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DETAIL SPECIFICATION FOR STATE-OF-THE-ART CAR

BOEING VERTOL COMPANY
Surface Transportation Systems Department
Philadelphia, Pa. 19142

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Prepared for
URBAN MASS TRANSPORTATION ADMINISTRATION
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16. Abstract

This document is the detail specification for the State-of-the-Art Car (SOAC). This specification represents the SOAC configuration as delivered to the Urban Mass Transportation Administration (UMTA) for test and demonstration.

The SOAC has been developed under UMTA's Urban Rapid Rail Vehicle and Systems program which has the objective of enhancing the attractiveness of rapid rail transportation to the urban traveler by providing him with transit vehicles that are as comfortable, reliable, safe and economical as possible. The SOAC is one phase of this program.

This specification was prepared by St. Louis Car Division, General Steel Industries, Inc. It has been reorganized into the format of the "Guideline Specification for Urban Rail Cars" by the Boeing Vertol Company, Systems Manager for the Urban Rapid Rail Vehicle and Systems Program.

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FOREWORD

This specification represents the State-of-the-Art Car configuration as delivered for test and demonstration.

The specification was prepared by St. Louis Car Division, General Steel Industries, Inc. It has been reorganized into the format of the "Guideline Specification for Urban Rail Cars" by the Boeing Vertol Company, Systems Manager for the UMTA Urban Rapid Rail Vehicle and Systems Program.

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INTRODUCTION

The U.S. Department of Transportation, Urban Mass Transportation Administration (UMTA), under Contract DOT-UT-10007, has engaged the Boeing Vertol Company to act as Program Manager of the Urban Rapid Rail Vehicle and Systems Program. This program is an integrated development program directed toward improving high speed, frequent-stop urban rail systems. The overall objective is to enhance the attractiveness of rail transportation to the urban traveler by providing service that is as comfortable, reliable, safe and economical as possible.

The objective of the State-of-the-Art Car (SOAC) is to demonstrate the best state-of-the-art in rapid rail car design, with two new improved cars to be built using existing proven technology. Primary goals for the cars are passenger convenience and operating efficiency.

The cars must be constructed in such a way as to be adaptable for the future demonstration of alternate subsystems. Subsystem modifications shall be consistent with providing a demonstration of the best available technology in the shortest possible time.

At UMTA's request, this specification was prepared using a rapid rail transit car guideline specification (developed under Contract DOT-UT-10010) as a baseline. Consequently, some paragraph numbers (from the guideline specification) are indicated as being "not applicable" or "not specified." When a paragraph is indicated as being "not specified," accomplishment of the intent of the paragraph is left to the discretion of the Seller.

SECTION 1

SCOPE

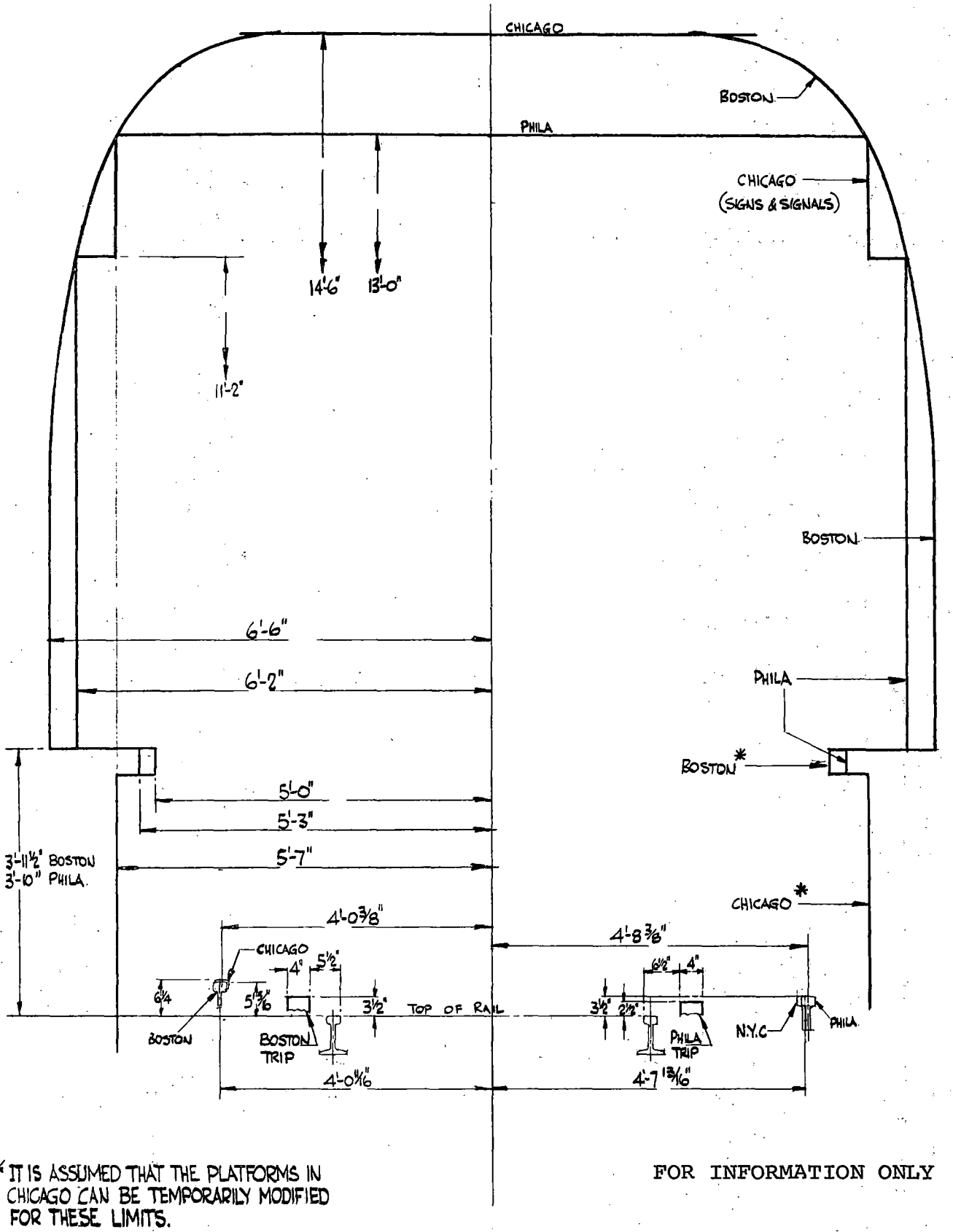
This specification comprises the detail requirements for the design, performance, construction and testing of an Urban Rapid Transit Car for the UMTA/Boeing Company. The overall characteristics of the vehicle are as follows:

Model Designation	SOAC (high density and low density)
Number of Cars	Two "A" Cars
Type of Power System	Electrical, Third Rail 600 VDC Nominal 450 VDC Minimum 650 VDC Maximum
Number of Seated Passengers (per car)	72 (high density) 62 (low density)

1.1 INTENDED USE

The transit vehicles described herein are intended for demonstration on selected portions of the following systems: (See Figure 1-1)

	Property	Line
a.	New York City Transit Authority (NYCTA)	Ind. Division
b.	Southeastern Penna. Transportation Authority (SEPTA)	Broad Street
c.	Massachusetts Bay Transportation Authority (MBTA)	Cambridge-South Shore
d.	Chicago Transit Authority (CTA)	Skokie-Swift
e.	Cleveland Transit Authority (CTS)	Airport



* IT IS ASSUMED THAT THE PLATFORMS IN CHICAGO CAN BE TEMPORARILY MODIFIED FOR THESE LIMITS.

FOR INFORMATION ONLY

COMPOSITE CLEARANCE OUTLINE
Figure 1-1

SECTION 2

DESIGN AND FABRICATION

2.1 GENERAL

This section defines the criteria for the design and fabrication of the transit cars, including the operational parameters, structural strength and environmental requirements.

2.1.1 OVERALL DIMENSIONAL CHARACTERISTICS AND OPERATIONAL PARAMETERS

2.1.1.1 Transit Car

The general arrangement drawings shall include the following dimensions with tolerances:

Length of car on centerline (over anti-climbers)	74 ft. 8-1/2 in.
Distance, center to center of trucks	54 ft. 0 in.
Truck Wheelbase	7 ft. 6 in.
Wheel diameter, new	30 in.
Width of car over side sheathing	9 ft. 9 in.
Width of car body at floor (without thresholds)	9 ft. 7 in.
Width over thresholds	9 ft. 7-1/4 in.
Width of side doors	50 in.

Height of side doors	6 ft. 3 in.
Height of empty car from top of rail (over roof sheet)	12 ft. 1-1/2 in. (at 3 ft. 10-1/2 in. floor height)
Height of empty car from top of rail (over pantograph, locked down)	13 ft. 1-7/8 in. (Cleveland) 13 ft. 6-1/2 in. (Chicago)
Height of car floor from top of rail (empty car)	3 ft. 5-1/2 in. to 3 ft. 10-1/2 in. (adjustable)

The car shall be designed to the NYCTA clearance lines. General arrangement, dynamic and equipment clearances shall be as indicated in Appendix 1 - Drawings.

2.1.1.2 Track

Track Gauge	4 ft. 8-1/2 in.
Minimum lateral curve radius (at centerline of track)	145 ft. 0 in. (max. floor height) 295 ft. 0 in. (min. floor height)
Power collector dimensions	Variable (See Figure 1-1)

2.1.2 WEIGHT

Empty car operating weight	90,000 lbs. maximum

2.1.3 DRAWINGS

The following drawings form a part of these specifications:

*2D35006	General Arrangement, High Density Car
*2D35007	General Arrangement, Low Density Car
2D35001	Design Cross-Section
*2D35018	Dynamic Clearance Diagram
*2D45044	Car Equipment Clearances
2D20001	Final Assembly, Placards and Paints
2D08200	Truck, Final Assembly
2D08300	Axle Assembly
2D08400	Axle Journal, 6 x 11
2D08402	Wheel, 30"
2D08306	Truck Pipe and Cable Assembly
2D08320	Height Adjustments for Platform Variations
2D20000	Car Body Assembly
2D21001	Structural Assembly
2D30300	Roof-Ceiling Assembly
2D30700	Cab Partition Assembly
2D31133	Floor Assembly

*Included in Appendix 1.

2D31141	Roof Assembly
2D35029	Pantograph Installation
2D35005	Structural Bulkhead
2D35019	Structural Assembly, No. 1 End
2D30100	Underframe Assembly
2D31000	End Weldment
2D35012	Anchor Rod Bracket Assembly
2D35014	Underframe Equipment Arrangement
2D22200	Drawbar Installation
2D31524	Air Piping and Cable Support Assy., Coupler 1
2D31525	Air Piping and Cable Support Assy., Coupler 2
2D35043	Pipe Schematic
2D21200	End Assembly, No. 2 End
2D35048	Pantograph Conduit, Circuit Breakers and Hostler Receptacle Installation
2D22300	Side Door Installation
2D22800	Side Window Installation
2D25300	Window and Side Sign Installation
2D23200	Panel Installation, Interior
2D31100	Panel Assembly, Interior
2D35069	Panel Assembly, Interior, Car No. 2
2D23300	Heater Installation
2D23700	Seating and Flooring Installation
2D24000	Lighting Installation
2D24400	Cab Interior Finish Installation
2D24700	Low Ceiling Frame Installation
1C24800	Low Ceiling Panel Installation
2D25000	Wiring Installation
2D25200	End Door Installation, No. 2 End
2D31015	A/C Unit, Thermostat and Speaker Installation
2D31037	Headlight and Tail Light Installation, No. 1 End
2D35049	Handbrake Installation
2D35070	Windshield Wiper Installation, No. 1 End
2D35095	Application of Vertical Panels and Front Dash, Cab
2D35072	Final Assembly, Exterior Paints
3W-16120	Side Door (O.M. Edwards Co.)
3W-16237	End Door (O.M. Edwards Co.)
2D40003	Glass, Side Window
2D45035	Glass, Side Window, Side Sign
2D40237	Glass, Side Door
2D40240	Glass, End Door
2D40248	Glass, Cab Door
2000027	Propulsion System (Garrett)
2000754	Drive Unit Assembly (Garrett)
2014606	Auxiliary Power Motor/Alternator (Garrett)
2000434	Auxiliary Power Control (Garrett)
2007002	Brake System (Garrett)

2.2 PERFORMANCE CHARACTERISTICS

2.2.1 DEFINITION OF SYSTEM UNITS FOR PERFORMANCE SPECIFICATION

2.2.1.1 Electric Propulsion

2.2.1.1.1 The required performance shall be obtained using a system voltage of 600 VDC. Nominal system voltage will be 600 volts with operating extremes of 450 volts and 650 volts, and occasional extremes of 425 volts and 675 volts. All on-board equipment shall function but not necessarily to specified performance at voltages other than nominal within the cited extremes.

2.2.1.1.2 The maximum acceleration and braking shall be obtained utilizing a motor duty cycle based on the operating profile illustrated in Figure 2-1. The thermal design of the motor shall be such that the duty cycle (Figure 2-2) may be repeated for a period of one hour, including a 30-second station dwell time after each cycle. Maximum train speed shall be obtained using not more than the continuous motor power rating and within the motor speed (RPM) limitations.

2.2.1.1.3 Power Consumption (Not specified)

2.2.1.2 Internal Combustion/Gas Turbine Propulsion (Not applicable)

2.2.1.3 Definition of Standard Train

2.2.1.3.1 The standard train shall consist of two self-propelled cars. Performance of the individual cars, operating separately, is contained in Sections 2.2.2, 2.2.3 and 2.2.4.

2.2.1.3.2 For performance purposes, the weight of each car shall be defined by the following table:

Empty Car Operating Weight.....AW0 (90,000 pounds)

Normal Load Car Weight.....AW1 (105,000 pounds)
Comprises:
Empty Car Operating Weight (AW0)
Seated Load plus Standing Load 15,000 pounds
(100 passengers @ 150 lbs. ea.)

Full Load Car Weight.....AW2 (113,000 pounds)
Comprises:
Empty Car Operating Weight (AW0)
Seated Load plus Standing Load 23,000 pounds
(153 passengers @ 150 lbs. ea.)

VEHICLE OPERATING PROFILE

Single Car
Car Weight: AW1 = 105,000 Lbs.
Station Spacing (Avg): 1.18 Miles

NOTES
1. Level tangent track.
2. Zero wind.
3. Data basis: HSGTC Acceptance Tests - 4/73.

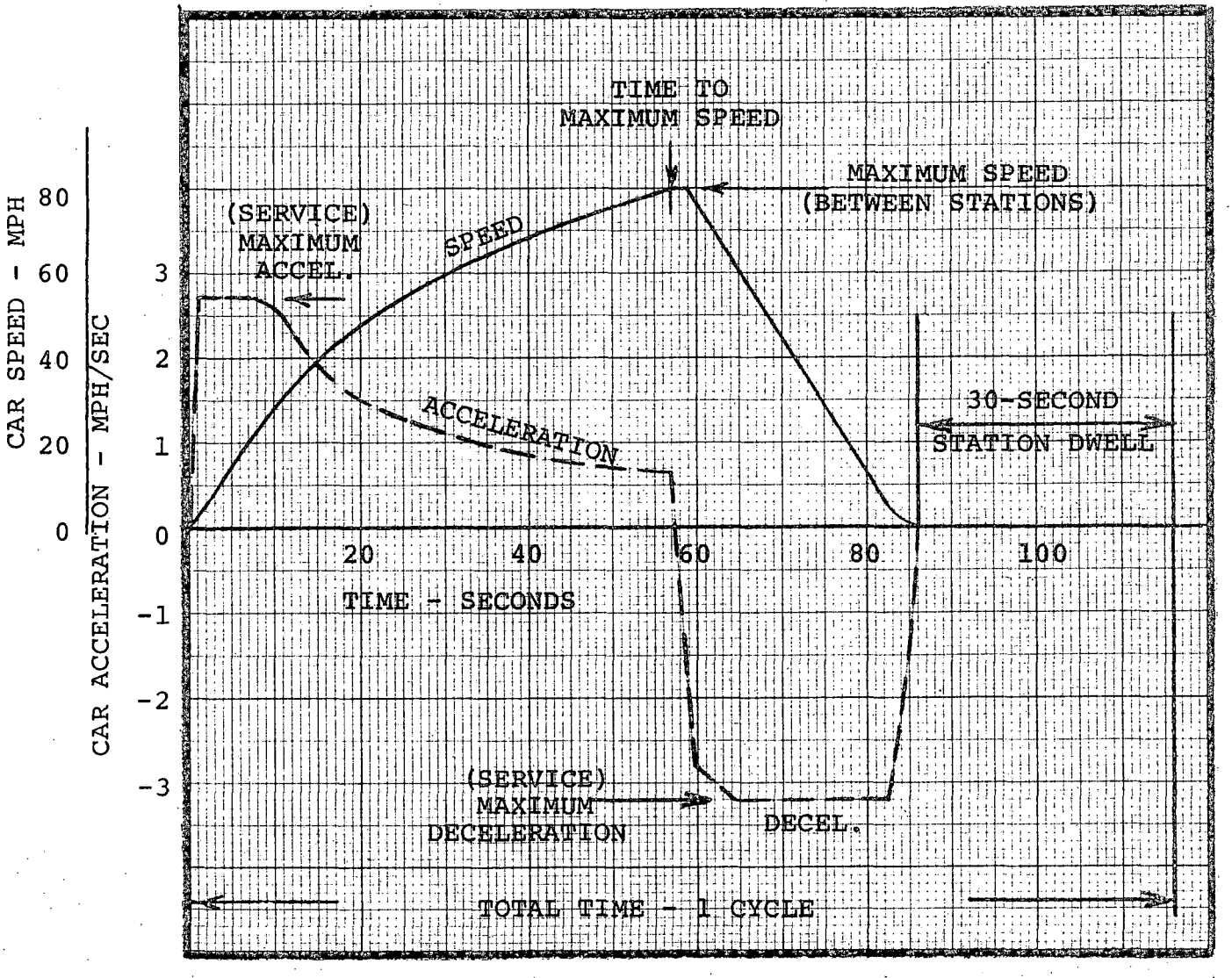


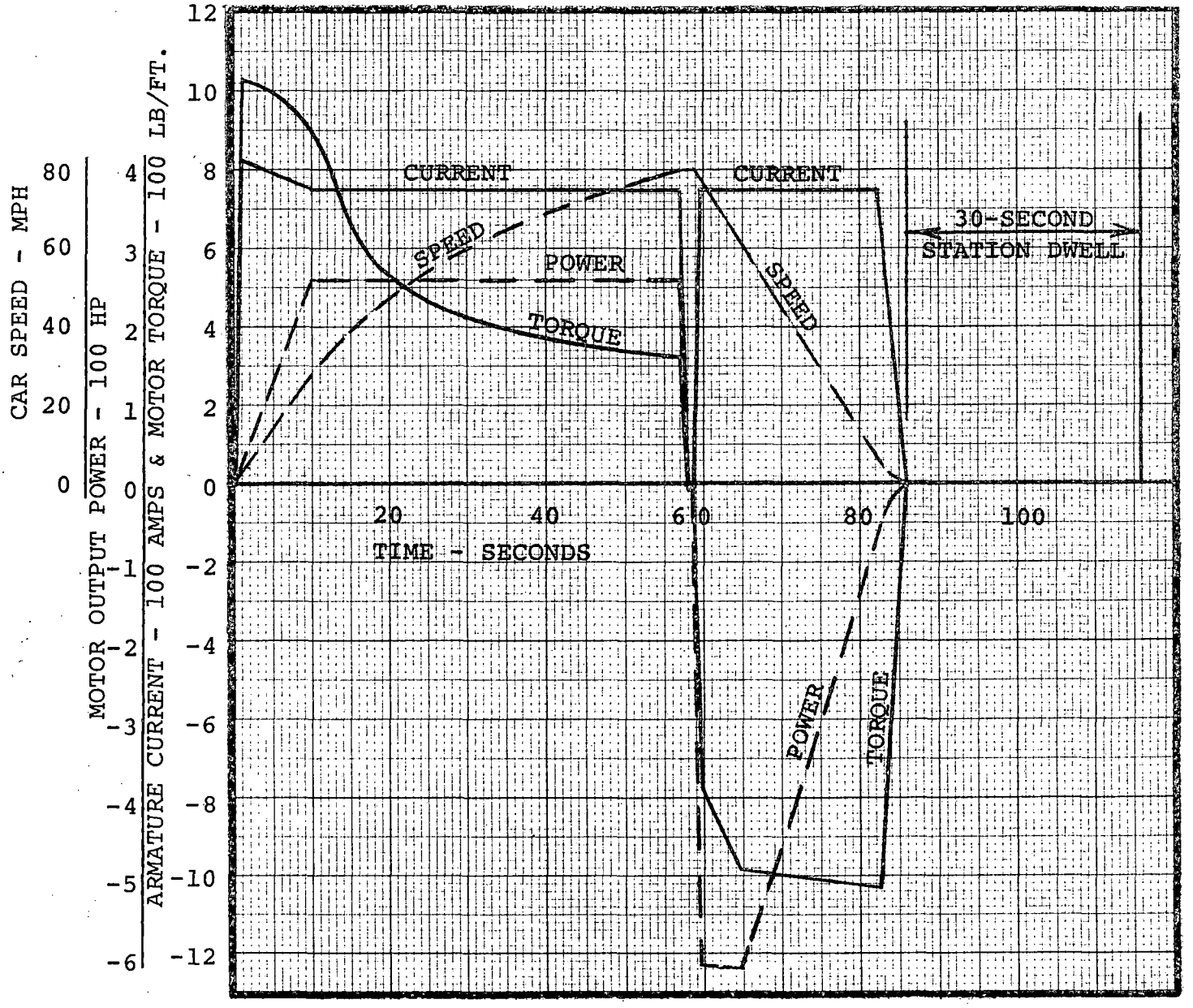
FIGURE 2-1

MOTOR DUTY CYCLE

Car Weight: AW1 = 105,000 Lbs.

NOTES

1. Single car.
2. Level tangent track.
3. Zero wind.
4. Gear ratio: 4.78
5. Wheel Dia.: 30 in. (new)
6. Gear losses included.
7. Data Basis: HSGTC Acceptance tests - 4/73.



SEE FIGURE 2-1 FOR SOAC OPERATING PROFILE

FIGURE 2-2

DESIGN TRACTIVE EFFORT
SPEED CHARACTERISTICS

Car Weight: AW1 = 105,000 Lbs.

NOTES
1. Level tangent track.
2. Zero wind.
3. Gear ratio: 4.78
4. Wheel Dia.: 30 in. (new)
5. 600V third rail.
6. Four motors per car.
7. Data Basis: estimated.

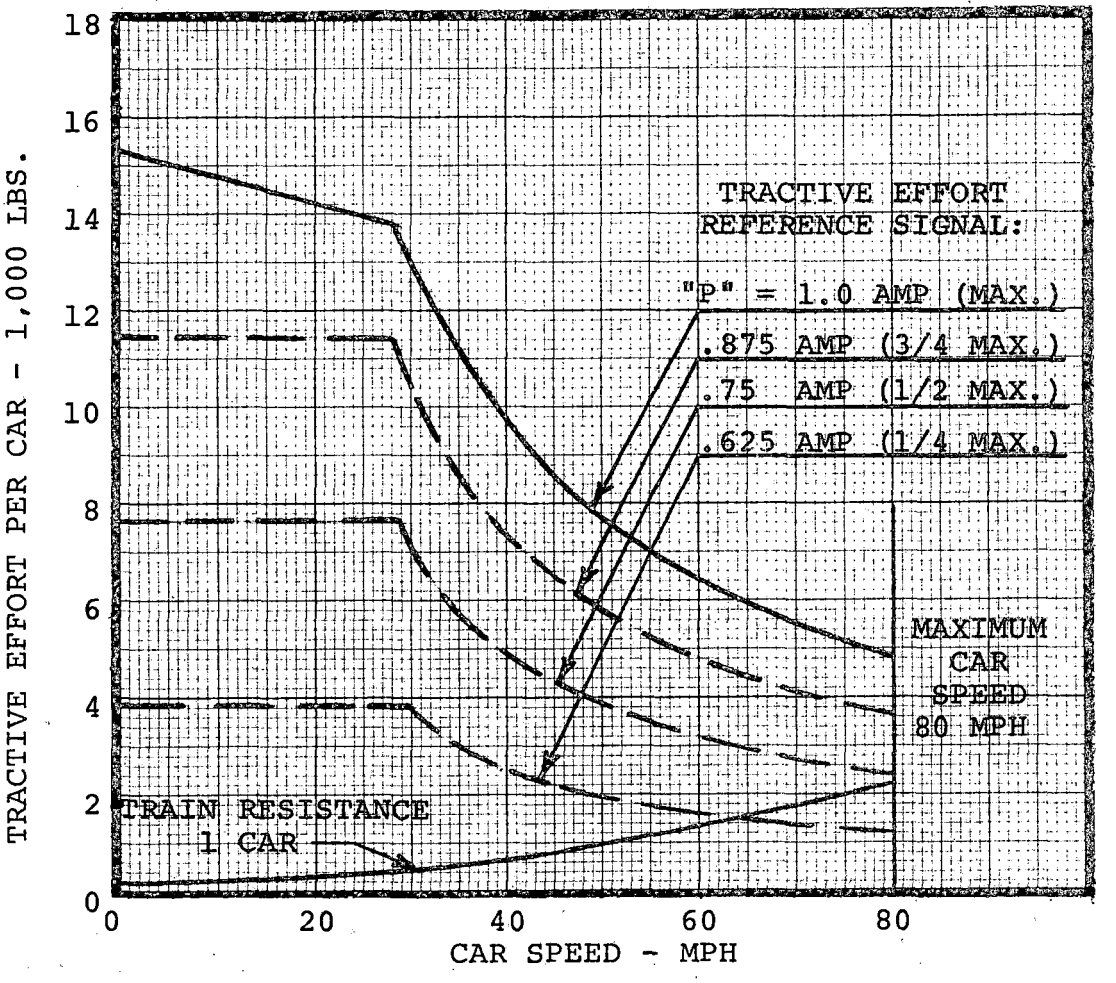


FIGURE 2-3

ACCELERATION AND DECELERATION CHARACTERISTICS

Single Car
Car Weight: AW1 = 105,000 Lbs.

NOTES

1. Level tangent track.
2. Zero wind.
3. Gear Ratio: 4.78
4. Wheel Dia.: 30 in. (new).
5. Includes jerk rate limits.
6. Data Basis: HSGTC Acceptance Tests - 4/73.

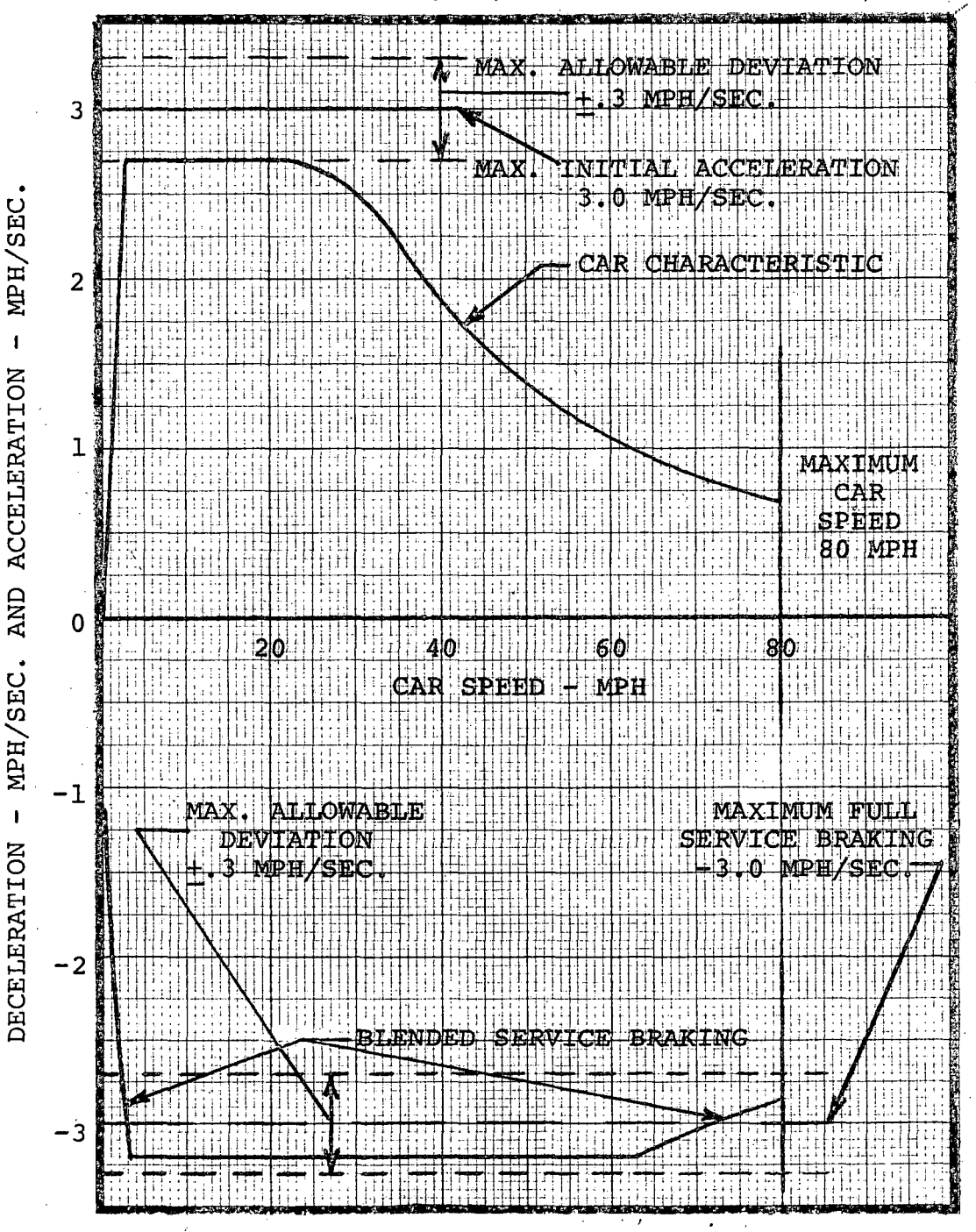


FIGURE 2-4

TIME AND DISTANCE TO SPEED

Single Car
Car Weight: AW1 = 105,000 Lbs.

