA _____	PAGE _____	OF _____				
CONTRACT NO. _____			CONTRACT/SUPPLIER _____			SYSTEM _____			CATEGORY _____			
Item No. (a)	Sequence No. (b)	Title (c)	Reference Paragraph (d)	Format/Quantity (e)	Schedule Date Submittal/Frequency/approval (f)	Received Data (g)			Resp. (h)	Status (i)		Action/Remarks (j)
						(1)	Calen- (2)	Ltr No. (3)		E R/Date (1)	OTA/Date (2)	
061		Recommended Contractor Technical Support	21.1.1									



APPENDIX A

TRANSIT AUTHORITY
SITE-SPECIFIC INFORMATION



APPENDIX A
TRANSIT AUTHORITY
SITE-SPECIFIC INFORMATION

A.1 GENERAL

To manufacture a rapid railcar which shall operate to the satisfaction of the purchaser and the transit patrons served by the purchaser, the contractor must be provided with that site-specific detail which shall affect the design adequacy of the rapid railcar being procured.

This appendix to the technical specification describes the fixed facilities, ambient environmental conditions, and duty cycle compatible with the rapid railcar described herein. In addition, a listing is provided of sections where purchaser completing detail is to be inserted prior to the release of the specification for bid.

Site-specific descriptions furnished in this appendix are to be considered by the contractor as ancillary information to the technical specification for use in developing the technical definition of the car meeting the requirements therein. Inclusion of this description of site-specific information in the specification does not relieve the contractor of the responsibility to have its representatives and its suppliers visit, view, inspect, and become thoroughly familiar with the operating transit system, including structures and maintenance and storage facilities. The purchaser is, nonetheless, responsible for the validity and accuracy of site-specific data and for maintaining its applicability throughout the warranty period.

Those aspects of the purchaser's route system which differ from the characteristics listed in this appendix must be identified by the purchaser.

A.2 FIXED FACILITIES

A.2.1 CLEARANCE

The standard clearance outline shown in the Specification Drawing represents the spatial envelope within which the standard design rapid railcar shall remain under operating conditions. The standard clearance outline provides a safety zone around the car dynamic outline.

Platform dimensions shall be as follows:

- | | | |
|----|--|--|
| a. | Platform height above top of rail | 42.359 inches |
| b. | Platform length (minimum) | 615 feet |
| c. | Distance from edge of finished platform to centerline of track | 5 feet, 5-1/2 inches
<u>Wood 3-1/2 inches</u>
5 feet, 2 inches |

A.2.2 CONTACT RAIL AND COVERBOARD LOCATION

- | | | |
|----|---|---|
| a. | Contact rail type | 150 pounds/yard,
6.85 times resistance
of pure copper |
| b. | Height and variance of contact rail above running rail | 3-1/2±1/2 inches |
| c. | Height of lower edge of coverboard above: | |
| | - Contact rail | 3-1/2 inches, minimum |
| | - Running rail | 7 inches, minimum |
| d. | Contact rail ramp angle | 67 degrees F, nominal
(high speed)
1.68 degrees F, nominal
(low speed) |
| e. | Distance between centerline of contact rail and gauge line of near running rail | 27-9/16 inches |

A.2.3

TRACK

- a. Rail Type -- 100 ARA, type "B" rail, 1:40 cant, 39 foot section
- b. Gauge --
 - Nominal 4 feet, 8-1/4 inches
 - Maximum 4 feet, 9 inches
- c. Horizontal Curves and Superelevation
 - Minimum lateral radius at centerline of tracks: 145 R-44
 - Mainline 125 feet
 - Yard 125 feet
 - Maximum superelevation 6-1/2 inches
 - Minimum tangent length 60 feet
 - Radius of smallest turnout 214 feet (No. 5)
- d. Vertical Curves and Grades
 - Vertical curves rate of change:
 - Mainline 2 percent maximum, parabolic
 - Yard
 - Grades:
 - Mainline 3 percent maximum
 - Yard 0.5 percent maximum
 - Other 0.5 percent maximum
- e. Wheel Load Limitations
 - Maximum load per wheel 17,200 pounds
 - Maximum load per truck 68,800 pounds