NOTES
1. Level tangent track.
2. Zero wind.
3. Acceleration per Figure 2-4.
4. Jerk limits included.
5. Data Basis: HSGTC Acceptance Tests - 4/73.

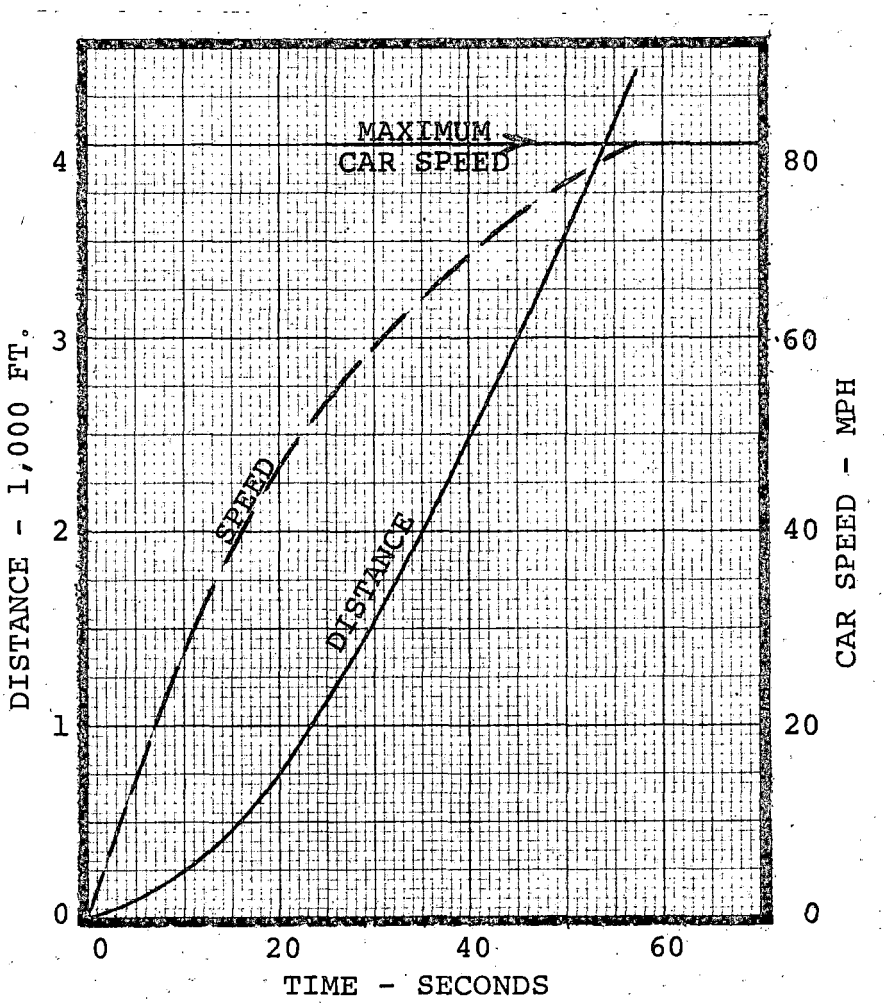


FIGURE 2-5

2.2.4.1.3 Both service friction braking and blended braking systems shall be capable of developing the performance specified in paragraphs 2.2.4.1.1, 2.2.4.1.2 and Figure 2-4. This requirement is deleted for the dynamic brake system below its fade point of 6 mph. (See Figure 2-6A for blended brake time, speed, distance diagram.)

2.2.4.1.4 The service friction brake system (without dynamic braking) shall be capable of the following performance at car weight AW1:

Initial Speed	Max. Distance to Stop
40 mph	450 feet
80 mph	2250 feet

(See Figure 2-6B for time, speed, distance, friction braking diagram.)

2.2.4.1.5 The dynamic/friction brake blending system shall provide the friction brake system with a signal proportional to the required brake effort less dynamic brake effort. Brake blending shall operate under the jerk rate limits of Section 2.2.6, with a maximum brake effort limit of -3.3 mphps. Combined (blended) braking shall not be less than service friction braking.

2.2.4.2 Emergency Brake System

2.2.4.2.1 The nominal emergency friction braking deceleration shall be 3.2 mphps $\pm$10 percent at speeds up to 40 mph using friction braking only. This rate shall be achieved up to car weight AW2, under control of the load-weighing system, exclusive of the translation error of car weight to suspension pressure.

2.2.4.2.2 The emergency friction braking system (without dynamic braking) shall be capable of the following performance at car weight AW1:

Initial Speed	Max. Distance to Stop
40 mph	425 feet
80 mph	2200 feet

(See Figure 2-6C for time, speed, distance braking diagram.)

2.2.4.2.3 Use of the emergency-stop mode of train control shall disable the wheel slip-slide system. Jerk rate limiting of Section 2.2.6 shall be deleted in the emergency-stop mode.

TIME AND DISTANCE TO STOP
BLENDED SERVICE BRAKING

Single Car
Car Weight: AW1 = 105,000 Lbs.

NOTES
1. Level tangent track.
2. Zero wind.
3. Deceleration per Figure 2-4.
4. Jerk limits and dead time included.
5. Data Basis: HSGTC Acceptance Tests - 4/73.

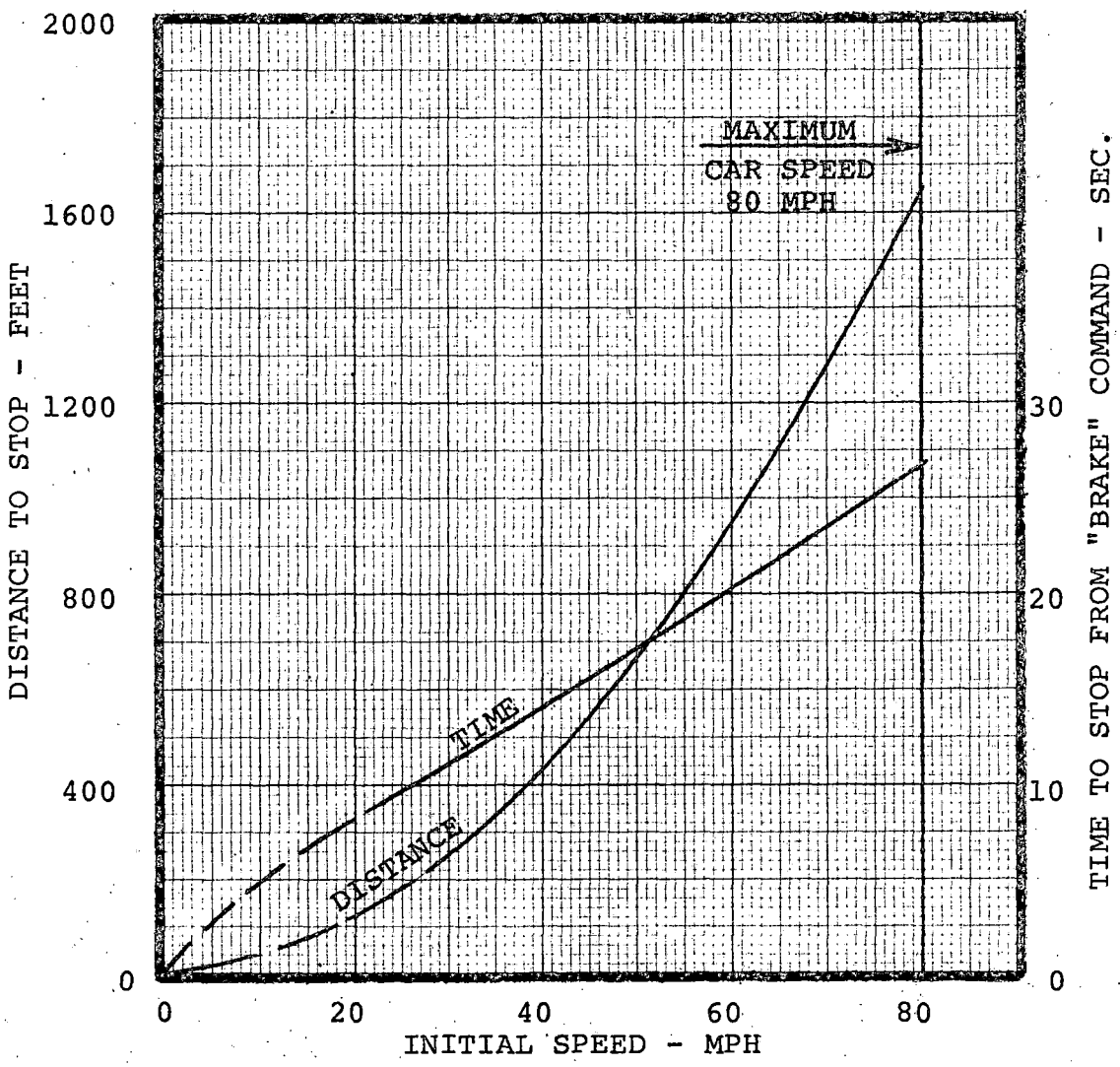


FIGURE 2-6A

TIME TO DISTANCE TO STOP
SERVICE FRICTION BRAKING

Single Car
Car Weight: AW1 = 105,000 Lbs.

NOTES
1. Level tangent track.
2. Zero wind.
3. Jerk limits and dead time included.
4. Data Basis: HSGTC Acceptance Tests - 4/73.

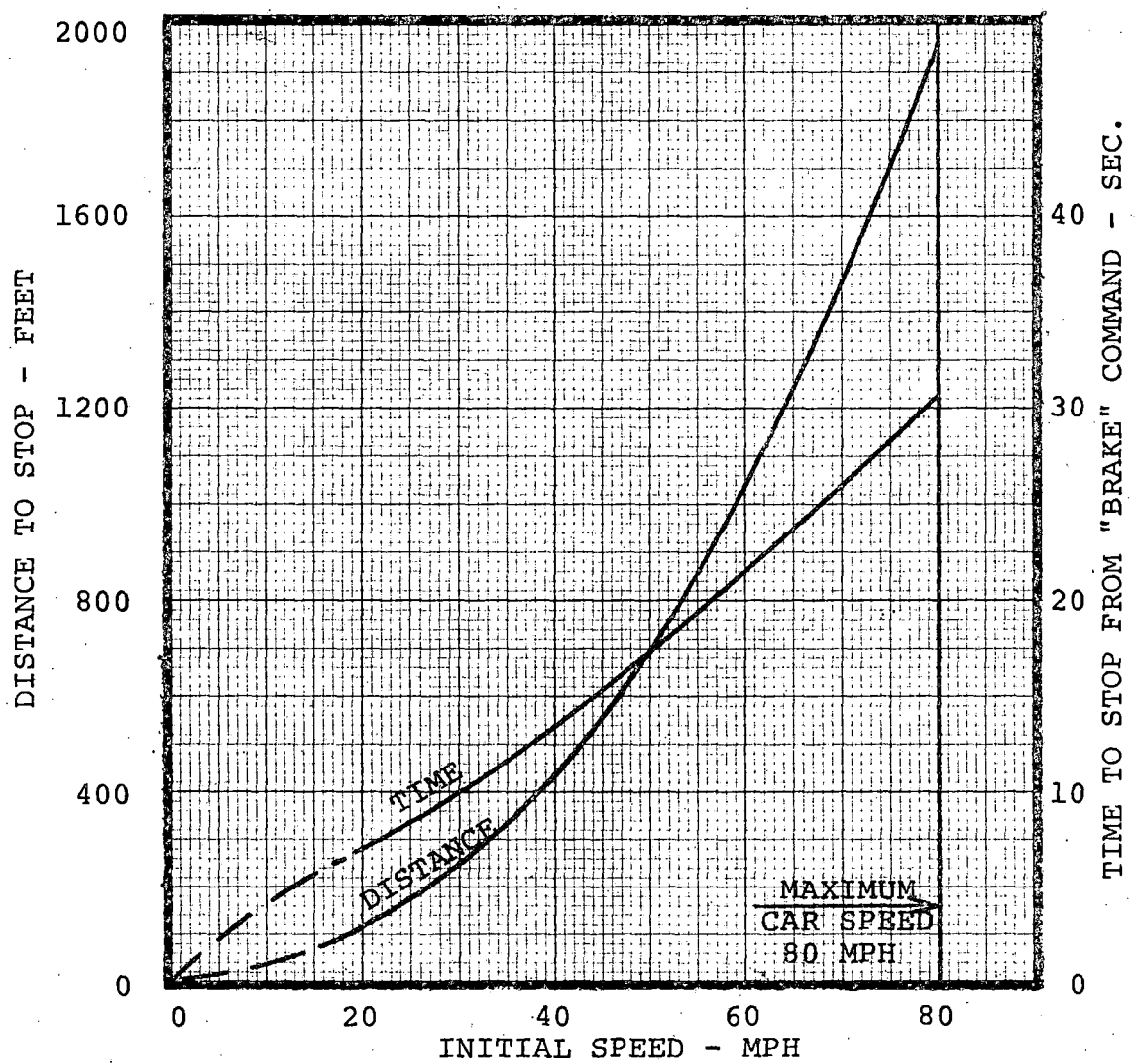


FIGURE 2-6B

TIME AND DISTANCE TO STOP
EMERGENCY FRICTION BRAKING

Single Car
Car Weight: AW1 = 105,000 Lbs.

NOTES
1. Level tangent track.
2. Zero wind.
3. Data Basis: HSGTC Acceptance Tests - 4/73.

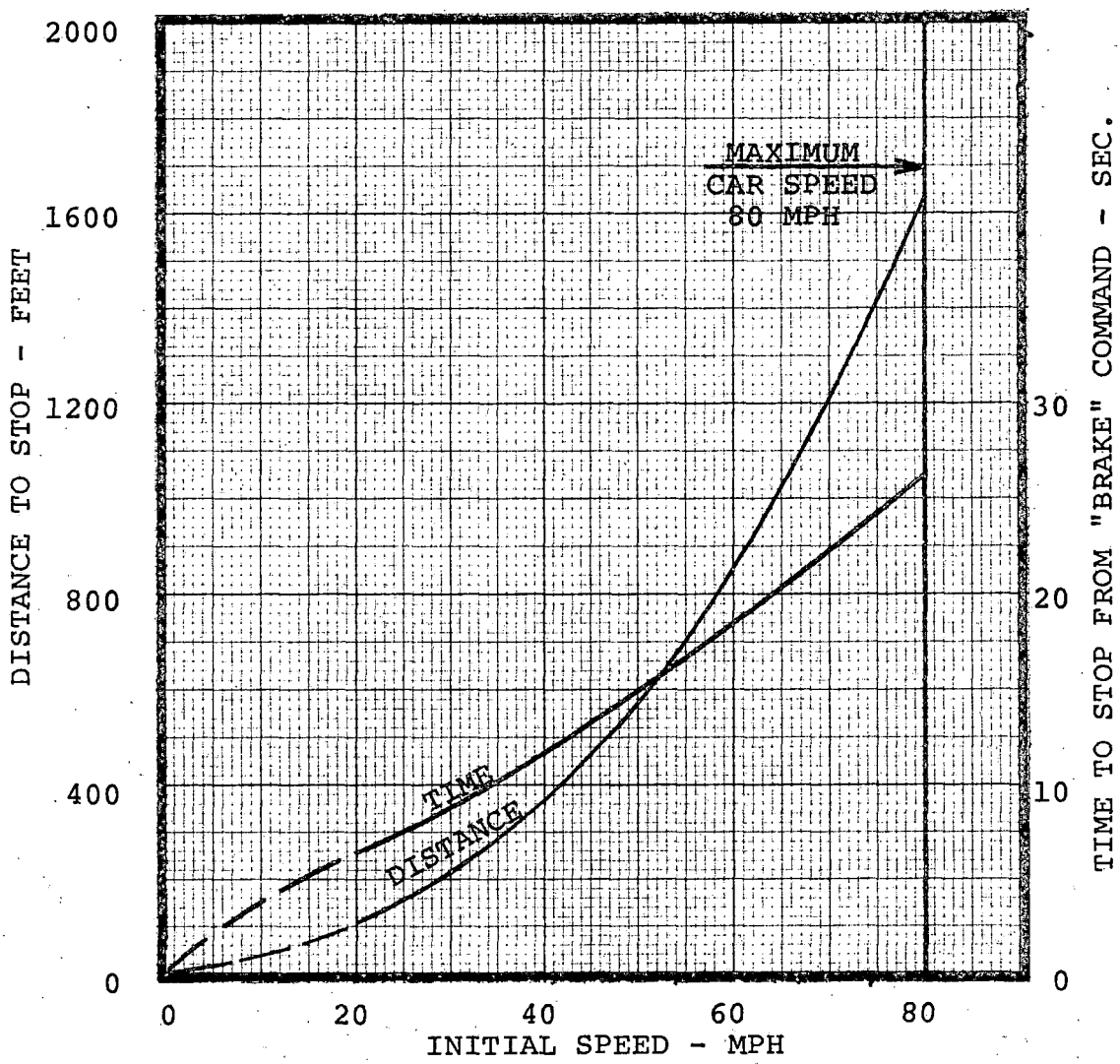


FIGURE 2-6C

2.2.5 WHEEL SLIP-SLIDE PROTECTION

2.2.5.1 General

The slip-slide system shall detect slips and slides whether they are random or synchronous. The wheel slip-slide protection system shall be fail-safe in design and construction. The normal failure mode of the system shall be such as to render the wheel slip-slide system ineffective and allow the brake to be applied.

Consideration will be given such that failure modes which produce invalid indications of a wheel slip or slide will be tolerated, providing apparatus is included to detect such invalid signals and restore braking effort within 1 to 5 seconds (adjustable) of the receipt of the invalid signal and providing the method of achieving the timing is inherently fail-safe. Failure of slip-slide shall not prevent braking or remove application of emergency brakes.

As a design goal, the efficiency of the wheel slip-slide detection system, as defined in Figure 2-7, shall be at least 80 percent during slips in acceleration and slides in braking, at 40 mph. Efficiency is defined as the average car deceleration or acceleration rate (mphps) expressed as a percentage of the rate which adhesion is capable of supporting during any continuous sequence of the wheel slip-slide detection system.

2.2.5.2 Operation

The slip-slide protection system shall be adjustable to function properly with differences of up to 2 inches in diameter among the wheels of a car. It shall detect slips in acceleration and slides in braking on the order of 7 percent of car speed, or 5 mph, whichever is greater, or wheel acceleration or deceleration rates in excess of 8 mphps. Alternative detection arrangements offering equal or better protection will be considered.

2.2.5.2.1 Upon detection of a slip during acceleration, power shall be reduced only on the axles of the truck which has a slipping wheel until the slip is corrected. Power shall then be reapplied automatically under the jerk limit control limitations of Section 2.2.6. Indication must be provided to the motorman. Release of tractive effort shall not be jerk limited.

2.2.5.2.2 Upon detection of a slide during braking the dynamic braking shall be reduced on all axles of the affected truck until the slide is corrected. Friction braking shall be modulated on the affected truck only, until the slide is corrected. After the slide has been corrected, braking shall be reapplied automatically at a rate consistent with obtaining maximum performance without exceeding the specified jerk limit.

SLIP-SLIDE PROTECTION SYSTEM EFFICIENCY

$$\text{Efficiency} = \frac{\text{Area } (A_2)}{\text{Area } (A_1 + A_2)} \times 100\%$$

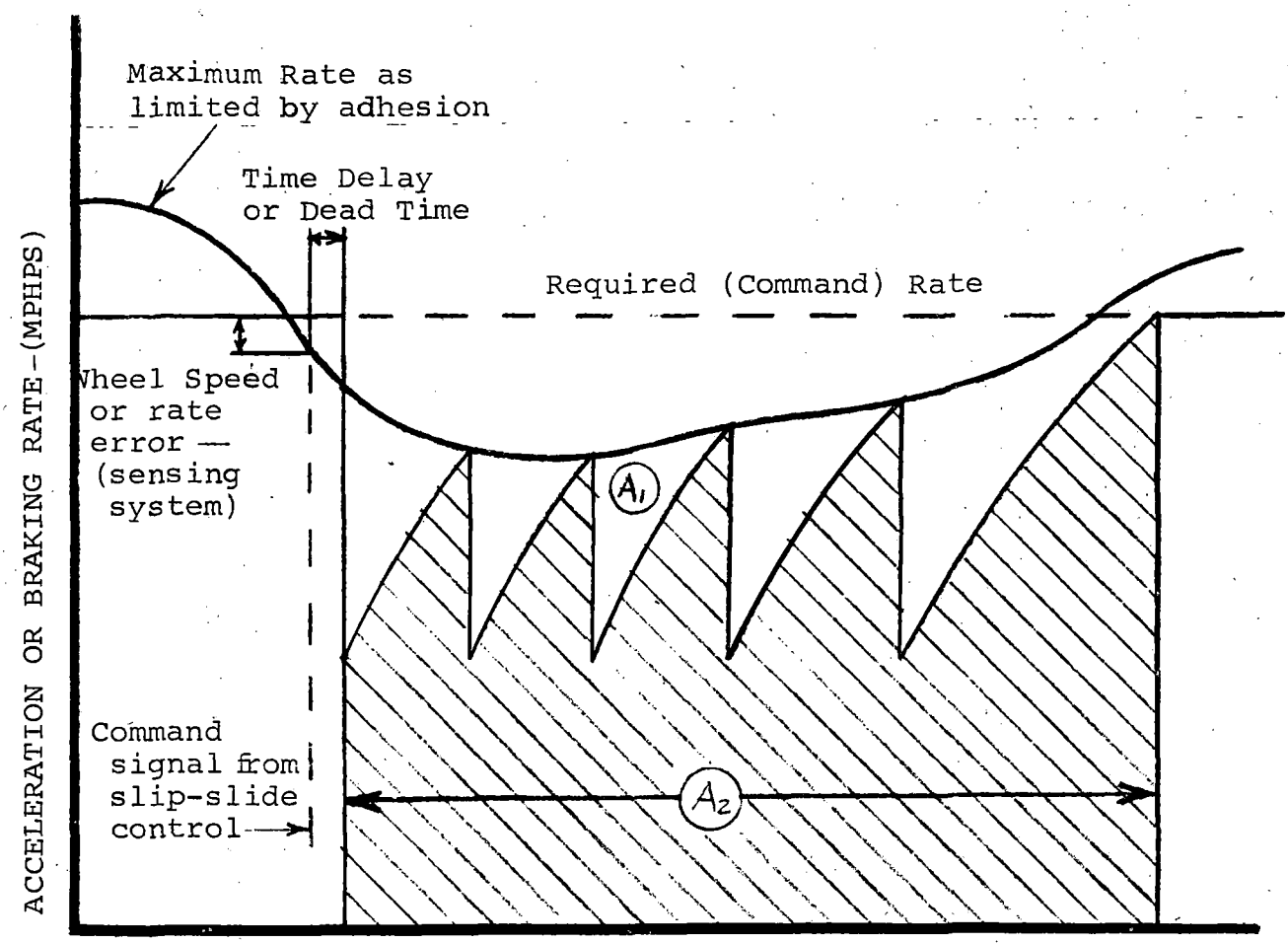


Figure 2-7

2.2.5.2.3 The wheel slide protection system shall be functional under all braking commands, except emergency. The system shall be so arranged that failure of any component of this system shall not prevent development of a full emergency brake application.

2.2.6 JERK RATE

2.2.6.1 The average rate of change of acceleration or deceleration of the car shall not be more than 2.5 mphps/ps under all normal manual control signals. Jerk rate limitation shall be inherent in the propulsion and braking system.

2.2.6.2 The jerk rate limits of paragraph 2.2.6.1 shall apply to power and braking applications and power and braking reapplications during normal function of the wheel slip-slide system. Instantaneous stop jerk shall not be greater than on R-44.

2.2.6.3 Jerk rate limiting for braking shall be fail-safe in design such that failure of the system shall not reduce the maximum available braking rate during deceleration.

2.2.7 CONTROL RESPONSE (DEAD) TIME

2.2.7.1 The maximum allowable response times for all detection and control systems shall be as follows:

Control Signal Change (MTC)	0.3 sec.
Acceleration and Deceleration Modulation	0.1 sec.

2.2.8 CAR LOAD-WEIGHING SYSTEM

2.2.8.1 The load-weighing system shall provide signals proportional to the total load on the trucks to both the traction system and dynamic and friction braking systems. The accuracy of the load-weighing system shall permit compliance with the acceleration and braking requirements of paragraphs 2.2.2.2 and 2.2.4.1.2 respectively, and the emergency braking requirements of paragraph 2.2.4.2.1.

2.2.8.2 Failure of the load-weighing system shall not allow greater acceleration or deceleration than provided for actual car weight and not less than the nominal initial acceleration and deceleration for an empty car.

2.2.9 SUBMITTAL OF PERFORMANCE DATA

Curves containing estimated values of car performance shall be provided by the Seller to substantiate the performance characteristics of the vehicle, if changed in any respect from data submitted at the time of bid. The data shall be presented in formats similar to Figures 2-2 and 2-7. This performance data shall include all pertinent data and criteria used to derive the performance characteristics of Section 2.2.

2.3 STRENGTH REQUIREMENTS

2.3.1 GENERAL

The entire car system which includes car body structure, trucks, doors, seats and interior appointments, shall be capable of resisting, without permanent deformation or failure, unless otherwise specified, the normal loads inherent in the type of service for which the vehicle is intended.

The trucks, including wheels, axles and brakes, shall withstand, without failure, the repeated loads induced by normal service.

The Seller shall be responsible for the allowable stresses used throughout the design. The Seller shall furnish the Buyer allowable stresses.

2.3.2 DEFORMATION

The car structure, including door support structure, shall not deform in a manner that would impair system function under service loads and operating conditions.

2.3.3 WEIGHT AND MASS DISTRIBUTION

The weights to be used for structural analysis and design are those assigned weights as described in paragraph 2.2.1.3.2 of this specification. Distribution of passenger load will be taken as uniform over the car length. Mass items will be assigned to the actual location on the structure.

2.3.4 FATIGUE

The stress levels used for repeated loads shall be 25,000 psi maximum for HTLA. The stress levels for stainless steel shall be prorated based on the yield stresses relative to 50,000 psi for HTLA.

2.3.5 DESIGN CONDITIONS

Design conditions are covered under the specific sections to which they apply; e.g., Car Body, Trucks, etc.

2.3.6 SUBMITTAL OF STRUCTURAL DESIGN DATA

The Seller shall demonstrate compliance with the requirement by suitably instrumented structural test as requested for R-44, or in lieu of same.

The Seller shall review stress analysis and design criteria with Buyer of structural members such as floor and equipment supports, front end framing, bulkheads and structural wind-screens and other deviations, if any, from the R-44 design.

2.4 MATERIALS

2.4.1 GENERAL

Composition, mechanical properties, and quality level shall conform to the latest release of the designated AISI, SAE, ASTM, OR AAR specifications, equivalent, or better.

2.4.2 STEEL

2.4.2.1 Structural steel sheets shall conform to the requirements of AAR-117, Reference Table 2-I, Grade I.

2.4.2.2 Carbon steel plate and bars suitable for forged and welded shapes shall conform to the requirements of Specification ASTM A113. Reference Table 2-I, Grade I-x.

2.4.2.3 Low alloy high tensile constructional steel with high corrosion resistance and suitable for welding shall conform to Table 2-I, Grade III.

2.4.2.4 Steel castings shall conform to Grade 70-36 of Specification ASTM A27, Reference Table 2-I, Grade VII. Truck castings to conform to low alloy cast steel. Reference Table 2-I, Grade VII-x.

2.4.2.5 High strength steel castings shall conform to grade 90-60 requirements of ASTM A148. Reference Table 2-I, Grade VII.

2.4.2.6 Carbon steel forgings with a minimum strength level of 88,000 psi UTS shall conform to ASTM A236, Class F. Finish shall conform to this specification and no complete decarburization shall be permitted. Reference Table 2-I, Grade III-x.

2.4.2.7 Alloy steel forgings with a minimum strength level of 110,000-125,000 psi UTS shall conform to ASTM A238, Class F. Reference Table 2-I, Grade III-y.

2.4.2.8 Rivet steel for sizes greater than 3/8-inch diameter, except those used on the body underframe, shall conform to ASTM A131. Small rivets shall conform to ASTM A31A. Reference Table 2-I, Grade VI.

2.4.2.9 Steel bolts for mounting equipment under car shall conform to ASTM A325. Reference Table 2-I, Grade I-ZZ, except Grade I-Z shall be used to mount the coupler anchor castings.

2.4.2.10 Hot rolled bar steel is to be used for brake levers, rods and hangers, conforming to Specification AISI C-1020, Table 2-I, Grade IV. Steel tubing parts, principally bushings, where fine grain is required, are to be made to Specification AISI C-1118, Table 2-I, Grade IV-x.

2.4.2.11 Wear plate spring steel shall conform to requirements of ASTM A68. Heat-treated coil springs shall conform to ASTM A125 for truck bolsters, equalizers and coupler heads. Other coil springs shall be manufactured from oil tempered spring steel wire which conforms to the requirements of ASTM A229.

2.4.2.12 Wheel forgings shall conform to ASTM A504, Class BR. Reference Table 2-I, Grade XIV.

2.4.2.13 Axle steel forgings shall be heat-treated and conform to ASTM A236, Class G. Reference Table 2-I, Grade XIII.

2.4.2.14 Couplers shall conform to cast steel ASTM A148, Grade 90-60 for the yoke, housing, drawbar carrier and anchorage casting, Table 2-I, Grade VII.

2.4.3 CORROSION-RESISTANT STEELS

2.4.3.1 Corrosion-resistant steel of the austenitic type 301, type 302, shall be used for structural members and sheathing. Structural shaped members are to be Corten (Table 2-I, Grade III).

2.4.3.2 Corrosion-resistant steel fasteners shall be used to attach corrosion-resistant steel parts.

2.4.4 ALUMINUM ALLOYS

2.4.4.1 Aluminum alloys shall conform to the composition, strength, quality requirements and corrosion resistance requirements of the specifications of the Aluminum Association.

2.4.4.2 Aluminum alloys joined by fusion welding shall be weldable aluminum alloy with high strength, good resistance to corrosion, and not requiring heat treatment after welding.

2.4.4.3 Aluminum alloy permanent mold castings shall conform to the requirements of ASTM B108. Castings shall be free from blow holes, cracks, shrinkage and other injurious defects.

2.4.4.4 Aluminum alloy extruded bars, rods, shapes and tubes shall conform to ASTM B308.

2.4.4.5 Aluminum alloy rivets shall be aluminum alloy 606IT6.

2.4.5 MAGNESIUM ALLOYS (Not applicable)

TABLE 2-I

STEEL CHARACTERISTICS FOR CAR AND TRUCK CONSTRUCTION MATERIALS

GRADE	I	I-x	I-y	I-z
Material	Sheets	Bars and plates	Bolts	Coupler Anchor Bolts
Standards	AAR 117	ASTM A113	ASTM A	AISI 2330
Grade or Class	To be approved	C	A	--
Chemical Constituents (Phosphorus, % Max.)	0.04	0.04	0.04	0.04
Sulphur, % Max.	0.05	0.05	0.05	0.04
Carbon, %	0.25 max.	---	---	0.28 - 0.33
Manganese, %	---	---	0.30-0.60	0.60 - 0.80
Silicon, %	---	---	---	0.20 - 0.35
Copper, % (when specified)	0.20 min.	0.20 min.	---	---
Nickel, %	---	---	---	3.25 - 3.75
Molybdenum, %	---	---	---	---
Chromium, %	---	---	---	---
Nitrogen, %	---	---	---	---
Mechanical Properties (Ultimate Tensile Strength psi)	---	48,000 - 58,000	According to dia.	120,000 min. 250 Brinell
Yield Point, psi, not to be less than	---	26,000	---	95,000
Elongation in 8", % Min.	---	26	---	---
Elongation in 2", % Min.	---	---	---	18
Reduction in Area, % Min.	---	---	---	59
Cold Bend	---	180°flat	180°flat	---

TABLE 2-I (Contd.)

GRADE	I-zz	III	III-x	III-y
Material	High-Strength Bolts	Low Alloy High Tensile	Forging Steel, Normalized & Tempered	Forging alloy Steel
Standards	ASTM A325	---	ASTM A236	ASTM A238
Grade or Class	---	---	---	N & T
Chemical Constituents (Phosphorus, % Max.)	0.04	To be Approved (2)	0.045	0.045
Sulphur, % Max.	0.05	---	0.050	0.050
Carbon, %	0.30	---	0.450-0.59	---
Manganese, %	0.50	---	0.60 -0.90	---
Silicon, %	---	---	0.15	---
Copper, % (when specified)	---	---	---	---
Nickel, %	---	---	---	---
Moybdenum, %	---	---	---	---
Chromium, %	---	---	---	---
Nitrogen, %	---	---	---	---
Mechanical Properties (Ultimate Tensile Strength psi)	120,000 250 Brinell	(3) 70,000 min.	88,000	125,000
Yield Point, psi, not to be less than	77,000 to 88,000	(3) 50,000	50,000	105,000
Elongation in 8", % Min.	---	---	---	---
Elongation in 2", % Min.	14	22	25	16
Reduction in area, % Min.	35	---	40	50
Cold Bend	---	---	---	---

(See notes at end of table.)

TABLE 2-I (Contd.)

GRADE	IV	IV-x	V	VI
Material	Hot rolled bar steel	Seamless steel tubing	Carbon molybdenum steel	Rivet steel
Standards	AISI C1020	AISI C1118	AISI 4023	ASTM A131 (4)
Grade or Class	50	Fine Grain	---	---
Chemical Constituents (Phosphorus, % Max.)	0.04	0.045	0.04	Basic 0.04
Sulphur, % Max.	0.05	0.08-0.13	0.04	0.05
Carbon, %	0.18-0.23	0.14-0.20	0.20-0.25	---
Manganese, %	0.30-0.60	1.30-1.60	0.70-0.90	---
Silicon, %	---	---	0.20-0.35	---
Copper, % (when specified)	---	---	---	0.20 min.
Nickel, %	---	---	---	---
Molybdenum, %	---	---	0.20-0.30	---
Chromium, %	---	---	---	---
Nitrogen, %	---	---	---	---
Mechanical Properties (Ultimate Tensile Strength psi)	55,000 min.	---	75,000 min.	55,000 - 65,000
Yield Point, psi, not to be less than	0.5 ult. tensile	---	50,000	30,000
Elongation in 8", % Min.	1,500,000	---	---	23
Elongation in 2", % Min.	30	---	20	---
Reduction in area, % Min.	---	---	50	---
Cold Bend	---	---	---	---

(See notes at end of table)

TABLE 2-I (Contd.)

GRADE	VII		VII-x	VIII
Material	Cast Steel		Low Alloy Cast Steel	Rolled Manganese Steel
Standards	ASTM A27	ASTM A148	---	---
Grade or Class	70-36	90-60	---	---
Chemical Constituents (Phosphorus, % Max.)	0.05	0.05	0.05	0.09
Sulphur, % Max.	0.06	0.06	0.05	0.03
Carbon, %	0.35 max.	---	0.15-0.25	1.00-1.30
Manganese, %	0.70 max.	---	0.55-0.85	11.00-14.00
Silicon, %	0.80 max.	---	0.40-0.65	0.10-0.20
Copper, % (when specified)	---	---	---	---
Nickel, %	---	---	2.00-2.50	---
Molybdenum, %	---	---	---	---
Chromium, %	---	---	---	---
Nitrogen, %	---	---	---	---
Mechanical Properties (Ultimate Tensile Strength psi)	70,000 min.	90,000 min.	75,000 min.	187-212 Brinell
Yield Point, psi, not to be less than	36,000	60,000	48,000	---
Elongation in 8", % Min.	---	---	---	---
Elongation in 2", % Min.	22	22	25	---
Reduction in Area, % Min.	30	30	50	---
Cold Bend	120° around 1" pin specimen, 1" x 1/2" cross-section		---	180° Flat (1)

(See notes at end of table.)

TABLE 2-I (Contd.)

GRADE	XI	XII	XII-x	XIII
Material	Wear Plate Spring Steel	Heat-Treated Coil Spr.	Oil Tempered Spring Steel Wire	Heat-Treated Axle Steel
Standards	ASTM A68	ASTM A125	ASTM A229	ASTM A236 Modified
Grade or Class	A	---	Comp. A	G
Chemical Constituents (Phosphorus, % Max.)	0.04	0.04	0.045	0.05
Sulphur, % Max.	0.05	0.05	0.05	0.05
Carbon, %	0.90-1.05	0.90-1.05	0.55-0.75	0.60 max.
Manganese, %	0.30-0.50	0.30-0.50	0.80-1.20	1.30-1.70
Silicon, %	0.15-0.30	0.15-0.30	0.10-0.30	---
Copper, % (when specified)	---	---	---	---
Nickel, %	---	---	---	---
Molybdenum, %	Wear Plate Temper 212-223 Brinell	---	---	---
Chromium, %		---	---	---
Nitrogen, %		---	---	---
Mechanical Properties (Ultimate Tensile Strength psi)		---	---	100,000 min.
Yield Point, psi, not to be less than	---	---	---	65,000 min.
Elongation in 8", % Min.	---	---	---	---
Elongation in 2", % Min.	---	---	---	20
Reduction in Area, % Min.	---	---	---	45
Cold Bend	---	---	---	---

TABLE 2-I (Contd.)

GRADE	XIV
Material	Forged Carbon Steel Wheels
Standards	ASTM A504
Grade or Class	BR
Chemical Constituents, Phosphorus, % Max.	0.05
Sulphur, % Max.	0.05
Carbon, %	0.57 - 0.67
Manganese, %	0.60 - 0.85
Silicon, %	0.15 min.
Copper, % When specified	---
Nickel, %	---
Molybdenum, %	---
Chromium, %	---
Nitrogen, %	---
Mechanical Properties (Ultimate Tensile Strength, psi)	---
Yield Point, psi, not to be less than	---
Elongation in 8", % Min.	---
Elongaton in 2", % Min.	---
Reduction in Area, % Min.	---
Cold Bend	---

TABLE 2-I (Contd.)

GRADE	XV			
Material	Austenitic Structural Stainless Steel			
Standards	AISI 201	AISI 202	AISI 301	AISI 302
Grade or Class	---	---	---	---
Chemical Constituents (Phosphorus, % Max.)	To be Approved	To be approved	To be approved	To be approved
Sulphur, % Max.	---	---	---	---
Carbon, %	---	---	---	---
Manganese, %	---	---	---	---
Silicon, %	---	---	---	---
Copper, % (when specified)	---	---	---	---
Nickel, %	---	---	---	---
Molybdenum, %	---	---	---	---
Chromium, %	---	---	---	---
Nitrogen, %	---	---	---	---
Mechanical Properties (Ultimate Tensile Strength Psi)	Dependent on temper and gauge			
Yield Point, psi, not to be less than				
Elongation in 8", % Min.				
Elongation in 2", % Min.				
Reduction in Area, % Min.				
Cold Bend				

TABLE 2-I (Contd.)

NOTES

1. For materials over 1/4" thickness, bend over pin of diameter equal to twice the thickness of test specimen.

2. Chemical constituents shall provide good workability, good weldability and high resistance to atmospheric corrosion.

3. The minimum yield point and tensile strength requirements for cold rolled sheets are 45,000 psi and 65,000 psi respectively.

4. For small rivets use ASTM Std. Specification A31A.

2.4.6 SOLDERING, WELDING AND BRAZING

2.4.6.1 Soldering

Solder used in applying copper tubes and fittings shall be a tin-antimony solder conforming to the following chemical composition equivalent or better:

Tin and Antimony	99.5% minimum	
Tin	94.5% "	For air conditioning
Antimony	4.5% "	tubing, silver solder
Copper	0.08% maximum	shall be used.
Other Impurities	0.10% "	

The flux used shall be an approved non-corrosive material. Solder joint fittings shall be in accordance with American Standards Association Specification B16.22 for wrought copper and B16.18 for cast brass.

2.4.6.2 Welding and Brazing

All fusion and resistance welding and all brazing shall be performed in accordance with an established procedure. The procedure shall be capable of providing a welded or brazed joint which conforms to the established quality level by the designated methods of destructive and/or non-destructive inspection methods.

2.4.7 NON-DESTRUCTIVE INSPECTION

All incoming materials shall be inspected by an approved statistical quality control plan or 100 percent. Such inspection shall include visual, dimensional, functional, hardness, magnetic particle, penetrant, etc., or other methods necessary to affirm required material composition and quality.

2.4.8 FASTENERS

2.4.8.1 Bolts and Nuts

Steel bolts shall be in accordance with Table 2-I, Grade I-y, I-Z and I-ZZ, as applicable. Nuts shall meet the requirements of ASTM A-194, A-325 or A-563, as applicable. Bolts and nuts shall conform to the latest standards of the American National Standards threads with a Class 3 fit. Bolts, unless otherwise specified, shall be furnished with hexagon nuts, and unless shown on the drawings as being peened, shall be drilled for and furnished with a suitable cotter pin and spring-lock washer. Cotter pins may be omitted on bolts 3/8-inch or less in diameter. The number of different sizes of bolts shall be kept to an absolute minimum. Self-tapping screws shall not be used unless specifically approved by the Buyer. All steel screws, bolts and nuts shall have an approved rust-preventive finish.

2.4.8.2 Lock Washers and Lock Nuts

Lock washers 5/8-inch size and smaller, may be commercial standard and those 3/4-inch size and larger shall be in accordance with specification MS 35340 or equivalent. For applications having the approval of the Buyer, elastic stop nuts with nylon collars may be used instead of standard nuts and lock washers. Where elastic stop nuts are used, the bolt threads must provide a Class 3 fit, with ends chamfered, must be clean and smooth, without burrs, and at least one and one-half threads must come through the locking collar. Bolts for use with elastic stop-nuts must not be sheared or drilled for cotter pins. All lock washers and lock nuts shall have an approved rust-preventive finish.

2.4.8.3 Rivets

Steel rivets shall be in accordance with paragraph 2.4.2.8. Blind rivets, if used, shall be approved by the Buyer.

Aluminum alloy rivets shall be in accordance with paragraph 2.4.4.6.

2.4.9 NON-METALLIC MATERIALS

Fabrics and other non-metallic materials used for interior appointments shall not be affected by industrial compounds used for cleaning purposes. Where any commonly used cleaner or lubricant will be detrimental to the application, the Seller shall inform the Buyer prior to approval of the engineering design.

The fire resistance of all major interior materials such as wall, ceiling, floor linings, seat upholstery, cushions and panels, plywoods and insulations, shall be certified in writing or tested to establish acceptable flash points and burning rates. This information shall precede approval of materials for use in construction. Acceptable materials shall exceed the values stipulated in the Boston Fire Code and DOT, Federal Highway Administration Standard No. 302 "Flammability of Vehicle Interior Materials" and shall have Flame Spread Index (Is) value of 50 or less (preferably 25) when tested in accordance with ASTM E162, latest issue.

2.4.9.1 Sandwich Panels (Not specified)

2.4.9.2 Elastomers

All elastomeric parts furnished shall be of best quality material or synthetic compounds and shall be compounded to insure against excessive oxidation or other failure due to workmanship or material. These parts include door and window seals, glazing strips, truck bumpers and snubbers, structural and compressible gaskets, mounting pads, etc. Elastomeric parts shall be capable of withstanding operational temperatures of 105° to -15°F. Elastomeric parts shall not be painted unless specifically approved by the Buyer.

2.4.9.3 Safety Glass

All safety glass shall conform to the requirements of the latest issue of the American Standards Association Safety Code Z-261.

The motorman's windshield shall be laminated stretched acrylic and tempered safety glass approximately 1-1/8 inches in overall thickness. The nominal dimensions of the laminates shall be as follows:

Stretched Acrylic	.826"
Polyvinyl Interlayer	.125"
Tempered Safety Glass	.188"

Glass for the side windows (including cab side windows) side doors, end doors, cab doors, end sign and side sign exterior shall be 1/4-inch thick laminated safety sheet glass, "A" quality. Additional requirements shall be as specified in the following drawings:

2D40003 Glass - Side Window
2D45035 Glass - Side Window Side Sign
2D40237 Glass - Side Door
2D40240 Glass - End Door
2D40248 Glass - Cab Door

2.4.9.4 Marking Films (Not specified)

2.4.9.5 Plastic Sheets and Laminates (Not specified)

2.4.9.6 Resilient Foams

Resilient foams to be used for fabrication on the transit cars may include latex, urethane and flat cushioning foams. All foam materials shall be graded and labeled in accordance with the requirements indicated and as standard with the recognized industry associations or societies.

2.4.9.6.1 Latex Foam

All materials and workmanship shall conform to the requirements of RMA Buyers Specification "Latex Foam." Foam shall be a soft, resilient, porous product made from compounded natural or synthetic rubber latex. Unless otherwise specified, latex foam shall be molded to size and shall have a smooth, natural skin surface, formed by contact with the mold or cover plates.

Molded material shall have a high resistance to tearing, flexing, wetting and exposure to flame. Cored and slab or uncored stock shall be selected to best meet requirements of each particular application.

Tolerances on dimensions of latex foam rubber products shall meet the requirements set forth in ASTM D1055, Table II. Molded latex foam shall have densities of 3.0 to 8.0 pounds per cubic foot.

Latex foam shall be certified to conform to the following physical and performance characteristics:

Characteristic	ASTM Test Method	Requirement
General	D-1055-62	As specified.
Maximum compression set under constant deflection	D-395-61 (Method B) as modified by D-1055-62	10% of original height.
Accelerated aging air oven. Maximum change in compression resistance.	D-573-53	±20%
Flexible strength after 250,000 cycles.	D-1055-62	No breakdown of physical structure, maximum permanent set of 5% of original height.

2.4.9.6.2 Urethane Foam

All materials and workmanship shall conform to SPI Standard Specifications and Tests for Plastic Foams. Unless otherwise specified, urethane foam shall be molded and shall have a natural skin on the surface. Cored and slab or uncored stock shall be selected to best meet requirements of each particular application. Special components as indicated shall be dimension molded.

The foam product shall be made from SPI Type II polyether base urethane, or approved equal. Tolerances on dimensions of urethane foam products shall not exceed those indicated for latex foam. Urethane foam shall have a minimum density of 1.8 pounds per cubic foot.

Urethane foam shall be certified to conform to physical and performance characteristics in accordance with ASTM D1564-64T.

2.4.9.6.3 Flat Cushioning Foam

Flat cushioning foam (carpet pad) shall be soft, resilient, porous, product conforming to ZZ-C-00811b, Type I, Class I. Materials shall be molded sheet with the flat parallel surfaces having high density skin faces and with an additional woven fibrous burlap fabric facing on one surface sufficient to maintain dimensional stability and shall be at least 3/16-inch thick. Cushioning foam shall be certified to conform to the requirements of ZZ-C-00811b, Type I, Class I, when tested in accordance with Federal Standard No. 601, Test Method 12131. Acoustic sound barrier to ASTM D1692-68 may be used in lieu of above.

2.4.9.7 Fabrics

Fabrics to be utilized include plastic coated fabrics, woven upholstery fabrics, and wool carpet. All materials shall be graded and labeled in accordance with the requirements of the specifications and standards indicated. Labels shall be permanently affixed to, or imprinted on, the backs of the materials.

2.4.9.7.1 Plastic Coated Fabrics

All materials shall be leather grain, vinyl coated fabrics and shall conform to the requirements of FS-CCC-A-700e, Class 4, Treatments a-1, b and c, except as modified herein. Total fabric weight shall be not less than 25 ounces per square yard. Color, grain and finish are subject to approval by the Buyer. FS-CCC-A-680A may be used in lieu of 700e above.

Plastic coated fabrics shall be washable and smooth textured to the extent that water and detergents or other cleaning agents will reach all convolutions in surface pattern.

2.4.9.7.2 Woven Upholstery Fabrics

Other than trim, woven upholstery fabrics shall be transportation grade 100% yarn dyed wool or nylon, with a high quality, heavy-duty backing. The fabrics shall be in accordance with the requirements of FAR-25-853B, Type II. Total fabric weight shall not be less than 28 ounces per square yard. Fabrics

shall be permanently mothproofed and treated for flame retardance in accordance with the requirements of paragraph 2.4.9.7.1 and certified. Colors are subject to approval of the Buyer.

2.4.9.7.3 Wool Carpet

Wool carpet shall be single needle construction all wool tufted through the back. Pile yarn shall be 100%, all pure virgin wool, permanently mothproofed. Backings (warp) shall be polyester or equivalent materials as approved by the engineer such as 12-ounce stainless virgin jute.

Carpet fabrics shall be certified by the manufacturer not to exceed a flame spread classification of 75 when tested by ASTM E84-61. Carpet fabrics shall be cleanable by standard commercial methods suitable for the specific wool material, construction, surface effect, color and sheen of the fabric as supplied and installed.

Wool carpet shall be certified by the manufacturer to conform to the following requirements:

Characteristic	Test Method	Requirement
Wear Resistance	(Not specified)	
Tuft Lock	ASTM D1335-60T	3.8 pounds, minimum
Shrinkage (length and width)	ASTM D2404-65T	1% maximum

2.4.9.8 Caulking and Sealing

Application of all caulking and sealing compounds shall be in accordance with the manufacturer's recommendations.

2.4.9.8.1 Caulking Compounds

Shall be non-staining and shall be supplied in colors closely matching those of adjacent materials and surfaces.

Caulking primers shall be quick-drying, colorless, non-staining sealers of the type and consistency as recommended by the manufacturer of the caulking materials, for the particular surfaces involved.

Packing (backstop) shall be non-staining resilient material, such as glass fiber roving, or neoprene, butyl, polyurethane or other closed-cell foams, or other compressible material, compatible with the caulking compound used.

Butyl tape shall be extruded polyisobutylene sealer compounded of 100% solids.

2.4.9.8.2 Application and Workmanship

Joints, spaces and junctures to be packed and caulked or sealed shall be completely cleaned of all dirt, dust, oil and other foreign materials which would adversely affect the caulking work. Surfaces shall be thoroughly dry before application of caulking compounds. When so stipulated by the manufacturer of the sealants, paint and other protective coatings shall be removed from surfaces to be caulked prior to priming and application of sealants. Preparation of surfaces to have polysulfide liquid polymer or silicone compounds applied directly to them shall conform to manufacturer's recommendations.

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 immediately before applying the caulking, to the maximum depth of the caulking seam.

Compounds shall be applied with pneumatic guns having proper size nozzles exerting sufficient pressure to fill completely all voids and joints. Unless otherwise indicated, the entire perimeter of each opening shall be caulked. Where the use of the gun is impracticable, suitable hand tools shall be used. The finish of caulking joints on flush surfaces and in internal corners shall be neatly pointed. All excess material shall be removed. Caulking, where exposed, shall be free of wrinkles and uniformly smooth.

Application of polysulfide compounds shall be in strict accordance with the manufacturer's recommendations. Storage shall be at temperatures below 50°F. Compounds shall not be used when they become too jelled to be discharged in a continuous flow from the gun. Modification of caulking compounds by addition of liquids, solids or powders, shall not be permitted. When using two-part compounds, only the amount of caulking which can be installed within four hours shall be mixed.

All adjoining surfaces, finishes and fixtures shall be carefully protected throughout the caulking operations and any stains, marks or damage thereto as a result of caulking and sealing work shall be corrected in a manner satisfactory to the Buyer.

2.4.9.9 Lubricating Materials

Lubricating oils and greases shall be approved by the Buyer and, in general, shall be as recommended by the Supplier of the parts to be lubricated. Specifications for and samples of the materials which it is proposed to furnish shall be submitted to the Buyer for analysis. The lubricant for drawbar carriers, brake lever guides, etc., shall be semi-fluid graphite grease.

2.5 PROTECTIVE COATINGS AND FINISHES

2.5.1 GENERAL

The Seller's processing procedures and facilities shall be subject to review and approval by the Buyer.

2.5.1.1 Dissimilar Metal Protection

The joints between aluminum and steel shall receive a heavy prime coat of approved zinc chromate paint. Aluminum conduit must be isolated from stainless steel floor beams by zinc chromate tape or other approved method.

Immediately prior to assembling, all parts or surfaces brought permanently in contact (except roof joints) shall be thoroughly cleaned and given a heavy coating of approved waterproofing compound. This coat shall not be allowed to become dry before riveting or bolting, and all surplus compound squeezed out shall be wiped off.

Joint surfaces between roof sheets shall be thoroughly coated with approved elastic sealing compound. The contact surfaces of spot-welded connections shall be thoroughly coated with an approved spot-weld sealer. Corrosion protection of stainless steel contacting surfaces is not required.

2.5.2 SURFACE TREATMENT

2.5.2.1 Aluminum Alloys

Surface treatment on aluminum alloys shall be selected from the following:

a. Chemical film treatment in accordance with ASTM B449-67 or ASTM D1730-67.

b. Anodic coating in accordance with ASTM D1730-67.

c. Hard anodic coating (where resistance to wear and abrasion is desired) in accordance with MIL-A-8625, Type III.

2.5.2.2 Carbon and Low Alloy Steels

Parts of the cars manufactured elsewhere than at the Seller's plant shall be thoroughly cleaned of rust, scale, grease and other foreign matter at the place of manufacture and painted with one coat of specified primer as protection during transit, or prior to assembly of the car. This does not apply to steel mill and foundry products in general, nor to non-ferrous metal parts.

All surfaces except on the underframe shall be cleaned of dirt, rust, grease, oil and surplus joint compound by sandblasting or by the use of Metal-Prep or other approved equivalent. The underframe shall be cleaned by sandblasting. Compounds, oil or grease not removed by sandblast shall be removed with benzol before priming.

No sand or dust shall remain on any part of the car structure after sandblasting. Particular care shall be taken to insure that no accumulation of sand or dirt remains in any enclosed part of the structure. Special attention shall be given to removing all traces of foreign matter, including the cleaning medium, immediately before priming. Trucks shall be cleaned but not sandblasted before painting.

Surfaces that become covered in assembling so as to be afterward concealed or inaccessible, shall be cleaned as specified in the preceding paragraph and painted with two coats of an approved preservative paint.

Immediately after sandblasting and cleaning, exposed surfaces on car body and trucks shall be primed with the first coat of approved priming paints. Priming coats are to be carefully applied with brush and thoroughly worked around bolts, rivet heads, laps, joints and all irregular surfaces. Specified metallic primers shall be applied as received from the manufacturer. No surfaces on which oxidation has started shall be primed. Such surfaces shall again be sandblasted or cleaned before priming.

Each coat of primer, surfacer and paint shall be applied and allowed ample time to dry to the satisfaction of the inspector before applying the succeeding coat. If any coat of paint does not cover, an additional coat shall be applied. The use of thinners, as to quantity and quality, must have the approval of the manufacturer of the paint in which they are to be used. All coats of paint subsequent to primers may be brushed or sprayed.

In addition to the priming coats as specified above, one coat of an approved metal preservative primer shall be applied to the inside of the entire car superstructure (inside of sheathing and inside and outside of posts and flooring) for a height of one foot from bottom of side sill.

Trucks shall be given one coat of approved metal primer and two coats of approved black paint. The first coat shall be of a lighter shade than the second. Wheels and axles shall not be painted.

The bottom surface of the subfloor shall be painted with an approved zinc chromate primer. The top surface shall be thoroughly cleaned and leveled.

Inside surfaces to which sheet insulating material is to be applied shall be given one coat of approved elastic compound and the insulation applied while the compound is still wet.

The bottom of door pockets shall be covered with a layer of Hydrex or an equal and approved waterproofing compound, arranged to drain toward holes provided for the purpose. This material shall also be used for filling recessed bolt holes in contact shoe beams.

Inside of side sign boxes shall be given one coat of black in addition to primer coats.

2.5.3 PAINTS AND COATINGS

2.5.3.1 General

The Seller shall furnish samples of paints and varnishes for the Buyer's approval. The samples shall be subjected to the following tests and analyses:

a. Amount and degree of hardness of caking in original containers.

b. Brushing and covering properties.

c. Time of drying.

d. Color comparison on 1/32-inch metal after drying.

e. Comparative flexibility of dried sample on 1/32-inch metal sheet.

f. Chemical analyses, requiring all materials to be pure and of the highest quality in accordance with the latest ASTM specifications, insofar as these apply. The use of inferior grades of materials will not be allowed.

g. Weathering tests.

h. Immersion tests in oil and/or water, as required.

2.5.3.2 Application

Thorough and careful methods of application shall be used to provide a durable, fully protective, as well as attractive coating for the cars. The finish shall be full gloss on the exterior sides and ends and on the interior of the cars where painting is required. Painting shall be done in a suitable building under special precautions to prevent dust or other foreign matter from collecting on the freshly painted surfaces. The temperature of the paint shop shall not be less than 60°F during the progress of the work.

2.5.3.3 Interior Painting

The car interior and side walls shall be of colors approved by the Buyer. The interior of the cabs shall be of colors approved by the Buyer and all visible equipment shall be of the same color and texture. The Seller shall submit color samples of all finish coat paints to be used for approval. The Buyer reserves the right to reject any and all paints and varnishes which, in his opinion, do not conform to the requirements herein specified.

The following schedule for interior body surfaces is based on the use of paints containing synthetic gums and oils. If other paint systems are proposed by the Seller the materials, systems and schedule shall be submitted to the Buyer for approval.

Preliminary to the following schedule of operations, interior surfaces to be painted shall be thoroughly cleaned and given one coat of approved primer, as specified in Section 2.5.2.

Schedule for each color:

1. Apply second coat of primer.

2. Knife in entire surfaces with approved knifing composition. Fill major imperfections with hard-drying lead putty, bringing them flush with adjacent surfaces.

3. Apply one coat of surfacer.

4. Rub to a smooth surface with fine wet sandpaper or rubbing stone and water.

5. Apply first coat of synthetic enamel.

6. Apply second coat of synthetic enamel.

Items other than stainless steel, posts and other areas not otherwise finished shall be painted to match the adjacent areas. The conductor's emergency valve cord handle shall be painted an approved red. A red marker shall be applied to indicate the normal position of the emergency valve cord handle.

2.5.3.4 Exterior Painting

Cars have a stainless steel exterior and do not require paint except (a) on the following items which will be painted as specified in an approved color: the fiberglass ends of each car, truck, the underside of the floor, cross-bearers, bolsters, anti-climbers, underfloor equipment, safety chains, steps and end door safety read plates; (b) striping and other decorations on the stainless steel surface which will be applied in an approved manner.

The following schedule for exterior body surfaces is based on the use of paints containing synthetic gums and oils. If other paint systems are proposed by the Seller the materials, system and schedule shall be submitted to the superintendent for approval.

Preliminary to the following schedule of operations, exterior surfaces, including the floor, shall be thoroughly cleaned and given one coat of approved primer, as specified in Section 2.5.2.

Schedule for each color:

1. Apply second coat of primer to exterior, including underframe and underside of flooring.

2. Apply one coat of approved surfacer to exterior surfaces, except the underframe. The coat of surfacer shall be given a light sanding.

3. Fill major imperfections with hard-drying lead putty, bringing them flush with the adjacent surfaces.

4. Apply second coat of surfacer to exterior, except underframe. The coat of surfacer shall be given a light sanding.

5. Apply first coat of "finish" enamel on all surfaces except underframe.

6. Apply second coat of "finish" enamel.

7. Apply lettering and numbers, and give equipment under car and outside iron work one or more coats of black, as hereinafter directed.

Equipment outside the car end shall be painted in an approved color to conform to the body of the car.

Miscellaneous forgings under the car shall be given one coat of primer and one coat of handrail black.