- f. Rail Wear
 - Vertical wear, maximum .5 inches
 - Horizontal wear, maximum .375 inches
- g. Crossovers
 - Frog characteristics and gauge
 - #5 and under frog 56.75"
 - #6 through #20 frog 56.50"
 - Guardrail gauge 54.75"
- h. Track Spacing 14 feet, 2 inches

A.2.4 POWER SYSTEM

- a. Voltage Range
 - 1. Minimum voltage 425 VDC
 - 2. Nominal voltage 600 VDC
 - 3. Maximum voltage 675 VDC

A.3 AMBIENT CONDITIONS

A. Exterior

Exterior ambient conditions for design purposes shall be as follows:

- 1. Summer - surface
 - a. 95°F(35°C) dry bulb temperature, 75°F(24°C) wet bulb temperature
 - b. 41°F (5°C) latitude, maximum solar heat rate
 - c. 105°F (41°C) condenser ambient
 - d. 8 mph (13 kmh) wind velocity

2. Summer - tunnel
 - a. 105°F(41°C) dry bulb temperature, 80°F(27°C) wet bulb temperature
 - b. 115°F(46°C) condenser ambient
3. Winter - surface
 - a. 11°F(-12°C) dry bulb temperature
 - b. 41°F(5°C) latitude, minimum solar heat rate
 - c. 11 MPH (20 Kmh) wind velocity
4. Winter - tunnel
 - a. 11° F (-12°C) dry bulb temperature

B. Average Conditions

1. 240 average rush hour passenger density
2. 2 minutes average time between stations (local)
3. 6 minutes average time between stations (express)
4. 10 seconds minimum time in station (doors open)
5. 58% time in tunnel as a per cent to total operating time

A.4 DUTY CYCLE

The maximum acceleration and braking shall be obtained utilizing a motor duty cycle based on the operating and route profiles, examples of which are illustrated in Figures A-1 and A-2. The thermal design of the motor shall be such that the motor shall be capable of operating continuously within the insulation rating as specified in 14.2.3A3 over the most severe profile and duty cycle.

The following parameters shall be assumed;

1. Average 30-45 second dwell times with 15-20 minute turn-arounds at the terminal stations.
2. Line voltage of 600 VDC in motoring.
3. Maximum manual motoring and brake command with no coasting.
4. Maximum round trip as specified in the route profile and schedule.
5. The traction resistance of the vehicle(s) calculated with the following modified Davis equation;

$$TR = 1.3W + 29n + .045WV + ((.0024 + (N-1)(.00032))AV^2)$$
$$(\approx 4.448(1.3W + 29n + .045Wv + ((.0024 + (N-1)(.00034))AV^2))$$

where:

- TR = Total resistance, pounds (Newtons)
W = Weight per train, tons
n = Number of axles per train
V = Train speed, mph
N = Number of cars in train
A. = Frontal area of lead car, feet²

6. 100 percent rheostatic electrical braking.
7. AW2 passenger load.