After all material is applied under the car, the underframe, floor and equipment, except the control parts and air compressor, shall be given one coat of approved black paint.

The control equipment, after its installation under the car, shall be given one coat of approved black insulating varnish.

One coat of primer and one coat of handrail black or other approved color shall be applied to exposed galvanized iron.

Waterproofing compound, such as Sealite 77-145 or approved equal, shall be applied after assembly to form a cove in corners at back of end sills, between side sheets and side sills, and in side doorways between thresholds and posts, and thresholds and sills.

2.6 ENVIRONMENTAL DESIGN GOALS

2.6.1 CLIMATIC CONDITIONS

The complete car, including all equipment and components, shall be capable of operating satisfactorily over an operating temperature range of -15°F to +125°F, except air conditioning roof line intake (105°F), (soak temperature -20°F to +150°F), and when subjected to any combinations of humidity, rain, snow, ice, dirt and dust that may occur in the geographical area in which the car will operate.

2.6.2 EXTERNAL OPERATIONAL ENVIRONMENT

(As specified in Sections 1.1 and 2.2.1.5.)

2.6.3 EFFECT ON EXTERNAL ENVIRONMENT (Not specified)

2.7 VIBRATION CRITERIA - DESIGN GOALS

2.7.1 COMPONENT DESIGN CRITERIA

2.7.1.1 General Provisions

All car body mounted, truck frame mounted, and truck axle mounted components shall be designed to have structural integrity and be operationally reliable for infinite life in the vibration environment at the point of attachment of the component.

In addition, these components shall be designed to prevent unacceptable vibration inputs to the attachment structure.

2.7.1.2 Vibration Environment

The vibration spectrum at the point of attachment shall be defined to reflect the fundamental forcing frequencies and the forcing levels at these frequencies throughout the operational range of the vehicle. The component structure and mounting shall be designed to prevent amplification, through component resonance, beyond a level twice that of the attachment point.

2.7.1.3 Vibration Output

Where rotating components are installed, the vibratory force output of those components shall be such that the vibration environment specified for component design shall not be exceeded.

2.7.2 RIDE QUALITY AND PASSENGER COMFORT DESIGN GOALS

2.7.2.1 General Provisions

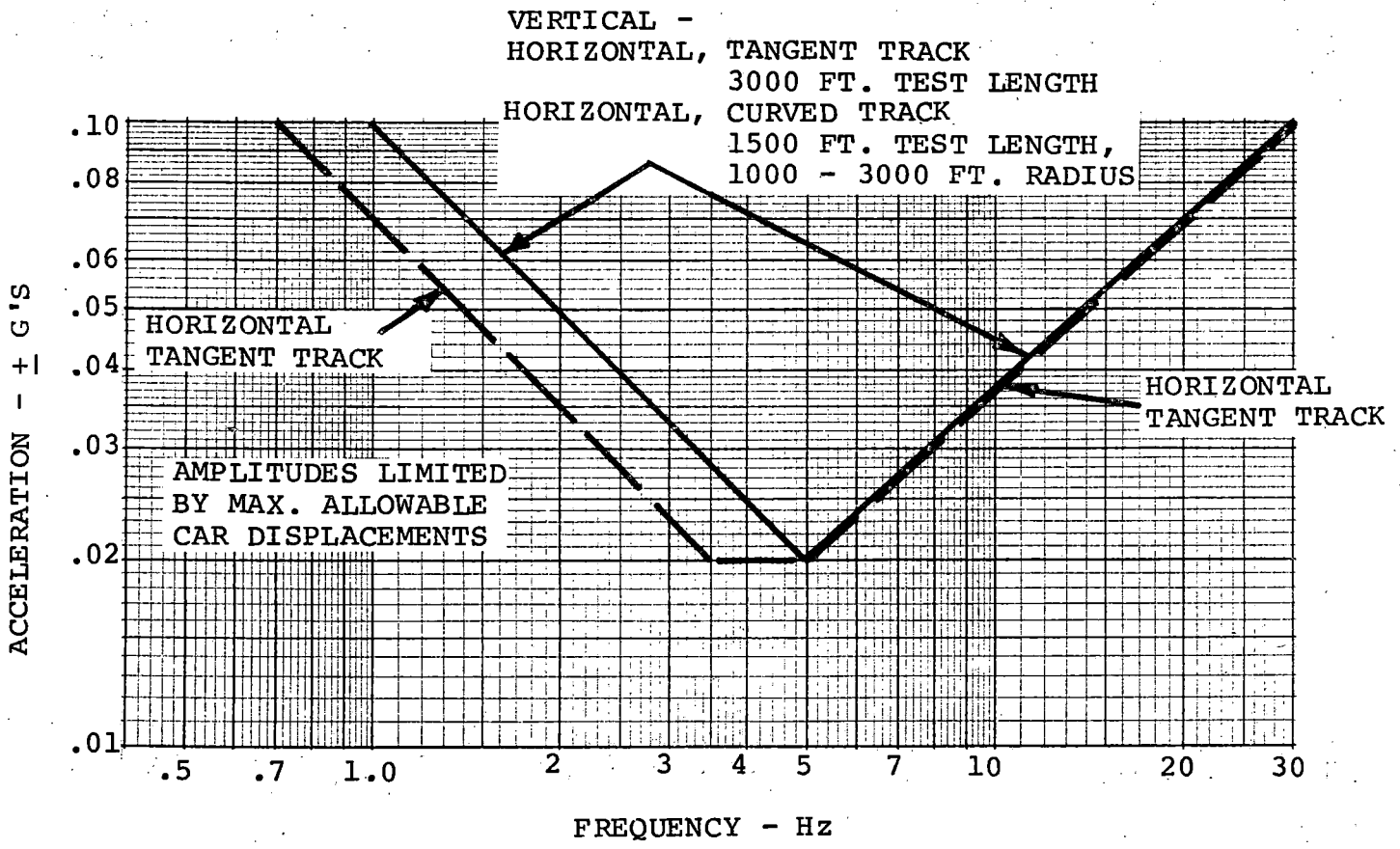
Throughout the operational environment, the car shall be designed to be free from objectionable vibration and shock. All equipment mounted in the passenger areas shall be free from resonance to avoid all annoying audio and visual distraction.

2.7.2.2 Vibration Levels

At all passenger and operator locations throughout the car, vibration levels shall not exceed those specified in the following paragraphs. These levels shall apply to floor, wall, seat frame and all areas with which the passengers and operators come in contact.

a. Steady state conditions at all steady railcar speeds, up to maximum speed, on tangent and curved track, average vibration levels measured during a typical 10-second running period shall not exceed the levels specified in Figure 2-8. No peak acceleration value (half amplitude), when measured to include frequencies below 30 Hz, shall exceed 0.10G.

b. Transient conditions for any slow or rapid linear acceleration or deceleration, or during switching or at cross-overs, the maximum vibration levels, recorded to include frequencies below 30 Hz, shall not exceed 0.20G recorded in any direction.



RIDE QUALITY GOALS

Figure 2-8

Vibration measurements shall be made in the car at locations and orientations which reflect vibration representative of passenger comfort based on proven experience or as a result of vibration analyses conducted to ensure the car meets the design requirements.

2.7.2.3 Track Condition

Vibration measurements made to ensure compatibility with the above criteria shall be made on the UMTA track at Pueblo, Colorado, as specified in Section 17.4.6.6.

2.7.2.4 Vibration Analysis (Not specified)

2.8 NOISE CONTROL DESIGN GOALS

2.8.1 GENERAL

This section contains the general requirements for sound pressure levels in crew and passenger spaces and at wayside. These maximum sound pressure levels shall be used as design goals only.

2.8.1.1 Definitions

a. Sound Pressure Level - The sound pressure level in decibels is defined as 20 log p/p_o where p is the measured rms sound pressure and p_o is the reference pressure, 0.0002 dyne/cm^2.

b. Reported Sound Pressure Level - The sound pressure to be reported in satisfying this specification shall be the arithmetic average of the measured minimum and maximum levels as measured on the slow meter position, provided the difference between the average and maximum is 3 db or less. If this difference is greater than 3 b, then the level to be reported shall be obtained by subtracting 3 db from the maximum level.

c. Pure Tone or Narrow Band - If the sound pressure level of any one-third octave band exceeds the level in the adjacent one-third band by 5 db or more, that band shall be considered to contain pure tone or narrow band components.

2.8.2 APPLICABLE DOCUMENTS

The following documents form a part of this section to the extent specified herein:

American National Standards Institute publications, including:

S1.1 - Acoustical Terminology (including Mechanical Shock and Vibration)

S1.2 - Physical Measurement of Sound, Method for

S1.4 - General Purpose Sound Level Meters, Specification for

S1.6 - Preferred Frequencies and Band Numbers for Acoustical Measurements

S1.10 - Calibration of Microphones, Method for the

S1.11 - Octave, Half-Octave, and Third-Octave Band Filter Sets, Specification for

2.8.3 NOISE CONTROL REQUIREMENTS

2.8.3.1 Interior Noise

The maximum allowable sound pressure levels in all parts of the car shall not exceed the values shown in Figure 2-9. Interior noise shall be obtained with the car at operational conditions as defined in Section 17.4.6.8. Noise levels shall be surveyed with the doors closed and all equipment operating at the ear levels of seated and standing passengers.

2.8.3.2 Wayside Noise

Sound pressure levels audible at the wayside shall not exceed the values shown in Figure 2-10. Wayside noise shall be measured as defined in Section 17.4.6.9 for dry, level, tangent and curved track. The radius of curvature for curved track measurements shall not exceed 300 feet. Measurements shall be made at axle height, 50 feet from the track centerline with the car operating over ballast and tie track.

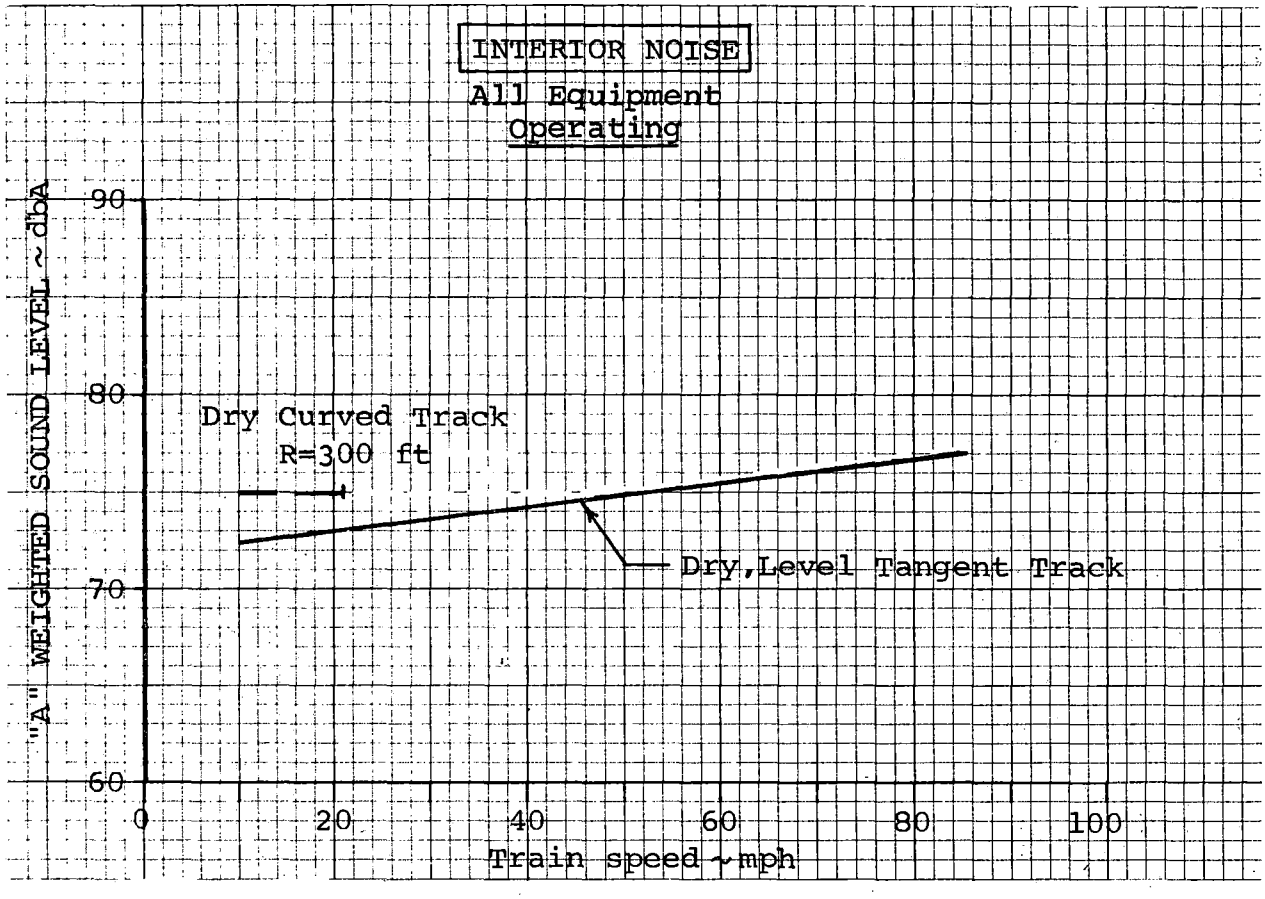
2.8.3.3 Equipment Noise

The noise of car equipment, including draft gear, should be designed so that it is not audible in the sound levels generated by the car in operation.

2.8.3.4 Pure Tone or Narrow Band Noise

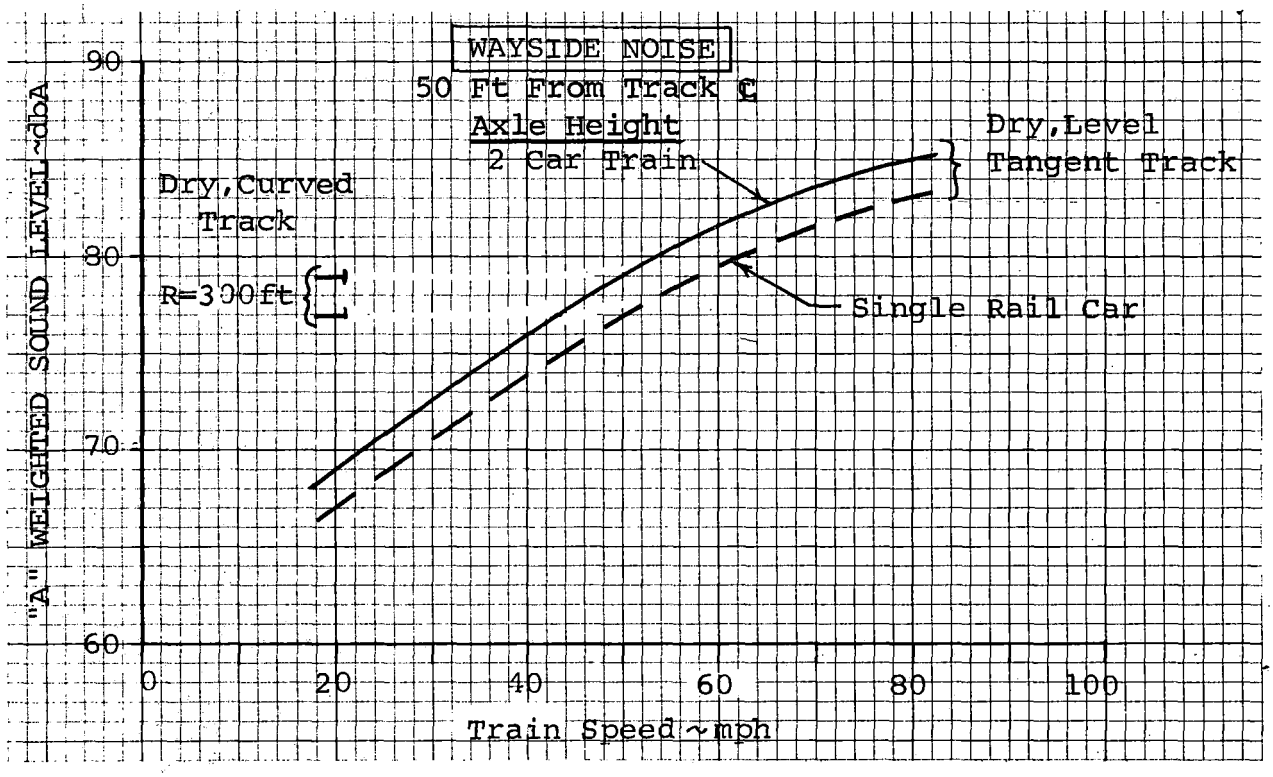
If interior noise environments contain pure tone or narrow band components as defined by paragraph 2.8.1.1.c, the requirements of Figure 2-9 are to be lowered by 5 db.

2.8.3.5 Required Reports (Not specified. Tests to be conducted by the Buyer.)



INTERIOR NOISE GOALS

Figure 2-9



WAYSIDE NOISE GOALS

Figure 2-10

SECTION 3

CAR BODY

3.1 GENERAL

The car body shall include the elements housing the operating crew and passenger sections and all related structure and appurtenances.

The car body shall be designed with structural integrity meeting the specified operational, functional and safety requirements.

The car body arrangement and dimensions shall be as shown on St. Louis Car Drawing No. 2D21001.

3.2 MOCKUPS AND MODELS
(Not required)

3.3 CONSTRUCTION

The car body shall be constructed to meet the design and strength requirements as specified for the New York City Transit Authority Equipment Contract R44 cars except as called for by this specification. The car structure shall be designed to maintain the passenger envelope within the limits and for the design loads as specified.

The car body and underframe shall be an integral structure and shall withstand the loads induced into the underframe by the trucks, coupler-draft gear and suspension units. Also, the car structure must be of sufficient stiffness to be commensurate with the requirements of Sections 2.7 - Vibration, and 2.8 - Noise, of this specification.

3.3.1 VERTICAL AND COMBINED LOADING

The loads and forces used in calculating the fiber stresses in the various members of the car body shall be either of the following combinations. For any part of the structure the combination that results in the higher stress shall be used as a design goal.

Combination A

(1) A passenger load varying from 0 to 350 passengers at 140 pounds each, the maximum being 49,000 pounds per car.

(2) An allowance for vertical impact of 26 percent of the total static load including the above maximum passenger load of 49,000 pounds.

(3) A horizontal buff or pull applied at the center line of the coupler faces amounting to 60,000 pounds static load.

(4) A force caused by the maximum acceleration or deceleration resulting from a 33 percent coefficient of adhesion.

(5) 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, on the four wheels on the outside rail.

Combination B

(1) A passenger load varying from 0 to 350 passengers at 140 pounds each, the maximum being 49,000 pounds per car.

(2) Under this combination of conditions it may be assumed that the cars will not be running at high speeds and the allowance for vertical impact can be omitted.

(3) A horizontal buff of 250,000 pounds or a pull of 200,000 pounds static load applied at the center line of the coupler faces and/or of the underframe.

(4) The forces caused by operation on curves will not apply in this combination.

3.3.2 CAMBER

Minimum positive camber between bolsters when assembled on jigs shall be 3/16-inch. Cambers shall be not less than zero (level) for a completed car loaded with maximum passenger weight.

3.3.3 COMPRESSION LOADING

The car body shall withstand a static end load of 250,000 pounds applied on the center line of the anti-climber end sills, without exceeding 50 percent of the yield point of the structural material and shall not have a vertical deflection between body bolsters greater than 0.205 inch.

3.3.4 CRASHWORTHINESS CRITERIA (Not specified)

3.3.5 HOISTING AND JACKING

The car structure shall be capable of being raised by jacking at four jack pads located at the bolsters.

3.4 UNDERFRAME

The underframe shall consist of the structural assembly on which the floor is mounted and to which the sides, ends, trucks and coupler are attached. Material and construction requirements shall be identical with those specified for the NYCTA Equipment Contract R44 cars except that modifications shall be made to accommodate the SOAC trucks and propulsion equipment as specified in Sections 10 and 11.

a. The underframe shall be designed as an integral part of the body structure and shall be subjected to the conditions of Section 3.3.

b. The underframe shall resist the coupler-draft gear induced loads of Section 4.1.2 without permanent deformation.

c. The underframe shall withstand separately the truck longitudinal shear load of 250,000 pounds and the vertical reaction from the truck without permanent deformation.

d. The underframe structure shall provide supports for equipment of sufficient strength and rigidity to withstand the load conditions of Section 3.9.2 and the vibration requirements of Section 2.7.

3.4.1 END UNDERFRAME

The end underframe shall resist, without failure, the compression loading specified in Section 3.3.3. The end structure shall also resist, without failure, the vertical reactions due to 225,000-pound end load applied along center line of draft as verified by test of the R-44 car for NYCTA.

3.4.2 CENTER SILL

The center and side sills are to be rolled or formed channels. Side sill stiffeners are required at the point of application of the shop body supports and slings. The principal cross-members may be built-up welded sections, plates and gussets. Intermediate cross-members of lighter section shall provide support for the floor sheets at the joints and equipment and may be of shallower depth, particularly for clearances over the trucks. The general arrangement of the underframe shall provide a level supporting surface for the floor sheets.

3.4.3 BOLSTERS

The body bolster shall be a welded assembly and stress relieved, if necessary. The bolster center fillers shall be a welded construction made of Grade III low alloy high tensile steel. Under the bolster, contact surfaces for the truck side bearings shall be provided consisting of steel castings, drop forgings or weldments faced with Grade XI spring steel wear plates. The body center plate bolt holes in the bolster are to be drilled to jig and chamfered.

3.4.4 ANTI-CLIMBER

Anti-climbers consisting of two 3-inch channels, 7.1 pounds welded together and welded to underframe, shall be used and shall resist the loads specified in Section 3.4.1.

3.5 BODY SHELL

The body shell shall include the side, roof and end elements mounted to the underframe as shown in Drawing No. 2D35001.

3.5.1 SIDES

The side structure shall be designed to resist the loadings induced due to the sides acting as an integral part of the car body structure. Sides shall be as shown in Drawing No. 2D21001.

All flat side sheets shall be of stainless steel, No. 4 brushed finish, and are butted against each other and joints welded and ground flush. The sheets under the windows shall be formed stainless steel sheets, No. 4 brushed finish, running parallel with the length of the car and extending from door opening to door opening.

3.5.2 ROOF

The roof structure shall be as shown in Drawing No. 2D21001 and shall support men working on roof, snow loads and loads imposed by water wash equipment. The area of the roof supporting the pantograph shall be reinforced to support pantograph and men working in this area.

Mounting provisions for roof mounted equipment shall be designed for the following load conditions:

a.	Longitudinal direction	3g
b.	Lateral direction	1-1/2g
c.	Vertical direction	1-1/2g

3.5.3 CAR ENDS

Modern, attractive car ends shall be incorporated in the car design. Drawings shall be submitted to Boeing Vertol for approval. The car ends shall be constructed of a one-piece molded laminated shell of fiberglass reinforced plastic as approved for the NYCTA R44 cars.

The "F" End structure shall be designed to accept a motorman's window extending full width and height of frontal area. Design wind force on windshield shall be 78 pounds per square foot, equivalent to 175 mph.

3.5.4 SKIRTS (Not applicable)

3.5.5 PANTOGRAPH INSTALLATION

The body shell structure shall be reinforced locally to accept the specified pantograph installation and shall meet the strength requirements of Section 3.5.2. A walkway running the length of the pantograph base shall be provided along both sides of the pantograph. The pantograph shall be located at the "R" end of each car. The roof-mounted pantograph support structure shall be readily removable and shall provide a "clean" roof appearance when removed.

3.6 INSULATION

3.6.1 GENERAL

The heat and sound insulation shall be a minimum of three inches thick, faced on one side with .002 aluminum foil vapor barrier applied to the complete roof, roof air plenum, side frame and end frame. Hollow posts, if used, shall be completely filled with an approved insulating material.

The floor shall be completed insulated from heat and sound with a minimum of three inches of insulation material sandwiched between the bottom of the plymetal floor and a retaining sheet, of approved material, adequately stiffened to prevent sagging and drumming and fastened to the underframe.

Formed metal ways shall be provided for all wires, conduit and pipe, extending through the retaining sheet, insulation and plymetal and adequately fastened to the plymetal and retaining sheet in an approved manner to prevent the entrance of moisture to plywood and insulation.

3.6.2 GRADING AND LABELING (Not specified)

3.6.3 INSTALLATION

Surfaces to which sheet insulating material is to be applied shall be given one coat of approved elastic compound, and the insulation whose edges have been protected against fraying shall be applied while the compound is still wet.

Insulation shall be retained in place by approved methods and shall not shake down in long service under vibrating conditions. All insulation shall be cut 1/3-inch oversize on both width and length to insure complete coverage.

An approved sound and vibration damping material shall be applied to the inner side of the floor, side, end and roof sheets and the outer side of air conditioning ducts.

3.6.4 MATERIALS

3.6.4.1 Sidewall

Material - Fiberglass with .002" aluminum backing
Density - 3/14 lb./cu.ft.
Thickness - 3"
Mfr. and Type - Gustin Bacon No. 75 Ultralite

3.6.4.2 Ceiling

Same as 3.6.4.1 above.

3.6.4.3 Floor

Rug Density - 4 lbs./sq.yd.
Underlayment Density - 0.8 lbs./sq.ft.
Lead Vinyl Density - 0.8 lbs./sq.ft.
Insulation - Same as 3.6.4.1 above

3.6.5 PERFORMANCE REQUIREMENTS

3.6.5.1 All insulation materials shall meet the requirements of Section 2.4.9 for the specific type indicated.

3.6.5.2 All acoustic insulation shall meet the requirements of Section 2.8.3.

3.7 FLOORS

Floors shall include continuous, horizontal planar elements mounted to the underframe as shown in Drawing No. 2D3113 3.

3.7.1 PRIMARY FLOOR

The floor sheets shall be 3/4-inch, 5-ply, exterior grade, A.C. fire-resistant, resin-bonded, fir plywood with solid and edge glued inner plies. The panels shall be bonderized on both "C" sides with 24-gauge zinc coated steel plate similar to Republic Steel Co.'s "Zinc-Bond" or Armco Steel Co.'s Zinc Grip Paint.

The floor sheets shall be secured to the side and center sills and to cross-bearers and floor stiffeners by watertight bolts and speed holding nuts, except in such locations where other type of fastening may be approved. All depressions in the floor surface due to countersinking of fasteners or other causes shall be filled with an approved compound. All exposed edges of plywood shall be completely sealed so as to prevent destruction of plywood fibers by water and/or car wash detergent cleaners. Before the floor finish is applied, the floor shall be sanded smooth where required and thoroughly cleaned and be free from dust, dirt, oil or grease. The floor shall be designed for 85 pounds per square foot. Floor beams shall be designed for 3 g's at yield strength. Vertical deflection shall be limited to length/360.

3.7.2 SUB FLOOR

The complete floor area, under the plymetal floor sheets and the side sill cover plate shall be fully insulated against heat and sound as specified in Section 3.6. The insulation shall be held in place with rustproofed retaining sheets. The retaining sheets shall be permanently fastened to the car underframe members in an approved manner and be adequately stiffened to prevent sagging and drumming.

3.8 MOTORMAN'S CAB

The motorman's cab and seat shall be as shown on Car Body Assembly Drawing No. 2D20000, Sheet 3, Cab Interior Drawing No. 24400 and Seating and Flooring Installation Drawing No. 23700.

3.9 UNDERCAR

3.9.1 EQUIPMENT ENCLOSURES

Materials, construction, fastening and attachment, drainage, cooling and environmental requirements shall be as shown in Drawing No. 2D35014.

3.9.2 UNDERCAR EQUIPMENT

The mounting provisions for undercar equipment shall resist the following load conditions:

a.	Longitudinal direction	3.0 g
b.	Lateral direction	1-1/2 g
c.	Vertical direction	1-1/2 g

Design stress used shall be 25,000 psi for HTLA.

3.10 INTERIOR

Color and material charts shall be supplied for design review.

3.10.1 FLOOR COVERING

Floor covering shall be wool carpet as specified on Drawing No. 2D23700.

3.10.2 SIDE LINING

Interior lining shall be fiberglass and melamine of sufficient thickness to resist mild impacts and scuffing normally encountered in transit service. Side lining shall be as shown on Drawings 2D31100, 2D23200 and 2D35069.

3.10.3 CEILING

Same as 3.10.2 except shall be as shown on Drawings 2D30300, 2D24700 and 1C24800.

3.10.4 MISCELLANEOUS

Interior finish shall be as specified in Drawing No. 2D23700.

3.11 WINDOWS

Side windows shall be laminated safety glass, 1/4-inch thick to ASA Z26.1. Glass size shall be 22-3/4 x 36-11/32 x 1/4 inches as shown on Drawings 2D22800 and 2D25300.

Windshield shall be laminated stretched acrylic and safety glass 1-1/8 inches thick. Light transmissability shall be at least 85 percent with a distortion of 1 in 8 or better.

3.11.1 SAFETY FACTOR (Not specified)

3.11.2 PRESSURE LOADING

The windshield shall withstand a uniform pressure loading of 78 pounds per square foot perpendicular to the surface of the window. This pressure loading corresponds to a speed of 175 mph.

3.11.3 IMPACT LOADING

The motorman's windshield shall withstand, without penetration, the impact of a 5-pound stone at 50 mph and a 1-pound stone at 80 mph.

3.12 SEATS

3.12.1 PASSENGER SEATS

The seating arrangement shall be as shown on Drawing No. 2D23700 for the high and low density cars.

The strength requirements of the passenger seat structure shall be specified by the car builder. Static test results, if available, shall be supplied. The strength capability of the car body seat support structure and seat attachments to that structure shall be supplied.

3.12.2 MOTORMAN'S SEAT

The motorman's seat and supporting structure shall be the same as supplied on the R44 car for NYCTA.

3.13 STANCHIONS, HAND RAILS, GRAB HANDLES, BARRIERS AND STEPS

Stanchion arrangement and location for the high and low density cars shall be as shown in Drawing No. 2D23700.

3.14 DOORS AND OPERATING MECHANISM

3.14.1 SIDE DOORS

Each car shall include four double-leaf sliding doors per side, located as shown in Drawing No. 2D23700. The doors shall be as shown in O. M. Edwards Drawing 3W-16120. The door design shall meet the requirements of Section 15.6 with regard to the aged and the handicapped. Doors shall not rattle or vibrate in the closed position.

a. The side door and supporting structure shall withstand, without door release or permanent deformation, and shall perform in a satisfactory manner after loading with 200 pounds applied perpendicularly to the plane of the door at the center of the front edge of a single leaf. The deflection shall not exceed 0.50 inch. Loading shall be with the door supported in a horizontal plane on blocks having a top surface 1 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 12 x 24 inches with the 24-inch dimension parallel to the front edge of the door.

b. Not specified.

c. The entire door system, including support mechanisms and drive system, must resist without yield, an obstruction load of 36 pounds maximum applied to the contact strip on the door edge. This load shall be applied over a small contact area (not a sharp object), in plane and perpendicular to the edge.

3.14.2 SIDE DOOR OPERATING MECHANISM

The door operating equipment shall be the all-electric, hold-in type, for opening and closing the doors on either or both sides of the cars. The door operators shall provide for smooth, continuous opening and closing of the doors under all design and operating conditions with no bouncing at either end of the cycle.

Each door operator shall include electrical and mechanical cutout features to bypass the operator electrically and mechanically lock the door in the event of a malfunction.

The door operator will be designed to operate while resisting a force of 36 pounds maximum at the edge. The door operator and its linkage shall allow the door to be forced approximately 1-1/2 inches.

The door operators shall be so designed that, at the applied potential of 36 volts, they shall maintain the following door speeds on test and in operating service, excluding time for audible door signals.

Opening - The time from control switch actuation to the complete opening of the doors, including cushioning, 1-4/5 seconds maximum.

Closing - The time from control switch actuation to the complete closing of the doors, including cushioning, 2-3/5 seconds maximum. The closing time shall be adjustable from 1-1/2 to 3 seconds and shall exclude the "chime" warning period.

Lower door operating speeds may be accepted when the door operators are responding to battery power at 32 volts.

3.14.3 END DOORS

A sliding end door with concealed closing device shall be provided at the "R" end only as shown in O. M. Edwards Drawing No. 3W-16237. There shall be no end door at the "F" end of the car.

The end door construction shall be equivalent in strength to 1-1/4 inches thick door with 20-gauge 301 stainless steel sheathing bonded to 3/8-inch cell honeycomb filler. Front and rear channels to be 16-gauge, 301 stainless.

3.14.4 CAB DOOR

The cab door shall be hung by an approved continuous hinge extending from top to bottom to permit the door to swing inward. The hinge shall be stainless steel and shall be provided with approved weatherstripping to prevent drafts through the hinge. Approved weatherstrips shall be provided for the door striking edges.

An approved concealed heavy duty railroad type door closer shall be provided for the cab door.

The cab door shall be glazed with 1/4-inch laminated safety sheet glass bedded in rubber. The visible glass size shall be 19-1/2 x 27 inches with corners 1-1/2 inch radius. The 19-1/2 inch dimension shall be centered on the door width and the visible glass shall be 9 inches below the top of the door.

3.15 INTERCAR CLOSURE/VESTIBULE

(Not applicable)

3.16 TOILET

(Not applicable)

COUPLER AND DRAFT GEAR

4.1 GENERAL

4.1.1 CONFIGURATION

Both SOAC cars are "A" cars and will be utilized as a two-car train. Fully automatic mechanical, pneumatic and electrical couplers shall be provided at the non-cab or "R" end of each car. Semi-automatic mechanical and pneumatic coupling shall be provided at the cab or "F" end of each car. Couplers shall have a length of 17 inches from pulling face to pivot pin with a hinge lug for vertical centering.

4.1.2 STRENGTH REQUIREMENTS

The coupler, coupler carrier, anchorage and attachment to the car underframe shall be designed to the following loads:

a. Draft gear deflection shall be 1-1/4 + 1/8 inches at a load of 100,000 pounds.

b. Draft gear deflection shall be 1-5/8 + 1/8 inches at a load of 225,000 pounds.

c. Draft gear preload to be supplied by car builder.

d. The draft gear emergency release load shall be 150,000 pounds $\pm$5,000 pounds in buff.

e. The coupler draft gear shall have an attachment to the car structure that resists the following loads without permanent deformation:

(1) Buff Load: 200,000 pounds
(2) Draft Load: 100,000 pounds

f. The yoke and radial housing casting shall withstand a working load of 150,000 pounds without yield and an end load of 400,000 pounds without failure, both loads being tension or compression.

g. The coupler shall be capable of withstanding the following static loads without failure:

(1) Buff Load: 400,000 pounds
(2) Draft Load: 225,000 pounds

h. Coupler and drawbar shall be capable of moving radially with a force of not more than 100 pounds, applied at the face of the drawbar.

4.1.3 GEOMETRIC REQUIREMENTS

The couplers, when coupled, shall be capable of negotiating the horizontal and vertical curves outlined in this specification as well as any normal track irregularities. In addition, the car and air coupler shall be designed to take a maximum change of grade of 5-1/2 percent with the radius thereof approximately 2,000 feet and the corresponding length of the vertical curve not less than 200 feet.

4.1.4 COUPLER ADAPTERS (Not required)

4.2 CAB END CONNECTIONS

4.2.1 MECHANICAL COUPLER

The coupler equipment shall be fully automatic, tightlock hook-type flat contact face with guide pins, car and air coupler as manufactured by Ohio Brass Company with the Walton "Electro-Pneumatic" system for automatic coupling and uncoupling.

4.2.1.1 Operation

The couplers shall have a gathering range of such proportions that they will couple when the vertical distance between the center lines of couplers does not exceed 3 inches and the horizontal distance between the center lines of the couplers does not exceed 3-3/8 inches.

The mechanical coupling of two cars shall be automatically accomplished by simply moving the two cars together. The couplers shall be capable of withstanding a total equivalent buffing strain of 400,000 pounds static load and a pulling strain of 225,000 pounds static load, applied horizontally at the center line of the coupler heads. The entire coupler and drawbar shall be capable of moving radially with a force of not more than 100 pounds, applied at the face of the drawbar with proper lubrication. All wearing surfaces shall have ample area to perform the service required.

Connections shall be provided in the coupler for two air trainlines. The air connections at the rear of the coupler shall be tapped for standard iron pipe size connections. The air lines at the face of the coupler shall be free flow, connected by spring-loaded, rubber-gasketed bushings.

The coupler hook shall be operated directly by an air cylinder through an intermediate lever. A cam for the operation of the mating hook shall be actuated by the hook of the coupler which initiates the uncoupling. The interlocking of the cam and hook shall maintain a complete engagement of the two mating hook faces. A torsion-type hook spring equipped with a roller for contact with the hook shall be provided to hold the hook in place. The coupler head shall be completely enclosed to prevent the entrance of foreign matter into the operating parts. The hook shank shall be made full depth of the opening. Readily replaceable hardened steel bushings shall be provided for all pins with adequate provision made for lubrication. A manually operated lever shall be included in the coupler to allow manual uncoupling from the track level.

4.2.1.2 Coupler Controls

Each coupler shall be provided with an electro-pneumatic control box containing valves, time control relays and electrical terminal blocks to operate the valves of the air brake system, coupler and the electrical circuits for the electric portion. This equipment shall be enclosed in an approved fabricated, lightweight metal box provided with a readily removable dirt, dust and weatherproof access cover.

The system of piping and wiring and the design of the valves shall accomplish the following desired operational results. The operation shall be a combination of air and electrical circuits using instantaneous solenoids and a time control relay unit for the proper sequence to insure maximum safety during the coupling and uncoupling operation. Emergency operation of the valves shall be provided in the event of an electrical failure.

4.2.1.2.1 Coupling Cycle - Cab End

Coupling cycle at the "F" end of each car: As the cars come together, the couplers shall automatically, mechanically and pneumatically couple. Separate actions must be taken in each car to allow free flow of air between cars.

4.2.1.2.2 Uncoupling Cycle - Cab End

While the train is stopped, set the brakes in the portion of the train to be left. Close the angle cocks on the portion to be moved. Manually, from track side, disengage the hooks by the handles, located beneath the couplers, buffing the cars as needed. When one or both hooks are disengaged, move the cars apart.

4.2.1.3 Materials and Configuration

The coupler and drawbar equipment shall meet the strength requirements of Section 4.1.2.

4.2.1.3.1 Yoke

The yoke in which the draft gear functions shall be cast steel, ASTM A148, Class 90-60. It shall be provided with rolled manganese steel wear plates ("Rolman" or approved equivalent). It shall be designed to allow a twisting motion inside the housing casting of 5 degrees to each side of the vertical center line, permitting the respective vertical center lines of two coupled cars to vary a total of 10 degrees from each other. The yoke shall be provided with a yoke pin of steel to specification ASTM A236. The yoke pin shall be provided with an approved grease gun fitting such as Alemite straight fitting No. 1710.

The yoke shall be provided with a helical spring or springs held by a special head bolt and washer in a pocket, the spring supporting the car coupler hinge lug. The jaw of the yoke shall neatly fit the coupler hinge.

4.2.1.3.2 Radial Housing Casting

The radial housing casting shall be cast steel, ASTM A148, Class 90-60. It shall be provided with rolled maganese steel wear plates ("Rolman" or approved equivalent). In order to place full responsibility for specific performance of the draft gear on the manufacturer, the drawbar shall be furnished and assembled complete with draft gear and yoke in housing. The yoke must have clearance inside the housing casting to rotate as described above. These castings will be inspected and gauged by means of special templates and jigs.

4.2.1.3.3 Anchorage Casting

An approved anchorage casting shall be provided for the attachment of the drawbar to the car underframe. The casting shall be ASTM A148, Class 90-60 cast steel secured to the car underframe with AISI 2330 special bolts. Shims as required shall be used to maintain a maximum clearance of 0.020-inch between drawbar and anchorage castings.

4.2.1.3.4 Drawbar Pin

The drawbar pin shall be AISI-C-1045 steel machined all over, drilled and tapped for grease gun fitting.

4.2.1.4 Draft Gear

The draft gear shall be of the twin-cushion type. It shall consist of two cushioning units composed of rubber mounted between metal plates arranged either side of a central abutment, so balanced that one group absorbs the shock in pull. These cushioning units shall be installed under an effective compression so that when one group is compressed, the other group will expand.

At a load of 100,000 pounds, the travel shall be 1-1/4 $\pm$ 1/8 inches, and the gear shall withstand a load of 225,000 pounds at 1-5/8 $\pm$ 1/8 inches travel.

The draft gear shall be provided with an automatic release shear mechanism to provide emergency release for severe end impacts. The shear pins shall be designed to shear upon a buff load of 150,000 $\pm$5,000 pounds, permitting the transfer of excess buff loads to the car's underframe by allowing the coupler and drawbar yoke to travel an additional distance before contacting the rear of the drawbar where the yoke shall be further cushioned by the rubber in the draft gear. When emergency release bolts shear, the coupler telescopes three inches (under no load) to permit the car's anti-climbers to engage.

The design of emergency release feature shall be such as to require no special tools and a minimum of hand labor to restore the mechanical coupler to a normal operating condition. It shall not be necessary to remove coupler, yoke or drawbar casting to replace shear pins. A specially designed gland nut shall be provided for the shear pin to facilitate its removal in the event of partial shear.

4.2.1.5 Coupler Carrier

The coupler carrier shall be cast steel, ASTM A148, Class 90-60, or drop-forged steel, AISI 4023. It shall be machined and provided with wear plates of rolled manganese steel ("Rolman" or approved equivalent). The bolts holding it to the car underframe shall be AISI C-1040 steel with physical properties equivalent to ASTM A236 finish turned.

4.2.1.6 Coupler Centering

The drawbar at both ends of each car shall be provided with an approved automatic air actuated centering device located on the car underframe and in close proximity to the drawbar pin. The device shall be activated in the uncoupled position and non-operative when cars are coupled. Provision shall be made to nullify the centering device by the operation of a negating valve located on the side sill under the ends of the car.

4.2.1.7 Coupler Indicator (Not required)

4.2.1.8 Protective Heaters (Not required)

4.2.1.9 Coupler Gauges (Not required)

4.2.2 ELECTRIC COUPLER

Electrical connections are not required at the cab end.

4.2.3 PNEUMATIC COUPLER

A pneumatic coupler shall be provided as part of the mechanical coupler head. It shall accomplish the function of connecting air lines between cars. Accidental uncoupling shall cause venting of air from a control line which shall automatically apply brakes to both portions of an unintentionally uncoupled train. Intentional uncoupling shall cause the brakes to be applied on the unattended section of the train only. No air shall be vented at any time from a separate main reservoir equalizing line where another pipe is used for initiation of brake applications. If the coupler design does not completely exhaust the air train line under these circumstances, satisfactory valving shall be provided to insure an emergency application.

4.3 NON-CAB END CONNECTIONS

The couplers at the "R" ends shall provide any other connections necessary for the automatic coupling and uncoupling of the cars, including electrical train lines. The coupler equipment shall be fully automatic, tightlock hook type, flat contact face with guide pins, car and air coupler and side-mounted electric couplers. Car and air couplers shall be as manufactured by Ohio Brass Company with the Walton "Electro-Pneumatic" system for automatic coupling and uncoupling. The electric coupler on the "R" end of each car shall operate in sequence with the car and air coupler.

4.3.1 MECHANICAL

4.3.1.1 Coupler

Same as Cab End. See Sections 4.2.1.1 and 4.2.1.2.

4.3.1.1.1 Coupling Cycle - Non-Cab End

Coupling cycle at the "R" end of each car: As the cars come together, the couplers shall automatically, mechanically, electrically and pneumatically couple. The through contact pins, which shall be permanently extended, shall complete the through circuits and energize the coupling circuit, permitting air to flow freely between the cars. In addition, the electrical contact pins shall be projected and air for the coupler centering device shall be exhausted, leaving the coupler free to move during train operation.

4.3.1.1.2 Uncoupling Cycle - Non-Cab End

Automatic uncoupling shall be accomplished by an uncoupling pushbutton switch located on the electro-pneumatic control box behind the locked "R" end swing panel. To activate the control box, the key switch must be closed with an approved key.

Pressing and releasing the uncouple switch shall result in the movable pins being retrieved, the loop circuits being remade, the trainline air valves shut off and air being applied to the hook cylinder. The hook cylinder will be energized for 10 seconds minimum during which time the cars shall be moved apart, buffing as required. If the cars are not parted in the allotted time, the uncouple switch must be reactivated to allow uncoupling.

Initiating the uncouple cycle will also set the emergency brakes on the cars to be left.

4.3.1.2 Materials and Configuration
Same as 4.2.1.3.

4.3.1.3 Draft Gear
Same as 4.2.1.4.

4.3.1.4 Coupler Carrier
Same as 4.2.1.5.

4.3.1.5 Coupler Gauges
(Not required)

4.3.2 ELECTRICAL

4.3.2.1 Trainlines

An electric coupler shall be provided at the "R" end as shown on Walton Drawing No. P-1852, latest revision. The coupler shall consist of two insulating blocks, each with 59 contacts to provide electrical connection between cars. Each block, mounted in a fabricated lightweight box, shall be applied one on each side of the "R" end coupler head. The box shall be mounted in an approved manner.

Each electric coupler box shall be provided with 59 front contacts and 3 back connections. Each connection shall be designed to receive conductors in an approved manner and the contacts shall be butt type of an approved material, the heads of which shall be completely silvered with coined tips 0.030-inch thick. The contacts shall have sample surface capacity, suitable shape and positive action to prevent fouling in coupling. Each contact shall be designed to transmit not less than 40 amperes for short periods and 30 amperes continuously. Contacts shall not stick or bind under normal conditions.

Provision shall be made for clamping firmly all the leads connected to the various contacts and a suitable clamping device shall be provided for the multiple conductor cables. The contact holder assembly shall be arranged as a drawer assembly, plug-in type. The drawer assembly shall be capable of being withdrawn partially, or fully, from the front of the coupler box. The multiple conductor cables shall be mounted through the coupler box in an approved weatherproof manner and wired to the plugs.

The contact springs shall have from 10 to 12 pounds initiating pressure. They must not take a permanent set due to compression in service.

The individual parts of the assembled electric coupler shall be sufficiently rugged to withstand the coupling impacts and repeated stresses to which they will be subjected in service. All parts shall be accurately finished to dimensions that insure proper fit and function, both of the individual parts and of the coupler as a whole.

The housing of the electric coupler shall be a fabricated lightweight box, the interior of which shall be painted with an approved insulating paint or enamel. It shall be provided with an opening on one side covered with a removable plate of sufficient size to make connections and to inspect and repair the terminals, cross-connections and other internal parts of the coupler. The cover plate shall be readily removable, but when in place it shall be dirt-, dust-, weather-, and carwash-proof.

The holder or block containing the contacts shall be a one-piece non-absorbing insulating material that is tough, fibrous and dense, but not brittle, or soft under heat. The creepage surface between adjacent contacts on the outside face of the holder shall be ample.

Each electric portion of the coupler shall be provided with a weatherproof cover or shutter which shall effectively exclude dirt, dust, weather and carwash water from the contacts when uncoupled. The shutter shall be operated automatically, opening with the coupling and closing with the uncoupling of the coupler. When coupled, the electric contacts shall be effectively protected against the entrance of dirt, dust, weather and carwash water.

The construction and operation shall be such that in coupling the "R" ends of the cars, the contact holders will be extended automatically to make connections between cars after the couplers have been locked. In uncoupling the cars, the contact holders shall be retrieved before the couplers are unlocked. There shall be 15 pins projecting at all times.

Provision shall be made in each electric portion for a manually operated lever to permit manual retrieving and extending of the contact holder. Back connections and fingers shall be provided for three circuits in each box. The circuits shall be opened when the holder is advanced and closed when the holder is retrieved.

4.3.2.2 High Voltage Bus and Jumper (Not required)

4.3.3 PNEUMATIC

A pneumatic coupler shall be provided at the "R" end and shall be the same as described in Section 4.2.3.

MISCELLANEOUS CAR BODY ITEMS

5.1 SIGNS

5.1.1 SIDE SIGNS

Two non-illuminated side signs of approved design and manufacture shall be furnished, located in the upper section of a window, one on each side of the car. One sign shall be located between the first two door openings and one sign located diagonally opposite.

The sign shall be designed to permit easy installation, removal and interchange of the curtains. Each sign shall have one opaque curtain with 25 printed readings, reading from outside of the car. Two color strip maps shall be provided for the inside readings of the car, one map for each of the readings on the outside of the car.

Changing of the readings shall be motorized using a conductor's key in a switch located at each sign. Provision shall also be made to manually change the readings of the sign with a removable crank inserted into a flush-mounted "Allen" type socket. One crank for each car shall be furnished.

5.1.2 SIGN CURTAINS

Curtains shall be polyester film or approved equivalent. Curtains shall be .004 to .006 inch thick and be self-extinguishing. Initial tear strength to be 1300 psi minimum; ultimate tensile strength to be 25,000 psi minimum. The curtains shall be readily spliced by taping. The finished sign curtains shall not deteriorate from the heat of the sign lamps.

5.2 FIRE EXTINGUISHER

An approved dry chemical fire extinguisher of the stored pressure-type, containing not less than two pounds of extinguishing agent, shall be installed on one end of the car. The extinguisher shall be mounted in an enclosed area and clearly labeled.

5.3 CAB ACCESSORIES

5.3.1 WINDOW WASHER AND WIPER

An approved electrically operated window washer and wiper shall be provided for the cab front window in each car. Stops shall be provided to limit the wiper blade in both directions. The wiper blade, in the off position, shall be protected from vandalism with an approved guard. The power portion within the cab shall be suitably housed with finish to relate to interior finish of cab. A two-position, rotary control switch shall be mounted on the motorman's console.

5.3.2 SPEED INDICATOR

Speed shall be shown on a digital readout. The speed indicator panel shall also contain the slip-slide and speed fault indicators and the speed limiting switches.

5.3.3 COMMUNICATIONS PANEL

A communications panel shall be provided on the extreme left-hand side of the console. The panel shall include the following equipment which is detail specified in Section 13:

a. Hand telephone set
b. Mode selector switch
c. Buzzer
d. Radio indicator lights and controls

5.4 STANDARD KEYS

The Seller shall apply for a new key for control and door operation to be used exclusively on the SOAC cars.

5.5 HORN

One pneuphonic horn shall be installed under the "F" end of each car with an approved operating device located on the motorman's console. The diaphragm seat and all other parts except the body shall be of non-corrosive metal. A cutoff valve shall be provided on the feed line. A push bar for operation of the horn shall be provided on the console.

5.6 PASSENGER EMERGENCY VALVE
(See Section 5.7)

5.7 CREW EMERGENCY VALVE

One non-self-closing, poppet-type conductor's valve shall be furnished for each car, located in the operating cab. The valve shall be provided with two pull cords and handles. One pull cord shall be located for passenger's use and the remaining cord for use of the conductor within the operating cab. All parts shall be of non-corrosive material.

5.8 ELECTRICAL OUTLETS

A 110-volt AC plug receptacle shall be provided in the operating cab of each car. The receptacle shall be housed in a sheet metal box with removable cover. The receptacle shall be a standard two-pole, 25-ampere, 110-volt unit. A 25-ampere shock selected circuit breaker shall be included in the receptacle box and connected to provide electrical protection for the circuit. A similar 32-volt DC outlet shall be provided on the aft left-hand interior partition adjacent to the hostler receptacle.

5.9 TOILET ROOM ACCESSORIES
(Not applicable)

5.10 DRINKING WATER
(Not applicable)

5.11 PANTOGRAPH POLE
(Not specified)

5.12 THIRD RAIL SHOE PADDLES

Two third rail shoe paddles shall be provided for each car to permit operating crew members to safely disconnect the car from the third rail prime power source. The paddles shall be stored in the motorman's cab.

5.13 SAFETY CHAINS

Safety chains or cable, with approved covers, shall be provided, attached to an end door post at each end of each car at approved heights. They shall be connected with a center vertical rod and shall have sufficient length to extend from car to car and to be freely unhooked while cars are standing on a 145-foot radius curve.

The fixed ends of the chains or cable shall be permanently attached to the end door post by approved means and the free ends of the chains or cable shall be fitted to a steel rod. The steel rod shall be arranged to insert into sockets, permanently attached on the adjacent car to form the sides of the passageway between cars.

5.14 HOSTLER

A hand-held hostling control box and cord set shall be provided for use in moving the car in reverse from the "R" end. A plug receptacle shall be provided on the aft left-hand interior partition mounted just below the ceiling. The control box shall have a three-position switch to permit selection of "DRIVE", "COAST" or "OFF."

SECTION 6

DOOR OPERATION AND CONTROL

6.1 GENERAL

Power-operated side doors shall be provided for passenger ingress and egress. Each side of the car shall be provided with four double-leaf, cushioned doors.

An end door shall be provided at the "R" end of each car (non-cab end). A cab door shall be provided at the "F" end cab area of each car. The end and cab doors shall be manually operated.

6.2 SIDE DOOR CONTROL SYSTEM

The door control system shall be activated by a key operated master rotary switch in the operating cab of each car. This master rotary switch in the "ON" position shall establish a door control operating position on either side of the car. The door control operating position switches shall operate all the doors on that side of the train. Removal of the key in the operating position, and with the doors open or closed, shall not prohibit the doors from being closed and the control system locked by the activation of another master rotary switch in the other car.

Near one end of each side of the car a door key switch, with interior and exterior keyholes, shall permit the end leaf of the end door to be opened and/or closed.

Interlocks shall be provided to prevent opening of the doors while the train is in motion, and to prevent the cars from starting while the doors are open. (Refer to Section 6.4.)

6.3 DOOR SIGNALS

Door signals shall be provided to indicate DOOR OPEN or DOOR CLOSED conditions to the operator and crew.

The side door control circuit shall be designed to provide an audible "chime" warning signal to precede the door closing operation. The audible warning signal shall only be energized after a full door opening cycle.

Visual door signals to indicate the position of the side doors shall be provided. An indicator light in each cab (but functioning in the operating cab only) will indicate, when lit, that all side doors are closed and locked and that the key switch in the master door control is in the "OFF" position. A red outside signal light at each door leaf shall indicate, when unlit, that the leaf is closed and locked. Any leaf not closed or locked shall cause the signal light to light.

An indication light in the cab shall be lit if either end door or cab door is opened or unlocked. A blue outside signal light (on both sides) shall indicate, when unlit, that the door is closed and locked.

6.4 DOOR SAFETY DEVICES

The door operation and control system shall be provided with safety devices to minimize the likelihood of passenger injury caused by door operation and to provide for emergency exit of passengers.

6.4.1 SIDE DOORS

Each side door operator shall be equipped with handles by which the door leaf may be manually opened in the event an emergency exit is required. An attempt to manually open the door while the cars are in motion shall cause tractive power to be removed and full braking to be applied.

The side door control system shall be interlocked with the propulsion motor control so that power cannot be applied to the motors with doors open. The motorman shall have the capability to bypass this interlock in case of emergency. The door control system shall also be interlocked with a motion sensor so that power cannot be applied to the door opening circuit while the train is in motion.

6.4.2 END AND CAB DOORS

Each end and cab door shall be provided with a concealed closing device which shall exert sufficient force to hold each door against the weatherstripping and allow the door latch to engage its keeper.

Each end and cab door shall be provided with mechanical and electrically operated locks. All locks in the train shall be electrically retrieved by energizing a 32-volt trainline wire with a two-position rotary key switch located in the motorman's console in each car.

The operation of the key switch shall cause an indication light, on the motorman's console, to be illuminated. Any door in a train that is unlocked or opened shall cause the indication lamp to be illuminated. The lock shall be capable of being opened with a standard car key.

Passenger operated emergency switches (one inside and one outside the door) shall be provided for the end door. These switches, when operated, shall electrically unlock the end door whenever the train is not moving. Breaking a protective plastic plate shall be required to gain access to the emergency switches. The switches shall be identified by an adjacent decal.

SECTION 7

HEATING, COOLING AND VENTILATING

7.1 GENERAL

This section specifies the air comfort system requirements for the vehicle. The system shall include heating and ventilating equipment, temperature controls and an air conditioning system.

7.2 DESIGN CONDITIONS AND REQUIREMENTS

7.2.1 DESIGN EXTERIOR AMBIENT CONDITIONS

Exterior ambient conditions for design purposes are as follows:

a. Summer - Surface

105°F dry bulb temperature; 78°F wet bulb temperatures.

270 BTU/Hr. ft.^{2} solar heat rate intensity for the glass installed on one end and one side of the car having the largest glass areas.

b. Summer - Tunnel (Not specified)

c. Winter - Surface

-15°F. dry bulb temperature.

d. Winter - Tunnel (Not specified)

7.2.2 DESIGN INTERIOR ENVIRONMENT WITH PASSENGERS

7.2.2.1 Interior Ambient Conditions

Interior ambient conditions for design purposes are as follows:

a. General (Not specified)

b. Summer

75°F. dry bulb maximum (at control thermostat)

72°F. dry bulb minimum (at control thermostat)

60% relative humidity maximum.

c. Winter

75°F. dry bulb maximum (at control thermostat)

70°F. dry bulb minimum (at control thermostat)

7.2.2.2 Temperature Variations and/or Limits

a. Ambient temperature differences in the vertical plane shall not exceed 20°F when measured at the center aisle at heights of 6 inches from the floor surface and 48 inches from the floor surface in accordance with AAR Specification for Temperature Readings, Section 3, Page 1-3-4.

b. Ambient temperature differences in the horizontal plane shall not exceed 3°F when measured at the center aisle at any station location from 12 inches from one end surface to 12 inches from the opposite end surface.

c. (Not specified)

d. Surface temperature of any exposed protective device, grille or shield used for the heating element or media shall not exceed 150°F as a design goal.

e. (Not specified)

7.2.2.3 Ventilation fresh air of not less than 18 cfm per occupant shall be distributed within the passenger and operator's compartments. Fresh air and the recirculated air shall be filtered through common filters.

7.2.2.4 No condensation shall be formed nor collected on any interior surface of the vehicle.

7.2.2.5 Operator's windshields shall be defogged by a two-speed blower controlled by three-position switch-mounted on side of motorman's console.

7.2.2.5 Noise levels of the heating, cooling, ventilating and distribution system airflow or equipment, as measured in the interior as well as the exterior of the vehicle, shall conform to the respective requirements listed in Section 2.8.

7.2.2.7 The ventilation system shall provide a positive interior pressure not to exceed 0.20 inches H_2O maximum when the vehicle is operating at zero speed.

7.2.2.8 (Not specified)

7.2.2.9 Air velocities exceeding 75 feet per minute shall not be directed in any space occupied or traversed by passengers.

7.2.2.10 (Not specified)

7.2.3 DESIGN INTERIOR ENVIRONMENT DURING LAYOVER OPERATION - NO PASSENGERS

7.2.3.1 Fresh air ventilation is not required.

7.2.3.2 Minimum ambient temperature shall be maintained between 40°F and 50°F $\pm$5° at the control thermostat within the capabilities of the 12 KW floor heat (approximately 43.5° at -15°).

7.3 AUTOMATIC HEATING, AIR CONDITIONING AND VENTILATING CONTROL

7.3.1 GENERAL

The Seller shall furnish and install temperature control equipment as required for proper operation of the system and as described in this section.

A heating, ventilating and air conditioning control system shall be provided for each air conditioning unit. The systems shall be designed with maximum regard for passenger comfort. The controls, equipment and apparatus shall be designed for long life and dependability with the further objective that they be as light in weight and as compact as possible. The separate systems shall employ separate temperature sensing and control apparatus. The control apparatus for both systems shall be mounted in a panel. The temperature sensing elements shall be mounted above each of the recirculating air grilles and ahead of the filters.

The control equipment shall be designed so as to transmit temperature changes to the heating, ventilating and air conditioning equipment with a minimum of time delay.