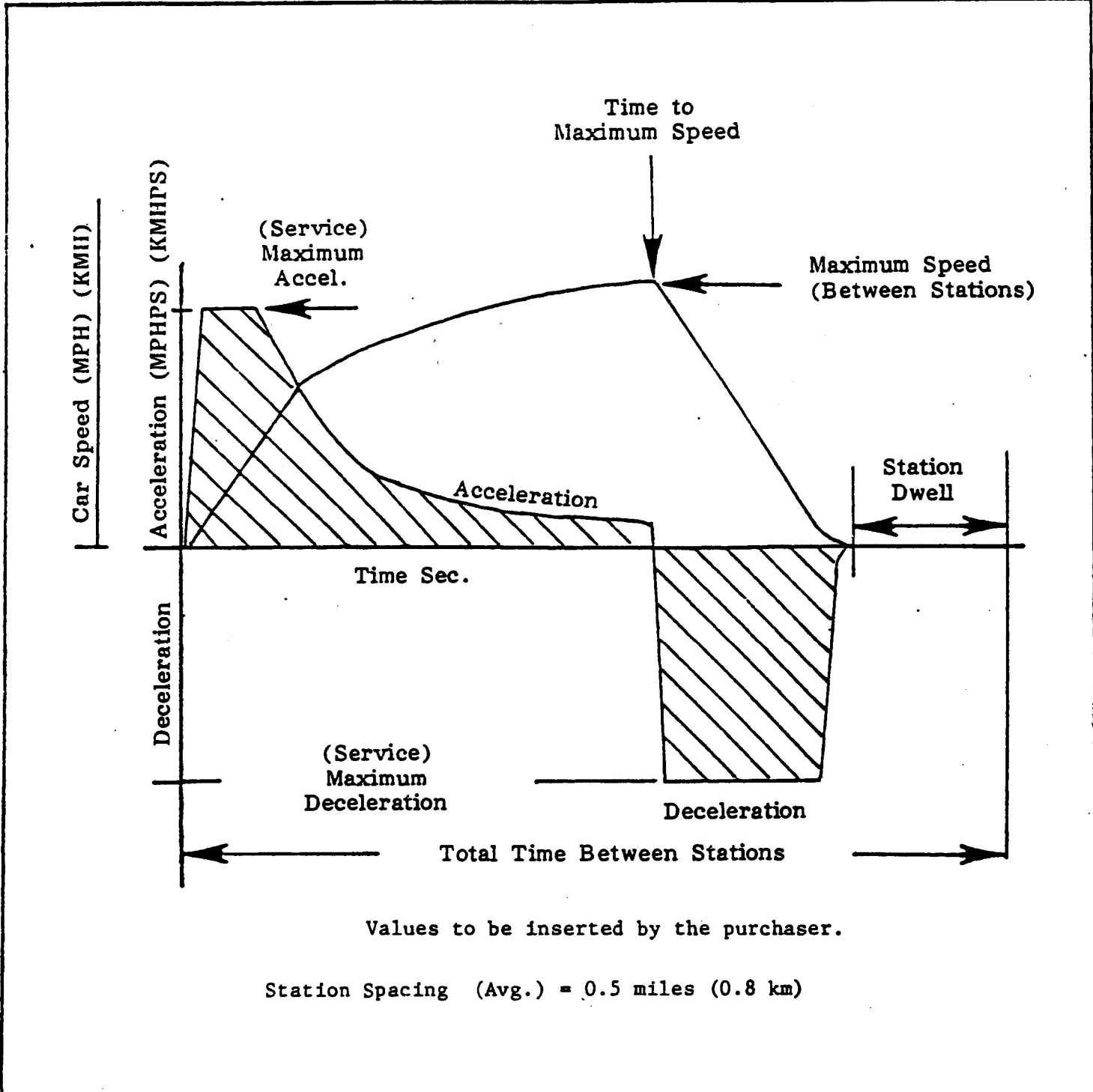
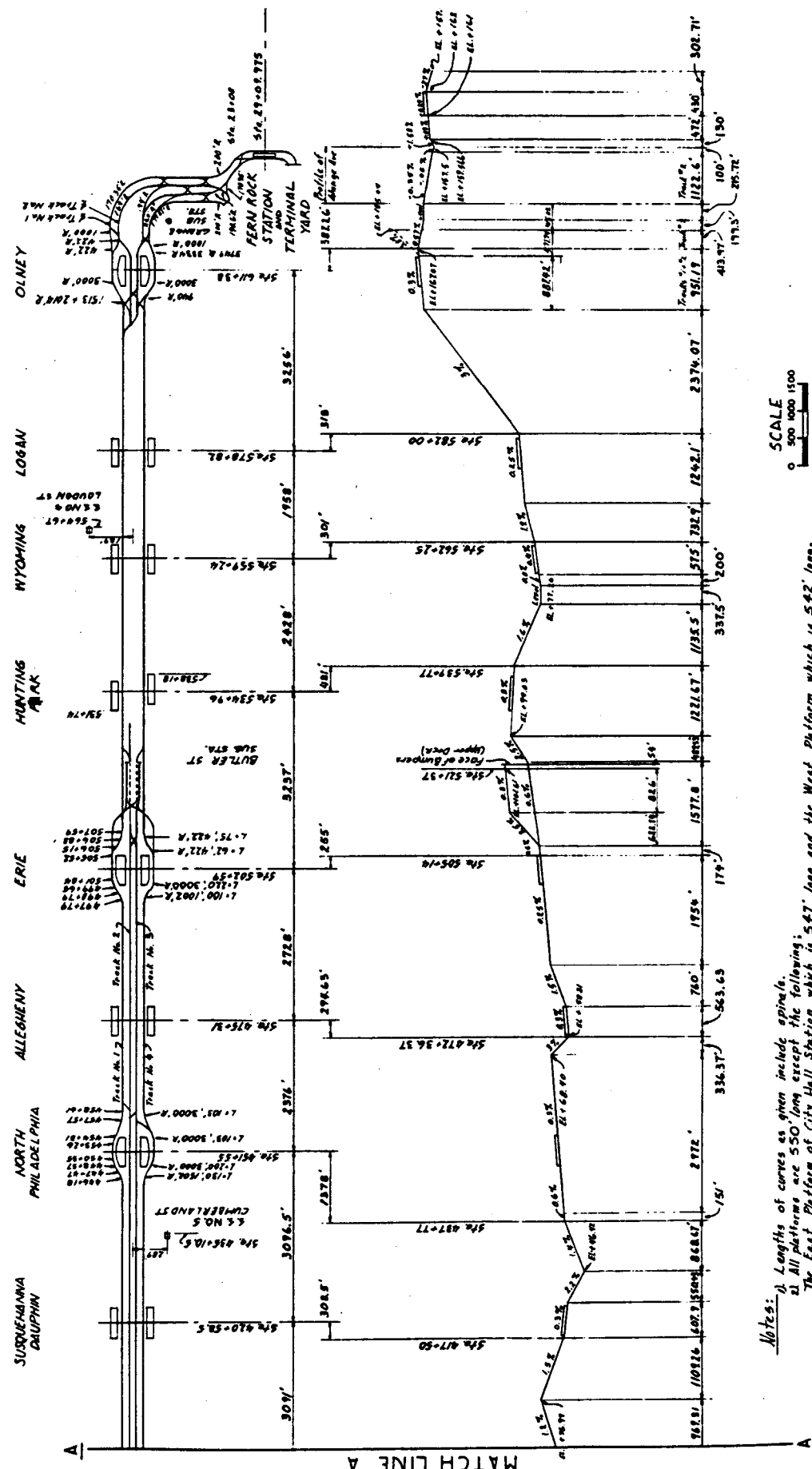