Wherever practicable, the control apparatus shall incorporate static electronic components such as diodes, transistors, saturable reactors, etc., in lieu of electromechanical devices. Electronic components which are sensitive to damage from transient voltage spikes shall be adequately protected from harmful voltages which may be induced by devices in related circuits or admitted on wiring connected in common with other electrical equipment. The electronic control assemblies shall be constructed as plug-in units attached with quick fasteners or other approved means to prevent the units from vibrating loose from the fixed jacks.

All equipment shall be designed to minimize adjustments necessary for operation. The need for adjustments shall be avoided wherever possible by the use of appropriate circuitry, stable components, and high-tolerance circuits. Adjustable components shall not be used unless absolutely required and approved by the Buyer. Any adjustable components used during design development to determine the correct operational settings shall be eliminated in the final design. All plug-in cards of the same part number shall be interchangeable without any additional adjustment.

Temperature sensing devices shall be accessibly located, shock-mounted, provided with mountings and terminals or connectors of an approved design, shall not be unduly influenced by local sources of heat, sun load or outside iar and shall be reasonably tamperproof. All equipment shall be of rugged industrial quality suitable for transportation service, easily removable and every precaution shall be taken to ensure maintenance free operation under heavy vibration operating conditions. All parts requiring periodic cleaning, inspection and maintenance shall have maximum accessibility.

All electric contactors, relays and panel boards shall be subject to approval and shall be protected from moisture, dust and dirt. No controls, except the temperature sensing units, shall be permitted in the plenums or mixing chambers.

Heating or cooling system equipment operation for either passenger or layover service shall be activated by operation of switches at the operator panels within the vehicle. Layover heat shall be activated when air comfort switch is off.

Heating and/or cooling operations shall be automatically accomplished to satisfy the environmental requirements within the vehicle. No manual adjustments or switching are to be required to cycle system operations between heating and cooling.

The control system shall be designed in such a manner that failure of either the heat thermostat or the air conditioning and ventilation thermostat will not adversely affect the proper functioning of the other.

Means shall be provided to automatically deactivate appropriate equipment operation due to:

a. Overtemperature of electrically powered equipment

b. Overtemperature of heat air supply.

7.3.2 HEATING CYCLE

The heating cycle shall be thermostatically controlled. The heat circuit shall be energized below 70°F car plenum temperature. Additional duct heating shall be provided when fresh air inlet temperature is below 35°F. The blower fans shall operate at their reduced capacity during the entire heating cycle.

7.3.3 VENTILATING CYCLE

Ventilating fresh air shall be supplied to the vehicle whenever passenger service heating or cooling system operation is activated. When the car plenum temperature rises above 70°F the control system shall change over from the heating cycle to the ventilating cycle. The heat circuit shall be de-energized and the blower fan speed shall be increased to full capacity.

7.3.4 AIR CONDITIONING CYCLE

When the car plenum temperatures increase to 72°F, the first stage of air conditioning shall be energized. If used, the reheat cycle shall also be energized at this control point. When the car plenum temperature increases to 74°F, the reheat cycle shall be de-energized. When the car plenum temperature increases to 75°F, the full cooling cycle of air conditioning shall be energized.

7.3.5 LAYUP PROVISIONS

When cars are laid up, provision shall be made to thermostatically control the car space temperature to a minimum of 40°F. This control system shall take over automatically when the regular heating, air conditioning and ventilating systems are de-energized. The layup heat shall consist of floor heat only.

7.3.6 CONTROL UNIT

An approved panel shall be provided to house the heating, air conditioning and ventilating control equipment. This unit shall include the trainline relay, heater and fan contactors, control relays and all other necessary equipment for the proper functioning of the heating, air conditioning and ventilating systems specified. Adequate electrical insulation shall be provided wherever necessary between the car body and the control panel. The dirt, dust and waterproof cover shall be made of fiberglass reinforced plastic of an approved color.

7.3.7 TRAINLINE CONTROL

The ventilating and air conditioning systems shall be arranged for trainline control of all units in the train from the motorman's cab of each car. Individual car temperature control shall be automatic as provided in 7.3.2, 7.3.3, 7.3.4 and 7.3.5.

Trainline control shall consist of a battery-operated relay on each car which shall be actuated by the momentary ventilating and air conditioning switch located on the motorman's console of each car.

7.4 EQUIPMENT

7.4.1 CAR HEATERS

7.4.1.1 General

The car heating system shall be thermostatically controlled, fully automatic and shall consist of floor and ceiling heat. The floor heaters shall be located so as to preclude down drafts and shall be constructed of corrosion-resistant material. The heating elements shall be mounted in the heater cases so as to prevent vibration but to permit expansion and contraction. Heater leads shall be of sufficient length to permit the removal of the elements.

7.4.1.2 Control of Heaters

Trainline control shall be provided so that all heaters in the train can be controlled from the operating cab of the lead car. Individual car temperature control shall be automatically provided as described in Section 7.3.7.

The trainline control shall consist of a battery-operated relay on each car which shall be actuated by the heat, air conditioning and ventilating switch in the motorman's console in the operating cab of each car.

7.4.2 COMPRESSOR CONDENSER UNITS

Each car shall be equipped with two compressor condenser units mounted under the car in such a manner as to prevent vibration from being transmitted to the car structure.

For modulating cooling the compressor shall be designed to reduce pumping capacity by automatically unloading in response to system pressure preset by the manufacturer. Positive pressure lubrication shall be provided with protected visual means to indicate lubrication.

7.4.2.1 Compressor Motors

Each compressor shall be driven by a totally enclosed motor rated for continuous duty. The motor shall have a nominal rating of 230 volts, 60 Hz, 3-phase AC and shall have the capacity to drive the compressor under any load condition. The motor shall operate successfully over a voltage range between 207 and 253 volts.

The motor shall provide satisfactory operation under any condition or load and shall be suitable for continuous service, including any time when a sudden change in operating conditions may cause large voltage transients. The circuit breaker used for the protection of the apparatus shall not be unduly loaded during this short period. Protective circuitry shall be provided to prevent the compressor motor from starting across the line. Motors shall be protected from overheating with applied safety appliances.

The armature and field coils shall be thoroughly insulated with Class "H" insulation or better, and be held securely in place and protected against mechanical injury. The motor shall be able to withstand the vibration environment specified in Section 2.7.

7.4.2.2 Condenser

The condenser coil shall be constructed of 3/8-inch tubing with .008 inch copper fins spaced no more than 8-9 fins per inch. No crevices, closures, etc., for dirt to accumulate shall be permitted to hinder the rapid cleaning of the coils. A fan for even air distribution over the heat exchange surface shall be directly connected to the compressor motor.

7.4.3 RECEIVER TANK

One receiver tank shall be provided, mounted on each compressor condenser unit arranged so that the sight glasses are visible in a manner approved by the Buyer. Shutoff valves shall be provided at the inlet and outlet and a purge valve shall be provided for service use. Visual indication of clear sight glass shall be provided at the end and the side of the tank to indicate the refrigerant level. The glass shall be readily replaceable in the event of breakage and the receiver tank shall be readily replaceable without unsoldering any fittings.

7.4.4 FILTER DRIER

An approved, replaceable core drier shall be provided mounted in the liquid line on the compressor condenser unit and shall include a shutoff valve at the inlet and outlet.

7.4.5 REFRIGERATION CONTROL BOX

Weatherproof control boxes, one for each system, shall be provided for safety pressure switches, test switch, pressure gauges, hand valves, charging connections, etc. To prevent the possibility of improper connections, different size piping shall be used for the high and low pressure lines. The box shall be mounted on the compressor condenser unit so that it may be readily visible from the side of the car. A safety trunk arm shall be provided to hold the cover of the box in an open position.

7.4.6 STRAINER AND VALVES

One strainer shall be provided for each system in an approved location before the expansion valve of the evaporator. The strainer shall be equipped with a removable and replaceable screen. Shutoff valves shall be provided on both sides of the strainer.

7.4.7 MOISTURE INDICATOR

Moisture indicators, one for each system, shall be provided and located in the liquid line of the evaporator.

7.4.8 LIQUID LINE SOLENOID VALVE

Electrically operated valves shall be provided in the main liquid line before the evaporator. A locking-type plug connector shall be provided.

7.4.9 CONTACTOR PANEL

One panel shall be provided in a weatherproof box for each system, and shall be mounted on the compressor condenser unit so as to be readily visible from the side of the car. All motor starting contactors and relays for the proper operation of the system shall be provided on this panel, exclusive of the temperature control. A safety trunk arm shall be provided to hold the cover of the box in an open position.

7.4.10 CAB AIR CONDITIONING

Air conditioning shall be provided in the operating cab of the car.

7.4.11 EVAPORATOR BLOWER UNITS

Each car shall be equipped with cooling units mounted as specified by the Buyer.

7.4.11.1 Evaporators

The evaporator coil shall be constructed of 3/8-inch tubing with .010 inch copper fins spaced eight to the inch. The evaporator shall be arranged for modulated control, each section fed through its own expansion valve. Expansion valves shall be so located to be readily accessible for maintenance and removal. A stainless steel drain pan shall be provided under the evaporator coil. Sufficient baffles to prevent condensate spillage and adequate drainage shall be provided.

7.4.11.2 Fan/Motor Assembly

The motor shall have a nominal rating of 230 volts, 60 Hz, 3-phase AC and shall have ample capacity to drive the fans under any load condition. The motor shall operate successfully over a voltage range between 207 and 253 volts.

The motor shall be able to withstand the vibration environment specified in Section 2.7 and shall be provided with a ground connection from the motor frame to the car body.

The fan assembly shall be rated at 2000 cfm at 1.3 inches of water static pressure. Total evaporator capacity for the car shall be 400 cfm.

7.4.11.3 Reheat

A total of 9 KW of electric heat shall be provided at each evaporator.

7.4.12 EXTERIOR AIR INLET

Exterior air inlets shall be protected against foreign particle ingestion by "egg crate" deflectors mounted at the roof line and internally. Provisions shall be made for the drainage of water to the outside of the car. The external air shall be further filtered as described in paragraph 7.2.2.3.

7.4.13 REFRIGERANT PIPING

All refrigerant piping shall be refrigeration grade seamless copper tubing unless otherwise specified. Tubing shall be preformed wherever possible and shall be assembled with as few fittings as practicable. Piping shall be supported by brackets and clamps no more than 4 inches from joints, fittings, valves and bends of 45 degrees or more and no more than 24 inches apart on straight pipe runs. All piping shall be protected from chafing and dissimilar metals in an approved manner. Piping runs shall be arranged to create no traps or other inconsistencies in the flow of the refrigerant. Flexible connectors, as approved by the Buyer, shall be provided for each pipe at each resiliently mounted unit.

Fittings shall be approved refrigeration grade wrought copper or cast brass material, and shall be located at identical positions in each car. Fittings, joints, etc., shall be in readily accessible locations for both testing and repair.

7.4.14 ACCESS DOORS

Access doors shall be provided in the low ceiling area for the maintenance and removal of the air conditioning equipment. Doors shall be provided with hinges, an approved locking arrangement and safety catches. Doors shall be sealed or weatherstripped in an approved manner to prevent air leaks.

7.4.15 DUCTING AND GRILLES

7.4.15.1 Flexible transition ducts shall connect the overhead air distribution duct. Transition ducts shall be fire-resistant and shall be able to withstand, without damage, the maximum temperature developed by the overhead heat unit before overtemperature cutoff in the event of blower failure.

7.4.15.2 Recirculation air grilles shall be provided at locations to be approved by the Buyer near the air conditioning evaporation units. The grilles shall be hinged and provided with safety catches and an approved locking arrangement to provide access to the evaporator unit. Grilles shall be designed to pass the required quantity of air without producing objectionable noise.

7.4.15.3 Air ducting shall be adequately insulated and constructed of fire-retardant materials. Ducts shall be designed to provide the specified air volume without exceeding 1800 feet per minute air velocities within the ducts.

7.4.15.4 Air movement within the car shall normally be accomplished by the blower fans which shall be mounted resiliently and may be supplied as a part of overhead evaporator units, if used. Fresh air shall enter through screened openings in the roof at both ends, shall be mixed with recirculated air passing through a ceiling grille and filter, be cooled or heated at both ends and enter into the plenum chamber. The plenum chamber shall be longitudinally divided by a diagonal member so that a separate duct is formed for each blower.

7.4.15.5 Diffusers, grilles and outlets shall be designed to provide evenly distributed air at velocities less than 1200 feet per minute. Installations shall be flush-mounted with exposed surfaces designed to complement other interior features.

A method of air flow adjustment by use of a standard screwdriver shall be provided to balance and equalize air flow in all passenger areas. In the cab areas, air flow adjustment shall be provided by use of an exposed hand control.

Grilles and outlets that are designed for access shall be provided with safety catches and limit chains or cables.

7.4.16 AIR FILTERS

Air filters shall be provided to filter both fresh and return air. Filters shall be standard size, commercially available, non-reusable and capable of 30 days normal operation between changes. Filters shall be mounted in dust-tight frames, shall be readily accessible and capable of being easily changed by unskilled labor. Condenser intake surface shall be screened.

7.4.17 EMERGENCY VENTILATION SYSTEM (Not required)

7.5 DESIGN DATA SUBMITTAL
(Not specified)

7.6 TEST AND DATA REQUIREMENTS

Refer to Section 17 for environmental testing and test data requirements.

SECTION 8

LIGHTING

8.1 INTERIOR LIGHTING

The passenger area of each car shall be illuminated by a fluorescent lamp system. The location and arrangement of lighting fixtures shall be in accordance with St. Louis Car Drawing No. 2D24000. Lamps will be provided with lenses or shields which are easily removable for service and which are designed to prevent the accumulation of moisture or dust. The lighting system shall not produce objectionable levels of brightness or glare.

8.1.1 INTENSITY

The lighting system shall provide the following minimum light levels with new lamps:

Location	Intensity
Passenger Area (at seated reading plane)	30 foot-candles
Side Door Area (at floor level within 20 inches of doors)	25 foot-candles

8.1.2 CAB LIGHTING

The operating cab area shall be illuminated by fluorescent fixtures and shall provide well lit, glare-free light for the car operator. Cab lights shall be controlled by a separate circuit breaker located in the cab.

8.2 EXTERIOR LIGHTING

8.2.1 HEADLIGHTS AND TAIL LIGHTS

Two headlights and two tail lights of the same diameter in recessed, weathertight housings, shall be provided at the "F" end of each car. Two tail lights shall also be provided at the "R" end of each car, controlled by a separate circuit breaker located adjacent to the hostler plug.

Each headlight shall be a sealed beam, 60-watt lamp with capability for replacement with a 150-watt maximum lamp.

Each tail light shall be a 15-watt lamp with a rubber-glazed red lens.

8.2.2 HOSTLING AND MARKER LIGHTS

Two hostling lights will be provided on the "R" end of each car, controlled by a separate circuit breaker located adjacent to the hostler plug. Each hostling light shall be a 15-watt lamp with a rubber-glazed clear lens.

8.2.3 TROUBLE LIGHTS (Not specified)

8.3 EMERGENCY LIGHTING

Each car shall be provided with eight incandescent emergency lamps which shall be powered by the car battery. These lights shall be automatically energized when the main light switches are on, but the main light circuits are interrupted. Six emergency lamps shall be located in the overhead center line of fixtures: two in each end fixture and two in the center fixture. The remaining two emergency lamps shall be located in a fixture at each car end, dropped-ceiling area.

If primary power is interrupted, headlights and tail lights shall remain lighted by the emergency power.

SECTION 9

MISCELLANEOUS ELECTRICAL EQUIPMENT

9.1 GROUNDING, BONDING AND LIGHTNING PROTECTION

9.1.1 GENERAL

Grounding and bonding shall provide a good conductive path from all metal structure to the low voltage side of all voltage sources, so that no metal part can be on a potential with respect to other metal parts and thus create a life hazard.

9.1.2 POWER SUPPLY

The ground side of the primary power supply (ground side of the traction motor, ground side of the transformer primary) shall be connected to a suitable bonding point on the truck. A suitable set of slip rings and brushes shall be provided between the truck frame and the axle to provide a path through the wheel rims to the running rails.

9.1.3 AUXILIARY SERVICES

All DC control voltages shall be one-wire systems with the low point connected to the car body.

9.1.4 PASSENGER SAFETY

All metal parts of the car which can be touched by the passengers shall be at ground potential.

9.1.5 ISOLATION (Not specified)

9.1.6 PANTOGRAPH

9.1.6.1 Pantograph Isolation

Adequate isolation shall be provided such that when the pantograph is in the locked-down position, inadvertent application of 1000 volts to the pantograph shall not result in arc-over to the car frame.

9.1.6.2 Ground Lead

Flexible ground connections shall be provided from the car body to each truck and from the intermediate frame and thence to the ground brushes of each axle. The ground lead from the pantograph grounding device shall be connected to the car roof.

9.1.6.3 Lightning Arrestor

The pantograph shall be provided with a 25 KV Thyrite type lightning arrestor.

9.2 WEATHERPROOFING - ELECTRICAL EQUIPMENT BOXES

9.2.1 DOORS

All doors to the external equipment boxes shall be watertight. The seals shall be made of suitable material (subject to Buyer's approval) and molded into the equipment box in such a manner that they cannot be dislodged.

9.2.2 CONDUIT ENTRY

All entries of conduits into the equipment boxes shall be through weatherproof fittings. Where a single wire enters an equipment box without a conduit, the entry shall be made waterproof by a suitable strain-relief bushing.

9.3 ELECTRICAL DISTRIBUTION SYSTEM

9.3.1 GENERAL

The car electrical distribution shall be in accordance with Book I, AAR Electrical Manual, Section 1, Chapter 3, titled "Car Electrical Distribution System."

9.3.2 WIRING

All car wire and cable shall be in accordance with MIL-W-1687-D, Type K and KK, up through size #1. AWG 1/0 and above to be Hypalon.

9.3.3 WIRE HARNESSES, CONDUITS, WIREWAYS

9.3.3.1 Wire Harnesses

All low voltage wires arranged in bundles containing more than two wires shall be in a prefabricated, bench-assembled, completely interchangeable harness. The finished harness shall include machine-applied wire terminations. Each wire of the harness shall be permanently marked along its entire length.

9.3.3.2 Conduits and Wireways

No wiring shall be left exposed to the elements. Conduit shall be used as needed to protect wiring.

9.4 CONNECTORS
(Ref. Section 9.3)

9.5 SWITCHES
(Ref. Section 9.3)

9.6 PROTECTION

Fuses, circuit breakers and other protective devices in the distribution circuit must be properly coordinated with the power supply and their installation is subject to design review.

9.7 LOW VOLTAGE SUPPLY

9.7.1 GENERAL

Each car shall be equipped with a nominal 37.5 volt DC supply system consisting of one or more storage batteries, battery box (es) and a battery charging system. The battery shall be a nickel-cadmium type meeting the requirements of AAR Electrical Manual, Section 1, Chapter 1, and the environmental conditions defined in Section 2.6 of this specification.

Systems and components which shall be supplied with low voltage include, but are not limited to, the headlights, tail lights, emergency lights, fluorescent lights, instrument lights, temperature controls, destination sign controls, door operators and door controls, communications system, propulsion and braking controls. All systems or components supplied directly from the battery shall be capable of operation in a voltage range between 28 and 44 volts.

The low voltage bus shall be supplied by the output of a three-phase rectifier system whenever there is a normal MA output. The bus shall be automatically connected to the battery during loss of MA output. The low voltage bus in all cars shall be connected in parallel through B+ trainlines of adequate capacity.

The Seller shall be responsible for coordinating the design of all circuits and equipment operated at low voltage to prevent damage or disturbance to function caused by electrical transients in the battery circuit. The Seller shall also be responsible for ensuring that equipment and circuits operated from the bus shall be so designed that sustained presence of any low voltage from the maximum down to zero shall not cause any damage.

9.7.2 CAPACITY

At normal battery operating temperature (above 0°F) the battery shall have sufficient capacity to:

a. Carry all emergency battery loads and sustain operation of the fluorescent lighting for interruptions in the main power supply of up to 30 seconds duration.

b. Provide all emergency battery loads in the absence of battery charging for a period of 1 hour.

9.7.3 BATTERY CHARGER

A battery charger capable of maintaining a charged battery under normal requirements shall be provided on each car. The charger shall have inherent current limiting to 22.5 amps maximum and shall be able to sense the charge level of the battery so as to reduce the average charging current level to that required to maintain a charged condition. The charger shall sense the loss of MA output to the rectifier system and automatically connect the battery to the low voltage bus during the time of loss.

9.7.4 WATERING

The battery in normal service shall require watering no more than every 720 hours.

9.7.5 BATTERY BOX

The battery shall be carried in an enclosure located on the undercar structure. The enclosure shall be constructed of corrosion-proof material and shall be ventilated. The interior

shall be fireproof. Convenient access for servicing or removing the batteries shall be provided.

9.7.6 BATTERY DISCONNECT

A battery circuit breaker of adequate capacity and approved design shall be provided in the operating compartment of each car to serve as a main service breaker for the battery system on each car.

9.8 AUXILIARY POWER SUPPLY

9.8.1 MOTOR GENERATOR (Not applicable)

9.8.2 STATIC CONVERTER (Not applicable)

9.8.3 MOTOR ALTERNATOR

9.8.3.1 General

The motor alternator described herein shall meet the requirements defined in Section 1, Chapter 2, Part 3 of the Association of American Railroads, Electrical Manual of Standards and Recommended practices, 1966 issue and the distribution system per Chapter 3 of the same manual, in addition to those of this specification. In the event of conflict with the reference manual, the requirements of this specification shall govern.

One motor alternator set shall be provided for each transit car.

The input power to the DC motor shall be nominally 600 VDC with limits and other requirements as defined in paragraph 2.2.1.1.1.

The AC output of the motor alternator shall be 3-phase, nominally 60 HZ, 230V rms line-line.

9.8.3.2 Capacity

The capacity of the MA set shall be determined by a load analysis which shall list as a minimum, the following:

a. All equipment being powered by the MA.

b. Power consumption of each equipment item, start and run.

c. Load power factors, starting and running.

d. Phases and phase balance.

e. Voltage and frequency requirements.

f. Overloads and transients.

The continuous capacity rating of the MA set shall be a minimum of 25% over the total load figures reflected in the load analysis. The Seller shall show in the analysis that no single starting load consumes more than 50% of the continuous rating of the MA set. The Seller shall take care that any single-phase loads are equally distributed between the three phases so that phase loads are always within at least 10% of each other. The load analysis shall be submitted to the Buyer prior to any testing of the MA set.

9.8.3.2.1 Power Factor

The MA set shall meet all performance limits specified with load power factors between unity and .8 lagging for all loads up to 150% rated.

9.8.3.2.2 Efficiency

The overall efficiency goal of the MA set shall not be less than 70% at full or output load and not less than 65% at half load.

9.8.3.3 Design

9.8.3.3.1 Service Life

The design criteria for service life of the MA set shall be 20 years with an average of 4,000 service hours per year.

9.8.3.3.2 Motor

The motor shall be balanced and tested in accordance with the NEMA standards.

9.8.3.3.3 Seals

Motor dynamic seals shall be limited to radial lip seals, face seals, or labyrinth seals.

9.8.3.3.4 Brushless Alternator

The AC generator shall be designed to use rotating rectifiers (diodes) in place of a slip ring with brushes.

9.8.3.3.5 Solid State Control

Circuit designs for voltage regulator and speed/frequency

control shall use solid state components. Protective functions shall utilize solid state components where practical.

9.8.3.3.6 Fail-Safe

Protective circuit elements for sensing faults such as over-speed/frequency, over-voltage, etc., shall be independent of those circuits which normally sense and regulate so that a failure of one will not prevent proper operation of the other.

9.8.3.3.7 Temperatures

The MA set together with all controls shall be designed to operate satisfactorily and meet all performance requirements over an ambient temperature range of 150°F to -20°F.

9.8.3.3.8 Cooling

The motor alternator set shall be self-cooled.

9.8.3.3.9 Humidity

The MA set shall operate with exposure to relative humidity up to 100%, including conditions where condensation takes place in the form of both water and frost.

9.8.3.3.10 Insulation

The MA set shall have Class B or H insulation.

9.8.3.4 Voltage Regulation and Control

9.8.3.4.1 Point of Regulation and Load Bus

The point of regulation shall be located as close as possible to the system load bus on the generator side of the load contactor. The bus contactor shall be a single unit having a set of three, single-phase contacts (3 PST) operated by one control coil.

9.8.3.4.2 Voltage Regulation

The transient and steady state three-phase voltage output shall remain within 230V $\pm$5% up to full load.

9.8.3.4.3 Frequency Regulation

The frequency of the AC output voltage shall be maintained within 60 $\pm$3 HZ during all steady state load conditions, and within 60 $\pm$6 HZ during load switching transients.

9.8.3.4.4 Wave Form

The crest factor for each phase voltage wave form shall be 1.41 ±5%. No single harmonic shall exceed 1.5% of the fundamental and the total harmonic content shall not exceed 3% of the fundamental for all normal operating conditions of the MA set.

9.8.3.5 Lubrication

The bearings used in the MA set shall not require lubrication more often than every 10,000 hours.

9.8.3.6 Protection and Fault Clearing

9.8.3.6.1 False Trips

Protective devices (circuit breakers, fuses, etc.) in the distribution feeders shall be capable of coordinating with the MA and its protective features (UV, OV, UF, etc.) so that shorts occurring on any distribution circuit shall be cleared before the MA trips.

9.8.3.6.2 Overvoltage

Overvoltage protection for the AC output shall be provided which functions to disconnect the generator from the loads bus and de-energize the generator before the voltage at the point of regulation exceeds the limits defined in the overvoltage curve of Figure 9-1. There shall be no automatic reset for this protection element. It will be manually performed by the motorman.

9.8.3.6.3 Undervoltage

Undervoltage protection for the AC output shall be provided which functions to disconnect the generator from the load bus within 3 to 5 seconds after any line-to-line voltage fails below 200 volts. If the fault condition (undervoltage) persists, the system shall trip off the line and remain off unless manually reset by the motorman.

9.8.3.6.4 Overfrequency

Overfrequency protection for generator output and overpseed protection for the DC drive motor shall be provided and may be managed by sensing either the drive motor speed or the generator output frequency. The MA set shall be shut down before the motor speed exceeds the maximum danger point. If the generator output frequency should exceed 70 Hz for five seconds, the MA shall be shut down.

9.8.3.6.5 Feeder Fault

Differential feeder fault protection shall be provided to both the DC input feeders to the MA set and the AC output of the MA set. The protection system shall provide for opening the input power circuit to the MA set within 0.1 seconds when the input current between the protected zone of the input exceeds 25 amps. Fault current detection between the alternator neutral and the car body ground will be provided.

9.8.3.6.6 Anti-Cycling

The system shall provide means to prevent cycling when a fault exists.

9.9 INTERFERENCE AND COMPATIBILITY

9.9.1 CONTROL AND TEST PLANS (Not specified-tests to be conducted by the Buyer)

9.9.2 ELECTROMAGNETIC INTERFERENCE DESIGN GOALS

Electromagnetic interference limits are required in order to avoid undesirable effects upon external environment along the right-of-way as caused by onboard vehicle systems. The limits of radiated interference shall be 109 dB over one microvolt/meter/MHz at 150 KHz to 84 dB over one microvolt/meter/MHz at 30 MHz (straight line, semi-log), 58 dB over one microvolt/meter/MHz from 30 MHz through 90 MHz, and 68 dB over one microvolt/meter/MHz from 90 MHz through 400 MHz. (Reference Figure 9-2) Testing shall be conducted in accordance with Section 17.4.6.7.