FIGURE A-1. VEHICLE OPERATING PROFILE SAMPLE
(Dependent Par, Standard Train, Etc.)



SCALE
0 500 1000 1500

- Notes:
- 1) Lengths of curves as given include spirals.
 - 2) All platforms are 550' long except the following:
 The East Platform of City Hall Station which is 547' long, and the West Platform which is 542' long;
 Fern Rock Station which is 430' long, and Pattison Ave. Station which is 1500' long.
 - 3) All grades are calculated parallel to Broad Street base lines except those of the long deflection curves at City Hall, Ridge Ave Branch and George Ave. which are calculated along arcs and tangents at center lines as shown on Drawings No. 21334 and 21385.

FIGURE A-2. SAMPLE ROUTE PROFILE (Part 1 of 3 parts)

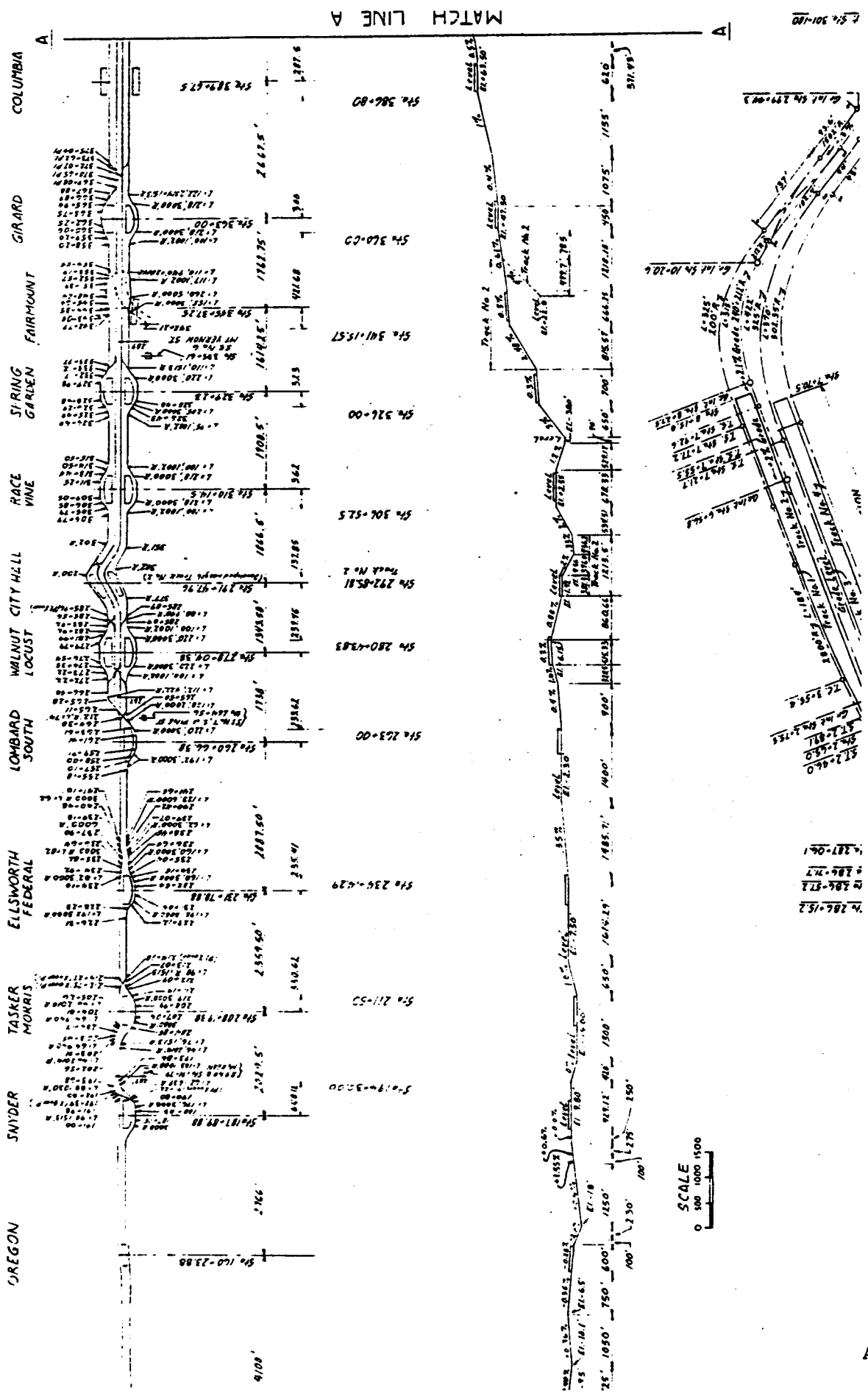


FIGURE A-2
CIVIL SPEED LIMITS
(Part 3 of 3 Parts)

Fern Rock-Olnet	both directions	20 mph or series
Olney-Logan	South bound	35 mph
300' north of north end of Erie station	both directions	20 mph or series
Erie, N. Philadelphia Giard, Spring Gar- den Race-Vine	both directions	35 mph @ end of platform
Walnut-Locust, Lom- bard-South, Ells- worth-Federal, Tasker-Morris, Snyder 500' north of	North bound	"
Lombard-South top platform	South bound	20 mph or series
Race-Vine to City Hall	South bound	"
City Hall to 900' north of City Hall	North bound	20 mph or series
300' north of Patti- son to Pattison	both directions	20 mph or series

A.5 Average Route Profile

* _____.

*Purchaser completing detail

PURCHASER REQUIRED COMPLETING DETAIL

The following is a listing of those subsections requiring information to be supplied by the purchaser and indicated by the notation: *_____.

Section 3

- a. 3.3.3.B Corner point speed
- b. 3.4.4. Wayside ground vibration requirements
- c. 3.5B Shock and vibration requirements
- d. 3.5C Shock and vibration requirements
- e. 3.6.3 Resources and capabilities

Section 4

- a. 4.1 Specification drawings
- b. 4.2 Trainline functions drawings
- c. 4.3.2 EMI environment

Section 5

- a. 5.1 Mockups and/or models
- b. 5.1.1B Models required
- c. 5.1.3 Training aids required

Section 6

- a. 6.2.2B61 Fluids for chemical resistance test
- b. 6.2.4A Tools for connecting wire terminals
- c. 6.2.4E Cable identification
- d. 6.3.2 Clamps to attach hoses
- e. 6.4.6 Flame and smoke characteristics
of interior materials