9.9.3 INTERFACE COMPATIBILITY (Not specified)

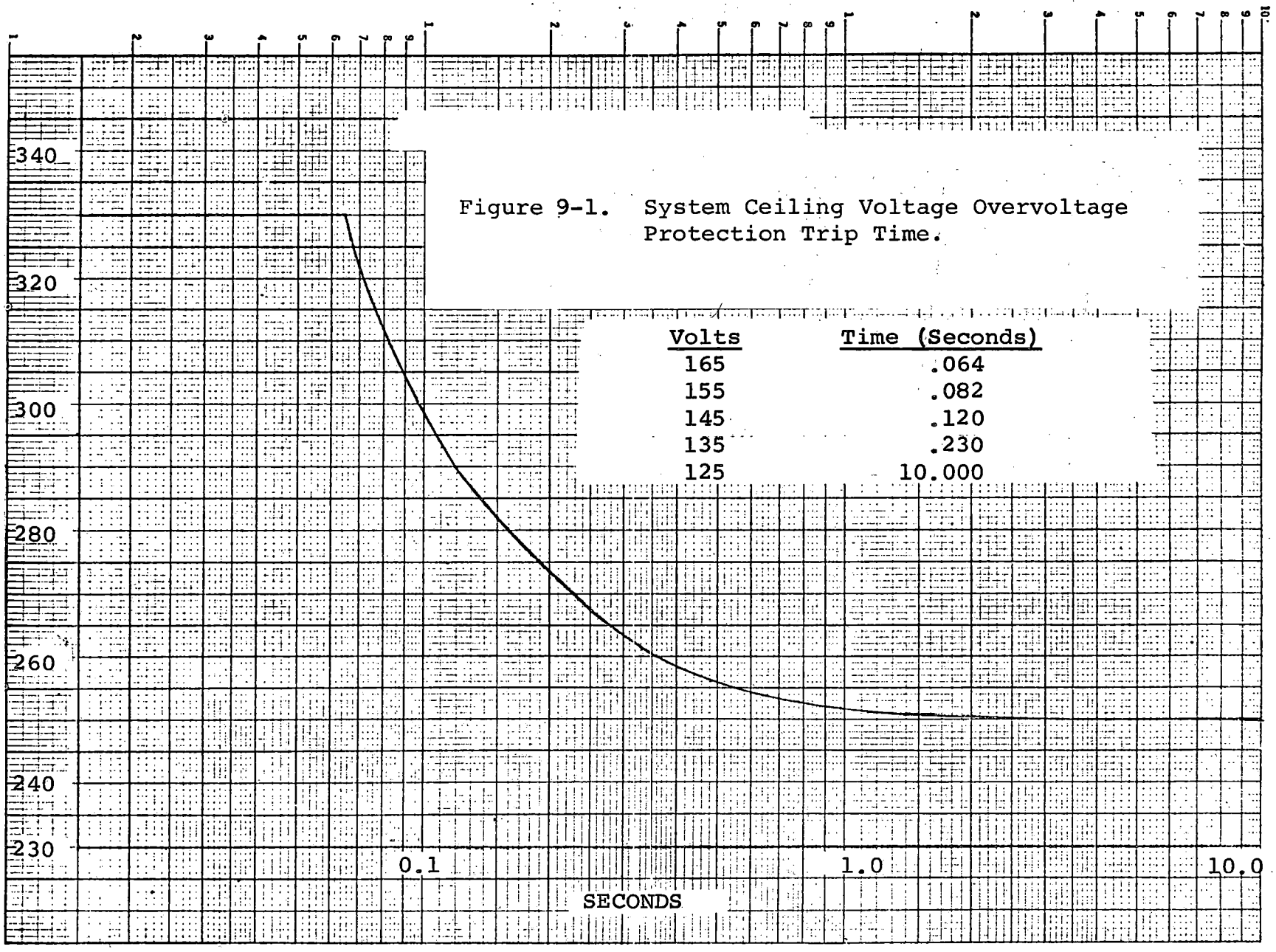
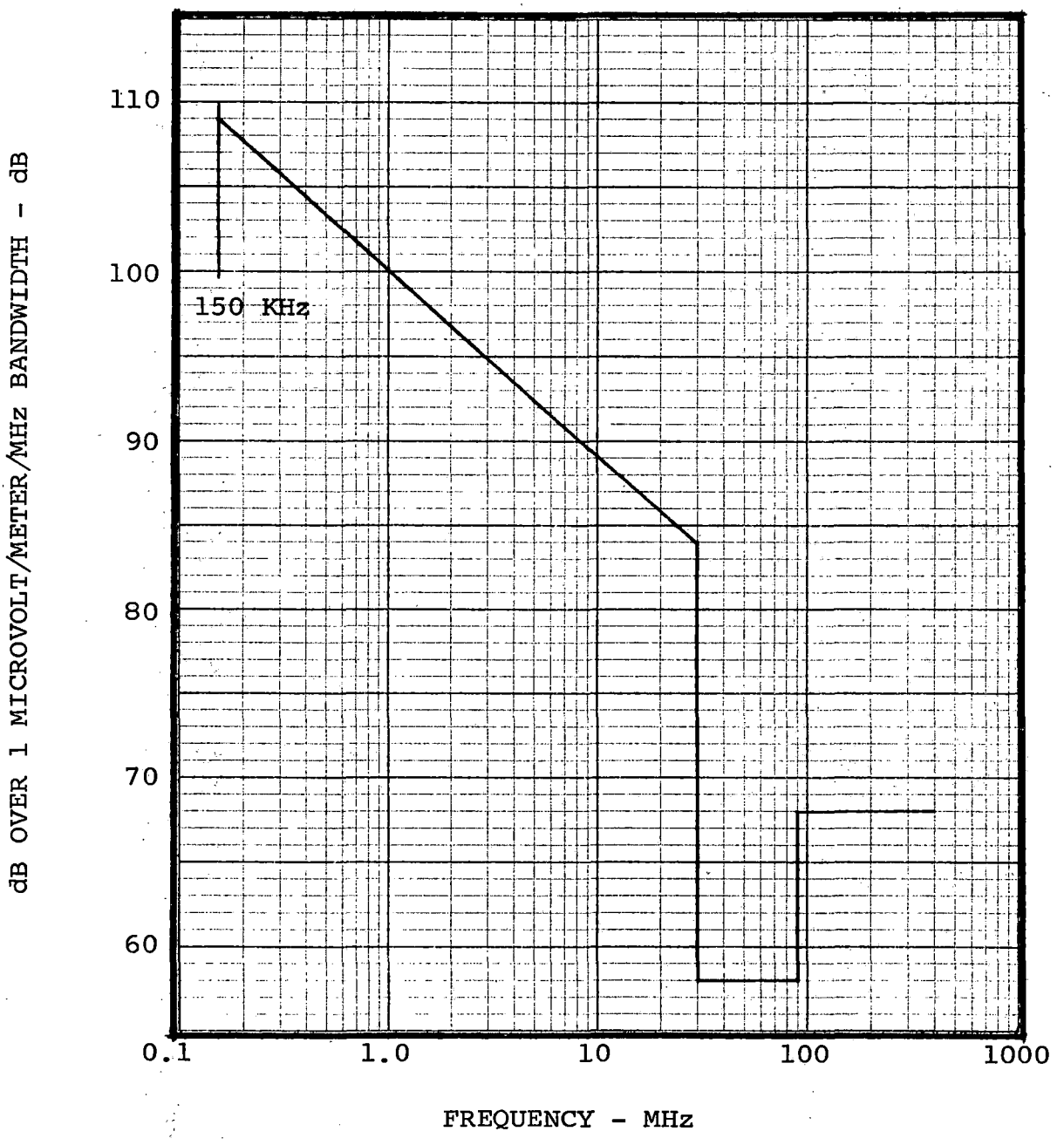


Figure 9-1. System Ceiling Voltage Overvoltage Protection Trip Time.

Volts	Time (Seconds)
165	.064
155	.082
145	.120
135	.230
125	10.000

FIGURE 9-1



RADIO FREQUENCY INTERFERENCE GOALS

FIGURE 9-2

SECTION 10

POWER AND TRACTION

10.1 PRIME POWER

Prime power for propulsion, auxiliaries and control will be provided as follows:

10.1.1 ALTERNATING CURRENT (Not applicable)

10.1.2 DIRECT CURRENT

Input power will have the following characteristics:

Design Point Voltage	600 VDC
Nominal Voltage Range	450 to 650 VDC
Maximum Voltage Range for Operation	425 to 675 VDC

The system shall meet all performance requirements at line voltage of 600 VDC. Below 600 volts, performance may be derated linearly to a maximum of 25% at 450 VDC. In the range from 425 to 450 VDC, system operation is required for one minute, after which the system may be automatically disconnected from the line. The system shall be tolerant of, or protected from damage by line voltage spikes of 6,000 volts magnitude and 5 microseconds.

10.1.3 SELF-GENERATED POWER (Not applicable)

10.2 CURRENT COLLECTION

Both pantograph and third rail contact shoes shall be utilized for prime power current collection as necessitated by requirements for compatibility with the five operational demonstration sites.

10.2.1 PANTOGRAPH

An approved, lightweight pantograph shall be mounted on the roof of each car over the centerline of the No. 2 truck. The pantograph shall be compatible with the characteristics of the catenary system of the Cleveland Transit System and the Chicago Transit Authority Skokie-Swift Line. The support for the pantograph shall be arranged to span several carlines in order to distribute its weight and, at the same time, provide electrical insulation from the car frame. Approved climbing steps shall be provided for access to the car roof in emergencies. An approved fuse and lightning arrest r shall be provided. (See Section 9.1.6).

The pantograph shall be electrically raised and lowered using a DC series motor in conjunction with a driving spring force which shall maintain the proper contact pressure against the catenary. Time to raise or lower the pantograph shall be 4 to 6 seconds. Provisions for manual drive shall be incorporated.

The pantograph shall have sufficient operating range when mounted on the car roof to accommodate the variation in trolley wire height encountered in the service intended. It shall operate down to within three inches of the locked-down position.

Control of the pantograph shall be through train line wires so that all of the pantographs in a train may be raised or lowered from the operating cab after the master controller has been made operative.

A red pantograph warning light shall be provided in the motorman's cab. The lamp shall be illuminated whenever a pantograph on the car or train is in the elevated position.

Change-over contactors shall be provided so that prime power may only be supplied from one source, i.e., third rail or overhead catenary wire. The source applied first shall lock out the other source automatically.

10.2.2 THIRD RAIL CURRENT COLLECTOR

Each car shall be provided with four third rail current collectors mounted one on each side of each truck. The devices shall be compatible with the characteristics of the third rail power system described in the prime power specification. The current collector used to transfer electrical energy from the contact rail to the traction main power terminals of the transit vehicle shall consist of a contact shoe that slides along the contact rail, associated springs or other devices to maintain suitable contact pressure of the shoe on the contact rail, and shunt wires to carry current from the shoe to the current collector fuse terminals. The collector assembly shall be mounted on the transit vehicle truck frame. The current collect shall be of the top contact (overrunning) design.

10.2.2.1 Location and Mounting Requirements

The location and mounting requirements and the control dimensions for the current collector shall be coordinated with the truck manufacturer. The assembly shall be designed and manufactured to ensure interchangeability of the components. The location of the current collector mounting bolts shall be coordinated with the transit vehicle manufacturer and shall, if necessary, provide the additional vertical adjustment necessary to operate on the five properties mentioned herein.

10.2.2.2 Collector Motions and Limits

The current collector design shall be capable of absorbing the following motions, imparted by the truck, without loss of contact, and shall be capable of adjustments within the ranges listed below:

10.2.2.2.1 Horizontal motion, parallel and longitudinal to the contact rail and reversible, will be 0 to 117 feet per second (80 mph) with an average velocity of 75 feet per second.

10.2.2.2.2 Horizontal motion, lateral to the contact rail will be ±1-1/2 inches maximum at frequencies of 0 to 2 c/s. When at rest, the collector shoe shall not extend more than 2-1/2 inches beyond the centerline of the contact rail.

10.2.2.2.3 Cyclic rotation of the mounting in a horizontal plane will be ±1/2 degree maximum at 0 to 2 c/s.

10.2.2.2.4 Vertical motion relative to the contact rail, will be ±1/2 inch nominal, at 1 to 4 c/s.

10.2.2.2.5 Maximum downward travel of the collector shoe below the top of the contact rail shall be 2-1/2 inches when off the rail.

10.2.2.2.6 Vertical mounting adjustment of the current collector assembly for wheel wear shall be down - 0, up - 1-1/2 inches, in maximum of 1/4-inch steps.

10.2.2.2.7 Contact pressure of the collector shoe shall be adjustable independently of the collector height. This may be accomplished by adjustment or by interchangeable springs with different constants.

10.2.2.3 Minimum Wear Depth of Collector Shoe

The collector shoe shall have a minimum life sufficient for approximately 10,000 collector miles. The collector shoe material shall be compatible with the contact rail wear surface, shall be sacrificial to the contact rail, and shall resist welding to the contact rail.

10.2.2.4 Folding or Removable Collector Shoe

The current collector assembly shall be designed to permit the collector shoe to be folded, or in lieu of the folding feature, the collector shoe shall be easily removed in order to isolate a car from the contact rail. Whichever method is used, the design shall permit the folding or removal of the collector shoe by means of an insulated tool or shoe paddle.

10.2.2.5 Other Collector Requirements

The design of the current collector assembly shall permit the collector shoe to track the contact rail with a minimum of sparking, bounce and arcing, and shall demonstrate a minimum of shoe bounce when running onto and off the contact rail at speeds of 0 to 117 feet per second (80 mph) with approach ramp slopes of 1 to 5 degrees.

The current collector assembly shall be designed so that there will be a minimum of replacement or renewable parts and shall be designed to facilitate the quick change of collector shoes. No electrical current shall pass through bearings or other movable connections. Provisions shall be made for easy lubrication of movable connections or bearings and the entire collector assembly design shall assure convenient inspection and cleaning. The collector insulation system shall be designed to permit ease of cleaning.

10.2.2.6 Electrical Characteristics

There will be four current collectors per car. Each current collector shall be designed to carry the required DC current. The current collector contact shoes shall have sufficient surface area in contact with the rail to pass the rated DC current at all operating conditions without heating to a temperature that would be detrimental to the collector shoe assembly.

10.2.2.6.1 Current Ratings

Each collector shall carry 500 amps DC continuously, 900 amps DC for 70 seconds.

10.2.2.6.2 Insulation

The collector mechanism shall be insulated from the car body. This insulation shall be rated for a nominal voltage of 1000 DC.

10.2.2.6.3 Electrical Connections

A suitably enclosed terminal shall be provided on the current collector fuse assembly to provide a connection point between the collector and the cable to the main traction power terminal. The location and size of the terminals shall be coordinated with the car manufacturer and approved by the car manufacturer. The fuse assembly shall not interfere with folding or removing of the collector shoe feature.

10.2.2.6.4 Fuses for Current Collectors

Current limiting type fuses suitable for rapid transit operation shall be provided on each current collector. The fuses shall be silent, non-flame producing and shall not require ventilation during fault interruption. The fuses shall be mounted in an appropriate weatherproof enclosure and shall be easily accessible for inspection and maintenance. Terminals for connection of shunt cables from the collector shoe, on the feed side and for cable connection on the load side of the fuses shall be furnished with the fuse holder. The fuse rating shall be suitable for the installation on the circuit energized from the contact rail and collector shoe.

10.2.2.7 Contact Shoe Shunts

Each contact shoe shall be provided with copper shunts of dimensions and capacity necessary for current collection attached to the shoe and to the bracket.

10.2.2.8 Contact Shoe Slippers

The contact shoe slipper per car shall be provided and fastened with clip retainers in the operating cab of each car. Slippers shall be maple, having a moisture content of not more than 12% and shall be thoroughly coated with an approved insulating paint.

10.2.2.9 Third Rail Pickup Cables

Third rail electrical pickup cables shall be provided to carry prime power current from the fuse terminals of the four current collectors to the main traction power terminal. The cables shall be of stranded construction consisting of 925 No. 24 Hypalon covered wires enclosed in protective neoprene tubing and shall be securely fastened to the trucks.

10.2.2.10 Ground Leads

Two car body ground leads shall be provided per car, one at each truck. The leads shall be bare, flexible cable of 235,000 minimum c.m. area taped at intervals to prevent spreading of strands. The leads shall be attached to suitable copper plates brazed to suitable steel plates which later shall be attached to the car center sill and to the truck transom by continuous peripheral welds.

Four truck ground leads shall be provided per car: two on each truck connected to the truck frame and the ground brushes. The truck ground leads shall be attached to the truck end frames in the same manner as the car body ground leads. The leads shall be bare, flexible cable of 125,000 c.m. area taped at intervals to prevent spreading of strands. They shall be ample length for flexibility and shall have T&B Method or approved equivalent terminals.

10.2.3 TROLLEY POLES (Not applicable)

10.2.4 SLEET SCRAPPERS (Not applicable)

10.3 INTERMEDIATE POWER (Not applicable)

10.4 ENERGY CONVERSION, ELECTRICAL SERVICE (Not applicable)

10.5 TRACTION

10.5.1 ACCELERATION & DECELERATION CONTROL

10.5.1.1 System Description

A series-type chopper system shall be used to supply power to the traction motor armatures. The motor fields shall be separately excited using power from the secondary power system. Chopper operating frequency shall be fixed at approximately 400 Hz.

10.5.1.2 Construction

The chopper assembly and its associated controls shall be constructed in modular form for easy maintenance.

10.5.1.3 Failure Modes

No component or module failure shall cause the catastrophic failure of an entire chopper assembly. The chopper system shall be designed for fail-safe operation.

10.5.2 OVERLOADS

Chopper system protection design shall be submitted to the Buyer for approval.

10.6 TRACTION MOTORS

10.6.1 GENERAL

Each axle shall be driven by a traction motor with the characteristics necessary to produce the tractive effort levels defined in Section 2.2.1, Figure 2-2. All traction motors shall be physically and electrically interchangeable between cars. The traction motors shall conform to the following specifications, except as modified:

a. IEEE, Standard No. 11, Rotating Machinery
b. IEEE, Standard No. 16, High Potential Test
c. USAS, C.35.1-1962, Rotating Electric Machinery

10.6.1.1 Mounting

The traction motor is rigidly mounted to the gear box. A coupling is provided between the motor shaft and the input pinion of the gear box. A flexible coupling between the output gear of the gear box and the axle is to be capable of accommodating the misalignment. The motor/gear box combination is supported by the axle coupling and a resilient mounting between the truck and the unit.

10.6.1.2 Rating (Ref. Section 2.2)

10.6.1.3 Ventilation

10.6.1.3.1 General

All electrical equipment, including traction motors and other components requiring ventilation or cooling air, shall be force-ventilated. The motor manufacturer will specify cooling air requirements. In the event of loss of forced cooling, system detection shall cut out entire car.

10.6.1.3.2 Air Intake

The cooling air supply shall have an intake from as clean a source as possible. This air shall be so ducted that it passes through a self-cleaning vortex tube-type cleaner as manufactured by General Electric, Donnelson, Aerotex, or approved equal.

The filter shall be on the upstream side of the blower and mounted so that it can be easily removed at regular maintenance inspections for cleaning.

10.6.1.3.3 Air Duct System

The air duct system shall provide a proper path for cooling air flow from the cooling fans to the system components requiring forced cooling such as the chopper and the traction motors. A minimum amount of flexible ducting shall be used consistent with the requirements for providing a cooling air flow path between the car body and the trucks.

10.6.1.3.4 Cooling Loss Protection

To protect the equipment from being operated without proper ventilation of the apparatus, a control cutout shall be provided. This device shall prevent power from being applied to the power circuits upon the loss of ventilating air to the system. The device shall prevent power from being applied to the major systems for all conditions of failure to the apparatus. This includes blower motor wheel failure, tripped circuit breaker in the blower motor circuit, or failure of personnel to start the blower motor when placing the car in operation.

10.6.1.4 Motor Insulation

Motor insulation shall not be deteriorated by common airborne materials including dust, water and salt. Insulation shall be Class H or approved equal and both frame and armature shall have synthetic resin vacuum pressure impregnation treatment or approved equal. Insulation materials shall be flame-resistant, and off-gassing resulting from high temperature shall be non-toxic.

10.6.1.5 Armature Balance

The motor armature shall be dynamically balanced within the limits tabulated below. The armature here includes all sub-assemblies which are rotated with and become part of the assembly when installed on the motor frame.

Armature Speed (RPM)	Maximum Unbalance (in.oz. per lb. of rotating mass)
3001-4000	0.002
4001-5000	0.0015
5001-6000	0.001

10.6.1.6 Armature Shaft Design

Armature shafts shall be designed so that damage to the drive portion of the shaft assembly shall not require replacement of the armature, windings and/or commutator.

10.6.1.7 Maximum Safe Speed

The motor shall have a maximum safe speed 10% higher than required to meet all requirements of the traction specified, with any permissible condition of wheel wear, without exceeding a commutator peripheral speed of 12,000 fpm.

10.6.1.8 Connections

Terminals and/or terminal block shall be clearly marked for positive identification.

10.6.1.9 Bearings and Seals

a. Bearings - Traction motors shall be equipped with anti-friction bearings of sealed lubrication type. Grease cavities shall contain sufficient lubrication to allow operation for 250,000 miles without lubrication. Bearing housings shall be provided with tapped holes closed with wired pipe plugs to permit the addition of a measured amount of lubricant at 250,000-mile intervals. The bearings shall be designed for a B-10 life of 500,000 miles.

b. Seals

   Motor dynamic seals shall be radial lip seals, face seals or labyrinth seals.

10.6.1.10 Overspeed Protection

Overspeed protection shall be based on sensing of the field current. This protection shall be activated whenever the field current drops to zero with the chopper in an ON condition. The supplier shall furnish the operating characteristics of the overspeed protection to the Seller.

10.6.2 DC SERIES AND SHUNT MOTORS

10.6.2.1 General

The motor shall be fully compensated (commutating poles and compensating windings).

Commutator bars shall be of zirconium copper or equal, of

uniform thickness and designed to permit radial wear of at least .375 inch. The commutator shall operate safety at maximum motor speed at any degree of commutator wear.

10.6.2.2 Brushes and Brush Holders

Brush holders shall be adjustable to accommodate .375-inch radial wear of the commutator. Design of the brush holder installation shall provide for easy access to the brushes. The brushes shall fit in the holders closely without binding. Brush tension shall be constant. Brush tension setting shall be retainable for the life of the brush.

10.6.2.3 Riser-Lead Connections

Connections between commutator risers and armature coil leads shall be tungsten inert gas (TIG) welded or equivalent in a manner that shall prevent separation under all conditions, including extreme over-temperatures.

10.6.3 AC INDUCTION AND SELF-SYNCHRONOUS MOTORS (Not applicable)

10.7 ELECTRICAL BRAKING

10.7.1 GENERAL

A dynamic braking system shall be provided. The dynamic braking system shall use the traction motors as generators and shall operate in conjunction with the friction braking system.

10.7.2 DYNAMIC BRAKING

The electrical braking load developed by the traction motors shall be dissipated in car-mounted resistor grids located under the car. Heat generated by the resistor grids shall be removed by ambient air in a manner not detrimental to the function and operations of other carborne systems.

10.7.3 REGENERATIVE BRAKING (Not applicable)

10.7.4 BRAKE BLENDING

The braking shall meet the performance requirements of Sections 2.2.4 and 2.2.6 with respect to deceleration and jerk rate after the dynamic braking fades out. The friction braking shall be blended with dynamic braking for speeds below 40 mph. Under normal conditions, friction braking shall not be required above 6 mph. Emergency braking is considered an abnormal condition and shall not be restricted by deceleration and jerk rate limits. (See also paragraph 2.2.4.1.5)

10.8 GEAR UNITS

10.8.1 GENERAL

The gearing shall be of a quiet type with the gear unit mounted on the axle. The gear unit shall be of the double-reduction type to insure satisfactory life of all components. Single reduction gear unit may be used if approved by the Buyer. All gear units shall operate satisfactorily with the proposed traction motors while conforming with the performance levels required.

10.8.1.1 Environmental Conditions

The gear box shall function satisfactorily under each of the following conditions in operation:

a. High temperature operation: Ambient temperatures to 125°F with relative humidity of not more than 5%.

b. Low temperature operation: Ambient temperatures to -15°F.

c. Humidity: Maximum ambient temperature of 100°F with relative humidity of 100%.

d. Salt spray: Exposure to and operation in an atmosphere containing 20% salt-laden mixtures.

e. Vibration: Vibration incident to operation of the vehicle.

f. Fungus: Exposure to moist fungus at an ambient temperature of 86°F with relative humidity of 95%.

g. Sand and dust: Exposure to a sand and dust density of 0.1 to 0.5 gram per cubic foot to a maximum ambient temperature of 125°F and with relative humidity of not more than 30%.

10.8.1.2 Corrosion Prevention and Control

The Seller shall emphasize corrosion prevention and control as an overall concept during design and production. Equipment shall be designed to prevent corrosion that would adversely affect its function during the specified service life consistent with required reliability and specified maintenance concepts.

10.8.1.3 Moisture and Fungus Resistance

No fungus nutrient materials shall be employed. Materials shall not be degraded by the presence of moisture, provided the material does not affect the performance of the system by the absorption, retention or release of moisture.

10.8.1.4 Noise (See Section 2.8.3.3)

10.8.1.5 Workmanship

General workmanship requirements shall be in accordance with standard industrial high-grade practices and of quality to assure safety, proper operation, high reliability, and service-life requirements. Particular attention shall be given to neatness, thoroughness of welding, forming, machining, and assembly of parts. Units shall be thoroughly cleaned of loose, spattered or excess metal chips, and other foreign material after assembly. Burrs and sharp edges shall be removed.

10.8.1.6 Standard Commercial Parts

Standard commercial parts shall be used to the maximum extent possible and shall be identified on the drawings by their manufacturer and part numbers.

10.8.1.7 Interchangeability and Replaceability

Mechanical interchangeability shall exist between like assemblies, subassemblies, and replaceable parts, regardless of manufacturer or supplier. Interchangeability, as used here, does not mean identity, but requires that a substitution of like assemblies, subassemblies, and replaceable parts may be easily affected without physical modifications to any part of the equipment. All parts having the same number shall be physically and functionally interchangeable.

10.8.1.8 Accessibility and Maintainability

Components of the transmission system requiring routine service checking, adjustment or replacement, shall be made readily accessible without requiring removal of integral parts.

Parts subject to wear, which require replacement or adjustment prior to expected life of the components of the system, shall be individually replaceable. Adequate bolted and gasketed inspection openings shall be provided where necessary for efficient inspection and routine maintenance.

10.8.1.9 Special Tools

The design shall be such as to accommodate to the greatest practicable extent, disassembly, reassembly and service maintenance with those tools and items of maintenance equipment which are normally available.

10.8.1.10 Useful Service Life

The drive unit gear box shall have a useful service life of twenty calendar years under normal operating conditions. The definition of service life does not preclude the overhaul of the unit during its useful life.

10.8.2 GEAR CASE

The gear case shall be of cast or fabricated steel. Suitable orifices and plugs shall be provided in the case for lubrication and breathing.

10.8.2.1 Gear Box Oil Drain

The gear box shall be provided with at least one oil drain opening located at the lowest point in the case or sump. The size of the gear box drain opening shall be commensurate with the size and function of the gear box. A drain plug, or plugs, shall be installed in the opening(s) and properly secured. One magnetic plug, capable of removal for inspection without necessitating oil drainage, shall be provided. The filler plug may be non-magnetic, provided a large magnet is supplied in the gear unit, located for maximum contact with the lubricating oil and readily removable for cleaning. All fills, drains and inspection plugs shall be wired.

10.8.2.2 Oil Level Indicators

Suitable means other than a dip stick shall be provided for visually determining the oil level of each gear box lubrication system.

10.8.2.3 Filling Provisions

The manufacturer shall specify the arrangement and location of the gear box lubrication system filling provision. The quantity and grade of lubricant shall be indicated on the filler cap whenever possible, or adjacent to the filler cap on the gear box housing. The lubrication system shall be readily accessible and designed to prevent overfilling.

10.8.2.4 Gear Box Breathers

The pressure within the gear box shall not exceed 1/2-pound per square inch above static atmosphere pressure, under any condition of operation. Breathers shall incorporate a suitable filter and shall be as small as practicable, but not less than 3/4-inch diameter, and so located and arranged that oil will not be lost from the gear box in any attitude in which the vehicle may be operated.

10.8.3 GEARS

Gears of adequate design for the duty required shall be provided throughout the gear unit. Gears shall be designed and applied to require inspection and adjustment no more frequently than once every 500,000 miles. One or two "break-in" inspections during the first 500,000 miles of operation will be acceptable. Gears shall be designed for a minimum life of 1,000,000 miles with no maintenance.

All main drive gears shall be fabricated from a high-quality gear steel as recommended by the American Gear Manufacturers Association (AGMA) Standard 241.02 and heat-treated/hardened in accordance with the following applicable AGMA Standards: 246.01, 247.01, 248.02 and 249.01. All gearing shall be designed in accordance with good design practice as defined by the AGMA in all of the applicable sections of the following AGMA Standards:

210.02	215.01	221.02	255.02	425.01
211.02	216.01	223.01	420.03	
212.02	220.02	225.01	421.06	

10.8.4 BEARINGS AND SEALS

The gear box shall be equipped with adequate bearings throughout. Bearing design and selection shall require inspection or adjustment no more frequently than once every 500,000 miles. Bearings shall be designed for a B-10 life of 500,000 miles under normal operating conditions. All bearings shall be manufactured from vacuum de-gassed or vacuum melted, bearing quality, through-hardened or carburizing grades of steel. All ball and roller bearings shall be of ARBEC/ABEC-3 quality, equivalent or better, and all tapered rolled bearings shall be Timken Class 2, equivalent or better.

All seals on rotating parts shall be radial lip seals, face seals or labyrinth-type seals. Inspection covers and gaskets shall be designed to prevent lubricant leakage.

10.8.5 LUBRICATION

The gear box shall be oil lubricated and provided with sufficient baffles, dams, passages, etc., to insure an adequate flow of lubricant to all bearings and gears under all conditions of rotation, speed, load, temperature and weather, including continuous operation in either direction at maximum speed. The unit shall be designed to prevent infiltration of moisture into the lubricant from all sources. The gear box shall have a large oil capacity for adequate cooling. All gear lubrication shall be in accordance with the applicable sections of AGMA Standards 250.02 and 251.01.

10.8.6 AXLE/GEAR BOX COUPLING

The gear box shall be coupled to the axle assembly through an elastomeric type coupling capable of affording sufficient torsional damping to isolate any unwanted wheel/axle vibrations and/or noise from the gear box.

10.8.7 GROUND BRUSH AND COVER

A ground brush, brush holder and cover shall be provided to protect the journal bearings from damage caused by passage of electrical currents through the bearings to ground potential. The complete unit shall consist of:

a. A bronze ground ring pressed on the axle

b. A support ring bolted to the inside of the journal bearing housing and positioned around the grounding ring

c. A brush holder box, mounted on the support ring, containing a spring loaded brush that shall ride on the bronze grounding ring. The brush holder shall be wired to the truck frame with a flexible electrical connection incorporating bolted terminals. The brush shall be replaced when worn to a minimum length of 1-1/4 inches.

10.8.8 OTHER

10.8.8.1 Speed Sensing

Each traction motor or gear unit shall have provision for mounting a speed sensor of an approved type. The speed sensor shall be located to provide for maximum protection from flying objects. The speed sensor is to be in such a location that its removal does not require removal of the truck.

10.8.8.2 Tolerances

For all interference fitted parts such as sleeves, bushings, pins, etc., tolerances of fit shall be such that the sustained stresses in castings shall not exceed 50% of the yield point. The sustained stresses in wrought products shall not exceed the following percentages of the yield point:

50% in the direction of grain flow
35% in the longer transverse direction
25% in the shorter transverse direction

10.8.8.3 Securing of Fasteners

All threaded fasteners and other connections shall be adequately secured to prevent loosening under all operating conditions.

10.9 TEST POINTS

Readily accessible test points shall be provided in a test panel for use in manual check of propulsion and control systems.