- f. 6.4.10 Marking films
- g. 6.4.11A Cleaning agents
- h. 6.4.13 Floor cleaning solvents
- i. 6.4.14 Color, texture, and finishes
- j. 6.6.2 Use of blind rivets
- k. 6.8.1A Paint specifications
- l. 6.8.1B Corrosive fluids and/or cleaning solutions

Section 7

- a. 7.2.7 Lifting or jacking points
- b. 7.4.1 Glazing locations
- c. 7.4.4C2 Windscreen glazing material
- d. 7.5.4A Cab door ventilation

Section 8

- a. 8.2.1B Type fire extinguisher
- b. 8.2.2A Repair and cleaning procedures
- c. 8.2.3A Material, color, texture, design, and fastenings of interior liners
- d. 8.2.5C Frames for adverting and maps
- e. 8.2.7B Keys
- f. 8.2.9B Seating arrangement
- g. 8.3B Grab handle locations
- h. 8.3C Barriers
- i. 8.3E1 Exterior logotype numbers, etc.
- j. 8.3E2 Passenger assistance
- k. 8.3E4 Emblems, logotypes
- l. 8.4.1A3 Center light fixtures

Section 9

- a. 9.7.1 Operator seat
- b. 9.10.1 Fire extinguisher location
- c. 9.10.4 Coat hook
- d. 9.10.5 Cab controls and indicators

Section 10

- a. 10.1.4B Accessibility of emergency lever
- b. 10.1.4D Obstruction detection
- c. 10.2.3 Location of door bypass switch
- d. 10.3.2 dBA level of door signal

Section 11

- a. 11.2B Vertical and lateral acceleration amplitudes
- b. 11.3.1C1 Dynamic outline
- c. 11.4.1A Tread and flange contour
- d. 11.4.2C Axle serial numbers
- e. 11.4.4 Pressure and fit for wheel assembly

Section 13

- a. 13.1 Contact rail steady state and transient impedance values and available fault current values

Section 14

- a. 14.4.1B Trip cock operating requirements
- b. 14.4.1C7 Test fitting locations for brake cylinder pipe

- c. 14.4.2A8d Brake pipe air pressure reduction level
- d. 14.4.2B Additional items to operate from the air compressor
- e. 14A.2,14.6A Dump valve maximum operating time
- f. 14A.2; 14.6B Maximum time braking removed
- g. 14A.2.1E Consist instrumentation

Section 15

- a. 15.3.1 Commands, carrier frequency, and code rate
- b. 15.3.2C Speed below which is considered zero speed
- c. 15.3.4 Pre-set deceleration rate and time limit
- d. 15.4 ATS data and train destination elements
- e. 15.4C Information bits, error security definition and maximum train speed for communication link
- f. 15A.3.1 Number of commands, carrier frequency, code rates
- g. 15A.3.1C Zero speed upper limit
- h. 15A.3.4 Deceleration switch limits
Deceleration rate and time limit
- i. 15A.3.5B1 Manual mode conditions
Manual mode limits
- j. 15A.3.5B2 Automatic mode conditions
Automatic mode limits
Number of separate identities for each element
Integration of motorized sign control

- k. 15A.4.1A Number of information bits
 Communication link
 Maximum speed percentage
- l. 15A.4.2B Lower limit percentage ATP speed
 Lower limits percentage of acceleration
- m. 15A.5.1B Speed measurement accuracy
- n. 15A.5.1C Speed control bank
- o. 15A.5.1D1 Alternate I
 Positive tractive effort levels
 Alternate II
 "P" wire control diagram
- p. 15A.5.1D2 Alternate I
 Negative tractive effort levels
 Alternate II
 "P" wire control diagram
- q. 15A.5.2A Station stop accuracy
- r. 15A.5.2B PSS overall system accuracy
 Marker system platform alignment
 Average closed loop deceleration rate

Section 16

- a. 16.3B2 Number of loudspeakers
- b. 16.5A Number of channels
- c. 16.5G Operating frequency
- d. 16.6 Chime signal functions and frequency

Section 17

- a. 17.4.2G Number of portable test gauges

Section 18

- a. 18.7A Shear pin requirements for shipping

Section 20

- a. 20.2.1.4 EMI frequency range
b. 20.4.3.5B Collecting rail surface dis-
continuities

Section 21

- a. Figure 21-1 Training locations

Section 23

- a. Figure 23-1 CDRL completing information

Appendix A

- a. A.5 Average duty cycle

APPENDIX B
DOCUMENT SOURCES.



DOCUMENT SOURCES

The below listed documents are those of Section 22, Applicable Documents, of the Standard Specifications that are not normally on hand at a transit authority. The list provides the address of the organization from which to order and the price as of September, 1980.

INDUSTRIAL			Address ¹	Price (\$)
ACRI	680	Standard for Air Filter Equipment	C	3.00
AGMA	240.01	Gear Materials Manual	D	12.00
AGMA	250.03	Lubrication of Industrial Enclosed Gear Drive		8.00
AGMA	251.02	Lubrication of Industrial Open Gearing		8.00
Aluminum Ind. Assoc.		Aluminum Standards and Data	E	
ANSI	B16.18	Cast Bronze Solder-Joint Pressure Fittings	F	9.00
ANSI	B16.22	Wrought Copper and Bronze Solder-Pressure Fittings		3.50
ANSI	B31.1	Power Piping		50.00
ANSI	C37.13	Low Voltage AC Power Circuit Breakers Used in Enclosures		9.00
ANSI	C37.14	Low Voltage DC Power Circuit Breakers and Anode Circuit Breakers		5.00
ANSI	C37.16	Low Voltage Power Circuit Breakers and AC Power Circuit Breakers, Ratings, Requirements, and Recommendations		5.00
ANSI	S1.2-1962	Physical Measure of Sound, Method for		5.50

¹Addresses are keyed to attached list

²Government documents free of charge

			Address	Price(\$)
ANSI	S1.13-1971	Sound Pressure Levels, Methods for the Measurement of	F	6.75
ANSI	Y32.16	Reference Designations for Electrical and Electronic Parts and Equipment		6.50
ANSI	Z26.1	Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways, Safety Code for, (including Addenda)		7.50
EIA	RS-152-B	Land Mobile Communications	G	6.00
EIA	RS-159	Vehicular Receivers		2.00
EIA	RS-160	Sound Systems		2.00
EIA	RS-186-D	Standard Test Methods for Passive Electronic Component Parts		3.00
EIA	RS-199-A	Solid and Semi-Solid Transmission Lines		5.70
EIA	RS-204-A	Land Mobile Communications FM or PM Receivers 25-470 MHz		8.00
EIA	RS-220	Continuous Tone-Controlled Squelch Systems		6.50
EIA	RS-278-A	Mounting Dimensions for Loudspeakers		3.40
EIA	RS-280-A	Solderless Wrapped Electrical Connections		7.50
EIA	RS-390	Semiconductor Logic Gating Microcircuits; Noise Margin Measurements		2.00
NEMA	LD3	High Pressure Decorative Laminates (1975)	H	10.20
NEMA	MG1	Motors and Generators		29.40

Address¹ Price(\$)

Address ¹	Price(\$)
H	8.45
K	3.00
A	(1)

NEMA WC5 Thermoplastic Insulated Wire
 *IPCEA S-61-402 and Cable for the Transmission
 and Distribution of Electrical
 Energy

NFPA 258-76 Standard Test Method for
 Measuring the Smoke Genera-
 ted by Solid Materials

GOVERNMENT²

FED-STD-501A Floor Covering, Resilient,
 Nontextile, Sampling and
 Testing

FED-STD 595a Colors

MIL-STD-105 Sampling Procedures and Tables
 for Inspection by Variables
 for Percent Defectives

MIL-STD-454F General Requirements for Elec-
 tronic Equipment

MIL-STD-461A Electromagnetic Interference
 Characteristics Requirements
 for Equipment

MIL-STD-471 Maintainability Verification/
 Demonstration/Evaluation

MIL-STD-889B Dissimilar Metals

MIL-STD-1472B Human Engineering Design
 Criteria for Military Systems
 Equipment and Facilities

DOD-P-21035A Paint, High Zinc Dust Content,
 Galvanizing Repair (Metric)

DOI/TSC GSP-064 Testing Procedures

Federal TT-P-38D Paint, Aluminum, Ready-Mixed

Federal TT-P-664C Primer Coating, Synthetic,
 Rust-Inhibiting Lacquer-Resisting

Federal WW-T-799E Tube, Copper, Seamless, Water
 and Refrigeration (For Use With
 Solder-Flared-Or Compression
 Type Fittings)

¹Addresses are keyed to attached list

²Government documents free of charge ³.

		Address	Price (\$)
MIL-C-005015	Connectors, Electrical	A	
MIL-P-8053 MIL-P-8053C	Plywood Core Sandwich Panels		
MIL-P-13949E	Plastic Sheet, Laminated, Copper Clad		
MIL-M-15071H	Manuals, Technical: Equip- ment and Systems, Contents Requirements for		
MIL-C-22750C	Epoxy, Polyimide		
MIL-M-38784A	Manuals Technical: General Requirements for Preparation of		
MIL-I-46058C	Insulating Compound, Electrical		
MIL-S-3930D	Low Voltage Switches		
MS-25036L	Wire Terminations, Crimp- Style Terminal Lugs		

MANUALS, PRACTICES, CODES AND GUIDELINES

INDUSTRIAL

		Address	Price (\$)
AAR	Communications Manual	M	1.20
AAR	Wheel and Axle Manual		
APTA	Guidelines for Design of Rapid Transit Facilities	P	25.00
APTA	Rapid Transit Systems Glos- sary of Reliability, Availa- bility, and Maintainability Terminology for Rail Rapid Transit		3.00
ASME	Boiler and Pressure Vessel Code for Unfired Pressure Vessels (1977)	Q	85.00

			Address	Price (\$)
AWS		American Welding Society Structural Welding Society	N	20.00
AWS		Welding Aluminum		4.00
AWS		Brazing Manual		20.00
22.4.2	GOVERNMENT			
AFSC		Handbook DH-1-3	B	
DOT	UMTA-MA-06 -0025-79-1	Flammability Tests, Electrical Insulation Fire Characteristics, 1978. (PB 294-840/4WT)	R	Contact NTIS
DOT	UMTA-MA-06 -0025-79-2	Toxicity (PB 294-841/2WT)		Contact NTIS
FCC		Rules and Regulations, Part 93	S	

A		U.S. Naval Publications & Forms Center 5801 Tabor Ave Philadelphia, PA 19120 Attn: Code 1052	215/697-3321
B		ASD/ENESS Mr. Vorvell Wright-Patterson AFB OH 45433	
C	ACRI	Air Conditioning & Refrigeration Institute 1815 N. Ft. Myer Dr. Arlington, VA 22209	703/524-8800
D.	AGMA	American Gear Manufacturer's Association 1901 N. Ft. Myer Dr. Arlington, VA 22209 (include \$2 postage & handling)	703/525-1600
E		Aluminum Industry Association 818 Connecticut Ave., N.W. Washington, DC 20006	202/862-5100
F	ANSI	American National Standards 1430 Broadway New York, NY 10018 Attn: Sales (add 6% shipping & handling)	212/354-3473
G	EIA	Electronic Industries Association 2001 I St. N.W. Washington, DC 20006 (Julia White)	202/457-4900
H	NEMA	National Electrical Manu- facturers Assoc. 2101 L. St. N.W. Washington, DC 20037	202/457-8400
K	NFPA	National Fire Prevention Assoc. Publications Department 470 Atlantic Ave Boston, MA 02210	202/466-3651

L	NHTSA	National Highway Traffic Safety Administration Order from: Superintendent of Documents Government Printing Office Washington, DC 20402	202/783-3238
M	AAR	Association of American Railroads Communication & Signal Div. 1920 L.St. N.W. Washington, DC 20036	202/293-4126
N	AWS	American Welding Society Publications Catalogue 2501 N.W. 7th Street Miami, FL 33125	305/642-7090
P	APTA	American Public Transit Assoc. 1225 Connecticut Ave. Washington, DC 20036	202/828-2800
Q	ASME	American Society of Mechanical Engineers 345 E. 47th Street New York, NY 10017	212/644-7703
R	NTIS	U.S. Department of Commerce National Technical Information Service 5285 Port Royal Road Springfield, VA 22161	703/557-4650
S	FCC	Federal Communication Commission Order from: Superintendent of Documents Government Printing Office Washington, DC 20402	202/783-3238

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