10.10 TECHNICAL DATA

In addition to the submittal of performance data required by Section 2.2.9, Seller shall furnish, or cause to be furnished by the appropriate supplier, description of the functioning of the propulsion, braking and control systems proposed. This shall include schematic diagrams, drawings and material lists to assist in defining the system operation.

10.11 DESIGN RESPONSIBILITY

The entire propulsion system supplied on these cars, including traction motors, gear units, couplings, propulsion and dynamic braking controls (except cab signal and train speed control apparatus, and air brake piloting system, if used) shall be the responsibility of one supplier and shall be manufactured by said supplier or under his control. The same supplier shall also be responsible for the auxiliary power system and apparatus.

The Seller shall require that the manufacturers supplying parts or apparatus covered by this section shall cooperate fully with each other and with the Seller and Buyer, to the end that all apparatus shall be properly installed to insure successful functioning and proper performance of the completed car in accordance with the requirements of this specification.

SECTION 11

TRUCKS AND SUSPENSION SYSTEM

11.1 GENERAL

A truck and car suspension system shall consist of an assembly of parts comprising the structures which support the car body at each end and shall provide for the attachment of wheels and axles. Provision shall be made for the installation of gear boxes, traction motors, brake system components and power collectors.

Each car shall be supported on two swiveling trucks having provision for the installation of two traction motors per truck. The distance between truck centers when installed on the car, shall be 54 feet. The trucks shall have a 7-foot 6-inch wheelbase and 30-inch diameter steel wheels.

Completely equipped trucks shall be capable of withstanding all stresses which may develop in service at speeds to and including 80 mph under the operational environment of this specification. The trucks shall also react all truck-mounted equipment loads; e.g., brakes, power drive, suspension, etc.

The completely assembled trucks with motors, brakes and other equipment must not exceed the clearance limits required between truck and car body, or between truck and roadway, for safe operation with maximum wear of all parts and load, over limiting lateral and vertical curves as well as tangent track. The minimum clearance above the top of the running rail shall be 2-1/2 inches when the truck is under design load, with all parts at condemning limits and springs solid. Truck testing shall be as outlined in GSI's Test Report T34701-1.

11.2 CONSTRUCTION

11.2.1 STRENGTH AND EQUALIZATION REQUIREMENTS

Truck frames shall conform to the strength requirements for 41,500 pounds per truck on bolster airsprings. The frame and bolster shall be protected against separation by a 2-inch (minimum) diameter steel locking center pin.

The trucks shall be attached to the car body by truck body connections developing 250,000-pound ultimate shear value per truck in the longitudinal and vertical directions.

Primary springing between wheel sets and truck frame shall be by use of two elastomer/laminated chevron springs at each axle journal box.

The truck assembly shall allow movement of each journal bearing location in the vertical direction to allow load equalization over the four wheels of one truck.

11.2.2 MATERIAL

Truck frame and bolster shall be of cast steel. Truck frames shall be stress relieved after any major welding is complete. Critical areas or repaired welds and castings shall be magnetic particle inspected per ASME 71-64. Cast truck frames shall be normalized. Each truck frame shall have accurately located tram marks so that truck can be easily checked for tram during life of the assembly.

11.2.3 PILOTS (Not applicable)

11.2.4 JOURNAL BEARING LOCATION

The truck design shall accommodate inboard mounted journal bearings.

11.2.5 CENTER PIVOT LINER

Center pivot liner shall be provided. Effective sound isolation shall be provided.

11.2.6 STOPS

Lateral stops shall be designed with a progressive rate so as to produce a low force at initial contact which shall build up as the stop is compressed. Stops shall develop sufficient force to limit motion. Steel stops shall be provided to protect the rubber bumpers under abnormal lateral impacts.

11.2.7 BOLSTER ANCHOR RODS

Two bolster anchor rods shall be provided per truck, one on

each side of the truck. The rods shall extend horizontally from the side sills to the ends of the truck bolster. The rods and attachments shall be capable of withstanding static and fatigue loads expected in service but static loading shall be no less than 5g of the truck weight on the two brackets. Adequate clearance shall be provided between the anchor rods and all parts of the truck.

11.2.8 HUNTING

Truck design shall provide sufficient restraint to prevent "hunting" or "nosing" of the truck at all speeds while at the same time allowing the cars to negotiate curves as sharp as 23°.

11.2.9 TRUCK-CAR SEPARATION

Safety straps shall be provided to protect against accidental separation of truck and car body.

11.2.10 EQUIPMENT MOUNTING

The truck shall be designed to accommodate a double reduction, parallel motor-drive arrangement, with a gear unit mounted on each axle and close-coupled to a motor suspended from the truck frame through resilient mounting pads, as shown on Garrett Drawing No. 2000754. The truck shall be arranged for application of package-type brakes with composition shoes.

11.2.10.1 Track Trip System

Track trip shall be included for emergency interruption of vehicle power and emergency brake activation.

11.2.10.2 Derailment Detection System (Not specified)

11.2.11 FRAME INSPECTION (Not specified)

11.3 SUSPENSION SYSTEM

11.3.1 REQUIREMENTS

A double convolution airspring shall be provided at each end of the bolster to support the car body. Each pair of airsprings shall be cross-connected so that rupture of the one spring shall deflate the other, thereby preventing lean. Safety of operation shall not be affected by failure of airsprings. However, some degradation of ride quality will be tolerated. Airsprings shall be so mounted and truck designed so that no chafing results due to normal operation. Airsprings shall be capable of easy maintenance and replacement.

11.3.2 STRENGTH

The load requirements for the suspension system shall be suitable for 41,500 pounds per truck on bolster springs.

11.3.3 COMBINATION SUSPENSION SYSTEM (Not applicable)

11.3.4 LEVELING VALVES

A damped leveling valve shall provide reasonably constant height of floor regardless of load in the car. The leveling device shall not automatically compensate for reduction in floor height due to wheel wear or for roll. Means to prevent excessive lean shall be provided. Rapid truck movement shall not materially affect the height of the car body.

A choke and cutout cock shall be provided in the leveling valve air line to each truck to prevent rapid air loss from the car in case of air spring rupture. Cutout cocks shall be wired in the open position. Means shall be provided so leveling valve can be supplied with air from the main reservoir system of the car.

11.3.5 FAILURE RESPONSE (Not specified)

11.3.6 FLOOR TO RAIL CLEARANCE (As specified in Section 2.1.1.1)

11.3.7 ADJUSTMENT PROVISIONS

Provision for approximately 5-inch vertical adjustment to suit various platform heights of the demonstration properties shall be provided.

11.3.8 NATURAL FREQUENCY (Not specified)

11.3.9 MOTION DAMPING

Vertical vibration damping shall be accomplished with orifices inside the air springs supplemented by external shock absorbers, if required. Lateral motion shall be damped through hydraulic shock absorbers. Both the lateral and vertical shock absorbers shall be of the externally adjustable type. Provision shall be made to change orifice size inside the air springs to further change the vertical damping if necessary. This is accomplished by changing removable orifices which shall be provided by the contractor as required during acceptance testing. Resilient stops shall be mounted on the car body which contact the truck bolster to limit excessive lateral movements of the car body. Provision shall be made for shimming the lateral bumper stops for adjustment of lateral clearances.

11.3.10 MATERIAL AND FABRICATION

Material and fabrication requirements for the suspension system components shall be as shown in Section 2.4 and Drawing No. 2D08200.

11.4 WHEELS AND AXLES

11.4.1 WHEELS

11.4.1.1 Material and Construction

Wheel material shall conform to ASTM Specification A504, Class BR. Wheels shall be manufactured to AAR standards. In addition to AAR requirements, wheels shall be machined and shot-peened in accordance with the following procedure:

a. Shot-peen entire plate.

b. The shot shall be hardened steel with a diameter equivalent to SAE 550-660.

c. Peening intensity shall be sufficient to produce an average arc height of not less than 0.008 Almen C2 on the front end fillet and the back hub fillet.

d. Arc height measurements shall be made in accordance with SAE Standard J-442 and SAE recommended practice J-443, either procedure.

e. The minimum peening time shall be sufficient to insure two times full coverage is attained as defined in SAE recommended practice J-443, alternate procedure.

f. Arc height determination shall be made on Almen strips attached to wheels at the beginning and end of production runs.

After shot-peening, unmachined areas shall be free of mill scale.

11.4.1.2 Strength

The strength requirements for the wheels shall be in accordance with AAR standards and recommended practices.

11.4.1.3 Tread and Flange Contour

Wheels shall have a narrow flange contour and a 1:20 tapered tread.

11.4.1.4 Dimensions

Wheel diameter shall be 30 inches.

11.4.1.5 Wheel Wear

Wheels shall be multiple wear with a condemning limit of 28 inches in diameter.

11.4.1.6 Wheel Matching

Maximum allowable difference in the outside diameter of any two wheels pressed on the same axle shall not exceed one tape.

11.4.1.7 Wheel Mounting

It is of the greatest importance that all machining, fitting and assembling of wheels and axles be the highest grade. Inner projecting hubs of the wheels shall be faced to a smooth finish and the wheel finish-bored at the same setting. The bore of the wheel shall be truly perpendicular to the inner face of the wheel rim and rounded to a 1/16-inch radius at the inside of the hub. Wheels shall be pressed on axles by suitable and approved apparatus at a pressure of from 55 to 80 tons.

11.4.1.8 Tolerance

Dimensions for finishing wheel bores are based on press-fit allowances of 0.001 inch per inch of diameter per foot of wheel seat. If the diameter of the wheel bore varies more than $\pm$0.0015-inch from dimensions shown on drawings, the wheel or the axle, or both, will be rejected.

Two wheels mated to the same outside diameter shall be pressed on an axle and upon the completion of this operation, the axle shall be revolved on its center in the presence of the inspector so he shall determine that the wheels are concentric with the axle, are of same diameter and that the inner faces of rims are true and parallel.

The eccentricity of any wheel shall not exceed 1/64-inch when measured at the center line of tread.

Inner faces of rims shall not be out of true more than 1/32-inch either individually or when measured between the two wheels on an axle.

The contractor shall furnish accurate gauges and templates for inspecting the assembly of wheels and axles.

11.4.1.9 Wheel Marking

Wheel marking shall be in accordance with current AAR Wheel and Axle Manual.

11.4.1.10 Wheel Balance (Not specified)

11.4.1.11 Pressure Diagrams

Pressures at which the gears and the wheels are pressed on the axles shall be measured and recorded by means of an approved recording gauge which shall be frequently checked with a standard gauge. The contractor shall furnish a pressure record diagram with each motor gear and with each pair of wheels. These diagrams must show a smooth curve of application.

11.4.2 AXLES

11.4.2.1 Strength

Strength requirements shall be in accordance with AAR standards.

11.4.2.2 Material

Axles shall be as shown on Drawing No. 2D08400 and in accordance with ASTM Specification A236, Class G.

11.4.2.3 Inspection

All axles when finished, shall be free from cracks, flaws, seams or other injurious imperfections. Interpretation of injurious imperfections shall be made in accordance with the appendix to ASTM Specification A21.

11.4.2.4 Marking

Axle marking shall be as shown on Drawing No. 2D08400.

11.5 JOURNAL BEARINGS

11.5.1 STRENGTH

The bearings shall be designed for a B-10 life of 1,000,000 miles at car weight AW1 of 105,000 pounds. The average operating speed of 25 mph shall be used.

11.5.2 LUBRICATION

Each assembly shall have a maximum capacity of two pounds of approved grease or as specified and applied by the bearing manufacturer.

11.5.3 MOUNTING

Journal bearing mounting shall be as specified in Drawing No. 2D08300. Bearings shall be pressed at a pressure of 40 tons.

SECTION 12

BRAKING SYSTEM

12.1 GENERAL

The brake system shall be a combined dynamic and automatic electronic-pneumatic friction brake system controlled by a "P-wire."

Braking shall be provided on each car with the capability of service and emergency braking in accordance with the requirements of Section 2.2.4. The braking system shall consist of two primary sections:

a. A fully variable pneumatic tread friction plus dynamic service brake providing normal deceleration.

b. An emergency friction brake providing shorter stops than service braking.

Provisions shall be made for cutout of friction brakes on individual cars to permit emergency movement of a train should a failure of the brake system occur.

12.1.1 OPERATING AND SERVICE CONDITIONS

Climate Conditions As Specified In Section 2.6.1

Operating Voltage Range 28 to 44 Volts, DC

Maximum Pressure, 160 PSIG

12.1.2 DYNAMIC BLENDED BRAKING

With dynamic brake effective in service braking, as specified, the combined braking rates of dynamic and friction shall be no less than the specified friction service brake levels listed in Section 2.2.1.7 and 2.2.4.

12.1.3 BRAKE OPERATION

The brake system shall be infinitely variable between coast (no brake) and the full service braking rate.

The brake system shall include a master controller located on the motorman's console in the cab of each car which will vary a trainline current analog loop circuit (P-wire) between 0.5 amps and 0 amps. Coast position of the controller shall produce 0.5 amps and full service position shall produce .1 amp or less with a full range of analog control between these two positions. A distinct handle position beyond full service shall produce an emergency brake application by rapid venting of the brake pipe. A deadman feature shall be included in the handle which shall produce a full service application when it is released.

The friction brake system shall provide continuous blending with dynamic braking. The level of dynamic brake feedback from the propulsion system shall be compared with the current analog brake request by the friction brake system. Friction brake shall be applied to make up any differences between called-for rate and actual braking effort of the dynamic brake.

The dynamic brake feedback signal shall be directly proportional to braking torque and shall be completely isolated. Ten volts DC shall represent full dynamic brake torque and 0 shall represent no effort. Ripple shall not exceed 10% and signal shall give a true torque reading with the friction brake providing 50K to 300K ohms resistance. The friction brake shall provide continuous variable load control of braking pressures in service and emergency applications. The sensor for the variable load feature shall convert car body weight to an air pressure proportional to car loading.

Braking rate shall vary infinitely between a 0.1 mphps rate at 0.45 amps and the specified full service rate at 0.1 amps.

During any brake application, if dynamic brake is effective, a minimum inshot pressure shall be provided to the brake units to insure that the shoes rest against the wheels for cleaning purposes and to insure minimum response times in changes of friction brake level.

The service brake magnet valves shall be arranged for energize-to-release so that no energy results in a full service application. The response time of the brake magnets shall not exceed 60 milliseconds.

The friction brake system shall include two trainline pipes: brake pipe and main reservoir pipe.

One compressor with a minimum displacement of 30 cfm shall be provided on each car.

Each car shall be provided with a 4.8 cubic-foot (minimum) main reservoir and two 2.0 cubic-foot supply reservoirs.

A pneumatic brake pipe emergency brake shall be available at any time when the system is charged, through the "emergency" position of the master controller handle, conductor's valve, trip cock, parting of the brake pipe or brake pipe hose, or the emergency brake button on the motorman's console.

The air brake system shall provide rapid service and emergency response at all times and shall permit prompt recharge of the brake pipe after an emergency application and after the vent valves have closed. It shall not permit brakes to creep on due to fluctuations of air pressure in the brake pipe.

The equipment shall be so timed to insure that the train has come to a stop before the emergency brake can be released.

The master controller shall be arranged to insure initiation of an emergency application when a motorman's console is de-energized such as for storage or changing ends. The console shall be de-energized by the use of a key. The key shall not be capable of being removed unless the master controller handle is in the emergency position and the handle shall not be capable of being moved with the key removed.

An emergency application shall insure positive interruption of propulsion and dynamic braking. It shall be possible to obtain a full emergency brake application at any time on a charged car. The friction brake system shall provide a 125-volt ampere contact to operate an emergency relay to pilot these functions.

12.2 STRENGTH REQUIREMENTS

The brake system shall be designed to withstand the loads induced in the system when complying to the performance requirements of paragraph 2.2.4.

12.3 BRAKE CONTROL SYSTEM

The brake control system shall be fail-safe and shall have sufficient capacity to make an emergency stop at any point on the transit systems noted in Section 1 during a normal run with a dynamic brake failure within the requirements of Section 2.2.4.2. The friction brake system shall provide smooth blending with dynamic braking. Refer to Sections 10.7 and 12.1.3.

12.3.1 HYDRAULIC BRAKE SYSTEM

(NOT APPLICABLE)

12.3.2 PNEUMATIC BRAKE SYSTEM

The pneumatic system installed on each car shall have sufficient capacity to supply the full braking requirements of both cars. Brake pneumatic system isolation shall be provided by a non-return check valve installed between the main reservoir and the supply reservoir. Only braking air shall be taken from the supply reservoir. Maximum pressure in the air brake system shall be 160 psi in the main reservoir and 110 psi in the brake pipes and cylinders.

12.3.2.1 Air Compressor

a. The compressor shall be a two cylinder compound design driven by an integrally mounted electric motor of approved design and furnished with a suspension frame. The compressor shall produce the required compressed air for the operation of the brakes, motor control switches, trip devices, coupler apparatus, horns and air springs. All parts of the compressor shall be designed to produce a reasonably noiseless and vibration-free performance at the nominal voltage.

b. The capacity of the compressor as measured by the displacement when driven by a motor operating at 600 volts D.C. against a pressure of 150 pounds per sq. in. shall be not less than 30 cubic feet of free air per minute. It shall be designed to operate continuously at maximum capacity. The compressor shall operate on an approved lubricating oil as specified by the compressor manufacturer.

c. The motor-compressor shall be a part of the complete compressor unit, which shall contain the No. 1 or sump main reservoir, a cooling system, pneumatic contactor, main reservoir safety valve, and automatic drain valve. The compressor unit shall be arranged for suitable mounting under the carbody, and shall be so mounted as to permit inter-changeability with like units. The air discharge temperature of the compressor unit shall be within 2° F. of inlet ambient temperature with the compressor running continuously under full load for 60 minutes.

12.3.2.2 Compressor Motor

Each air compressor shall be driven by a totally enclosed direct current interpole motor.

With current supplied at 600 volts, the motor shall have ample capacity to drive the compressor when displacing 30 cubic feet of free air per minute against a pressure of 150 pounds per square inch. It shall also operate successfully and maintain a positive pressure at the compressor of from 130 to 150 pounds per square inch at any voltage between 400 and 700 volts.

The motor shall commutate successfully, as defined in the latest Standards of the I.E.E.E., when operating under any of the above conditions of load. It shall not flash, puncture the insulation or be subject to any injury that would render it unsuitable for continuous service, when crossing gaps in the contact rail, or at any time when a sudden change in operating conditions may cause the voltage to fall to zero and rise momentarily to a value approximately double the normal voltage. The circuit breaker used for the protection of the apparatus shall not be unduly loaded during these short periods.

The compressor motor shall be provided with a ground connection from the motor frame to the compressor cradle.

12.3.2.3 Compressor Contactor

The compressor contactor, which is a part of the Compressor Unit, shall cause the compressor to cut in at 130 pounds per square inch main reservoir pressure. Positive action of the contactor shall not be influenced by a slow rate of depletion of the main reservoir pressure. It shall be readily adjustable, positive in action and able to function repeatedly under conditions met within service.

12.3.2.4 Compressor Intake Filter

The compressor intake filter shall be an approved disposable element of adequate size to permit the passage of the air required for the maximum capacity of the compressor.

12.3.2.5 Reservoirs

Reservoirs shall be low alloy steel with approved flanged fittings and enameled inside and outside to resist corrosion. There shall be one 16 x 60 inch main reservoir, one 16 x 42 inch supply reservoir on each car. Each compressor unit shall contain a main sump reservoir.

12.3.2.6 Operating Units

a. The pneumatic operating unit shall be a pre-assembled laminated pipe bracket arranged for mounting securely to the car underframe. It shall include application and release magnets, selector cock, variable load valve, feedback transducer, emergency valve, emergency pressure switch, load transducer, J-relay valve plus such parts or accessories necessary for a complete operating unit.

   The unit shall be arranged to permit removal of the individual operating devices and shall be so located under the car to minimize piping to adjoining equipment. Flanged fittings shall be included for pipe connections.

b. The electronic operating unit shall be a solid state unit mounted in the operating cab of each car. Plug-in units shall be provided for ease of maintenance.

   The unit shall be arranged for a plug-in of a portable brake analyzer which can completely check out the operation of the friction brake system independent of the car master controller.

12.3.2.7 Cutout Cock

A vented cutout cock with extension handle shall be provided in the brake cylinder line for cutting out all the brake cylinders of a complete car and venting same to atmosphere. It shall be arranged to permit operation from inside and outside the car.

Other cutout cocks shall be provided where required. All handles shall be arranged so that in the open position, they shall be crosswise of the flow of the air and in the closed position, parallel with the flow of the air.

12.3.2.8 Trip Cock

One self-resetting trip cock with adjustable connections shall be furnished, to be mounted on the No. 1 truck of each car and connected by means of rubber hose to the brake pipe. The trip cock shall be designed so that the opening of the cock will cause an emergency application of the air brakes.

The cock shall remain open until brake pipe pressure is reduced to a low value.

It shall not be necessary to manually reset the trip cock. The trip lever shall be of a proper length and shape so that it will positively engage the track trip.

A magnet valve cut-off shall be provided to nullify the trip cock in cab signal.

12.3.2.9 Air Gages

An illuminated air gage shall be furnished in each car and flush mounted on the motorman's console. It shall be of a standard manufacture, shall match the equipment on the console and shall have a silvered dial graduated from 0 to 160 pounds. The gage shall have two indicating hands, one "red" for main reservoir pipe pressure and one "black" for brake pipe pressure.

12.3.2.10 Automatic Drain Valve

An approved automatic drain valve shall be applied directly to the No. 1 or sump reservoir. The automatic drain valve shall be provided with approved diaphragm and seals.

12.3.3 ELECTRICAL BRAKE SYSTEM

(NOT APPLICABLE)

12.3.4 VARIABLE LOAD CONTROL

The friction brake shall provide continuous variable load control of braking pressures in service and emergency applications. The sensor for the variable load feature shall convert carbody height to an air pressure proportional to car loading.

12.3.5 INDICATING LIGHTS

A "brake-on" indication lamp shall be provided on the motorman's console to indicate that a brake in the train is applied. Any friction brake application in a train shall energize a 32 volt trainline wire and illuminate the "brake-on" lights.

12.4 HANDBRAKE

The handbrake shall be located inside the cab of each car. The handbrake shall be hydraulically controlled and shall hold an empty car on a 5% grade. To indicate that a handbrake is in an applied or release position, a 32-volt indication light shall be provided in the motorman's console in each operating cab. The trainline wire shall be energized through a switch in the handbrake. The contacts of the switch shall be open when the handbrake is in the release position and closed in the fully applied position.

12.5 ELECTRO-MAGNETIC TRACK BRAKE

(NOT APPLICABLE)

12.6 SNOW BRAKE

Provision shall be made for a "snow brake", designed so that when activated by a "snow brake switch" located on the motorman's console of each car, the brake shoes shall be held against the wheels with a predetermined and constant force in all positions of the master controller handle other than the braking and non-operating positions. The snow brake shall be made operative on all cars of the train by the operation of the momentary snow brake switch in an activated console. In its ON position the switch shall energize all master snow brake relays through a 32 volt trainline wire and each relay shall be held in by a local feed. In the OFF position, this switch shall de-energize the master snow brake relay in each car. Deactivating the console shall also deactivate the snow brake.

COMMUNICATIONS

13.1 GENERAL

This section includes the requirements for public address, intercommunications and train-wayside radio systems. All communications systems shall be intelligible and acceptable under all operating conditions.

13.2 PUBLIC ADDRESS SYSTEM

13.2.1 GENERAL

Each car shall be equipped with a complete public address system designed for subway car service. The system shall be designed to provide means for authorized train operating personnel to make announcements, audible throughout the train, from any microphone station or telephone hand set by the operation of the mode selector switch. (See Section 13.3.2.3.) The operator of any microphone station or telephone hand set in either car, shall control all of the amplifiers in both cars. All microphones or telephone hand sets not in use shall be deenergized. The system shall provide maximum intelligibility under the conditions of high noise and vibration normally encountered with a train in motion.

13.2.2 Requirements

13.2.2.1 General

a. The equipment shall be operable without damage under any combination of service conditions specified in Section 2.6 of this specification.

b. Materials and workmanship shall be in accordance with the best manufacturing practice for high quality electronic equipment. All components such as resistors, capacitors, transistors and transformers shall be a commercially available type.

c. The equipment shall be properly protected from damage and capable of withstanding the rigors of subway operation.

13.2.2.2 Amplifiers

a. The amplifier shall consist of a completely transistorized unit housed in a box located in the operating cab of the car. The amplifier shall be front mounted without the necessity of removing the rear of the enclosure. All electric connections shall be made through a fixed plug in the amplifier and a self-aligning receptacle in the back of the enclosure.

b. The power output shall be 10 watts at a maximum 2.5% distortion, and shall be 20 watts at a maximum of 5% distortion over the frequency band of 150 Hz to 10 kHz when measured in accordance with RETMA Standard SE 101-A.

c. There shall be two inputs to each amplifier. The microphone input shall be a low impedance input of 50 ohms. The line input impedance shall be 600 ohms.

d. The gain shall be at least 80 db for the microphone input and at least 46 db for the Line input when measured at 1 kHz and in accordance with RETMA Standard SE 101-A.

e. The gain controls shall be mounted on the amplifier chasis and the gain adjustment control shall not be accessible from the front of the amplifier.

f. All transformers shall be vacuum impregnated with epoxy, silicone or other acceptable impregnating or potting material.

g. All resistors, capacitors and other components, shall be securely mounted on terminal boards providing a terminal post or terminal posts for connection to each wire or resistor or capacitor.

h. All transistors shall be of the silicon "plug-in" type and mounted for easy removal.

i. All potentiometers shall be of the locking type and shall be sealed against dust and shall be marked on the chassis as to their function.

13.2.2.3 Microphone Stations

a. Two microphone stations shall be provided in the cab of each car adjacent to the left and right side windows, and shall be painted to match the interior color of the cab.

b. The microphones shall be of an approved noise-cancelling type. They shall be of low impedance of broadcast quality with a field response of ±3db from 150 Hz to 10 Hz and a nominal impedance of 38 ohms.

c. A momentary press-to-talk button shall be located on the front plate of the microphone station. This momentary press-to-talk button shall energize a dust protected plug-in relay. The press-to-talk button shall be clear anodized aluminum (24ST) and shall be so designed as to snugly fit the hole in the front plate so as to preclude insertion of foreign objects which might cause the button to bind.

d. A push button circuit breaker shall be mounted on the front plate of the microphone station. In order to preclude willful damage to the circuit breaker, it shall be so mounted that the top of the circuit breaker button shall be flush with the microphone plate when the circuit breaker is in its tripped condition. The push button stem of the circuit breaker shall fit snugly in a steel collar so as to exclude the insertion of any foreign objects. The rated capacity of the circuit breaker shall be 4 amperes at 28 VDC. A rubber boot shall be provided to protect the terminals against accidental shorts.

e. A volume-indicator pilot light shall be provided to give a visual indication to the conductor of amplifier output.

13.2.2.4 Loudspeakers

a. Eight weatherproof loudspeakers shall be furnished and mounted in approved locations in the roof. The speaker housing and installation shall be in accordance with AAR Joint Specification of the Electrical Section (Mechanical Division) and the Communication Section, 12-3, Section D-10, paragraphs 1, 3, 4, and 5 insofar as possible. The loudspeakers shall be dust tight and capable of withstanding the vibration normally encountered in subway service. The coil of the loudspeaker shall be totally sealed.

b. The loudspeaker electric requirements shall be in accordance with AAR Joint Specification 12-8, Section C, a Rating Impedance of 16 ohms and a minimum power handling capacity of 10 watts.

13.3 INTERCOMMUNICATIONS SYSTEM

13.3.1 GENERAL

Each car shall be equipped with a complete transistorized approved intercom system with maximum intelligibility under subway operating conditions. The system shall be designed to permit a conductor, located in another operating cab, to communicate with the motorman only, by means of a telephone hand set through a shielded pair of trainline wires. The system shall be powered from the nominal 32 volt battery supply on the car.

13.3.2 REQUIREMENTS

13.3.2.1 Same as 13.2.2.1

13.3.2.2 Telephone Hand Set

An approved telephone hand set, complete with a press to talk bar switch and coil cord shall be mounted on the motorman's console. The telephone transmitter shall be common to all three modes of communication (radio, intercom and P.A.) and the audio receiver shall be common only to the intercom and radio. The hand set shall be held in place with spring clips and a coil cord of approved length shall connect it to the console. When the mode selector switch is in the radio position, the telephone hand set shall be connected to the transmitter receiver unit specified in Section 13.4.2.2.

13.3.2.3 Mode Selector Switch

A three position mode selector switch shall be provided on the communication panel to permit the selection of either PA, Intercom or Radio. Only the radio position shall be activated by the reverser key switch; the PA and intercom shall be active in each console of the train. The radio position shall control the transmitter-receiver function, which when activated, shall provide the radio transmitter with operating voltage, switch the antenna from the receiver to the transmitter and mute the receiver and loudspeaker specified in Section 13.4.2.4.

13.3.2.4 Buzzer

A buzzer button shall be provided on the communication panel to permit one position to signal another position to pick up the hand telephone set. The buzzer and the "INTERCOM" position on the Mode Selector Switch shall be activated by a circuit breaker on the low voltage CB panel.

13.4 TRAIN TO WAYSIDE RADIO COMMUNICATIONS SYSTEM

13.4.1 GENERAL

Each car shall be equipped with a complete approved train to wayside radio communication system, except that only one (1) portable mobile transmitter-receiver unit shall be provided for the two cars. The equipment shall be FM-2-way radio equipment designed specifically for heavy-duty railroad applications in the 148-174 mc frequency band and shall consist of a portable mobile transmitter-receiver, mounting bracket, antenna, and cabling. A telephone hand set, loudspeaker, radio panel and a mode selector switch all mounted on the motorman's console shall complete the system.

The portable mobile transmitter-receiver shall be equipped with a receptacle containing all necessary connections. The mounting bracket shall be equipped with a plug connector which will mate with the above receptacle. Upon inserting the transmitter-receiver into the mounting bracket, and connecting the telephone hand set to the transmitter-receiver unit, with an approved type plug connector, the transmitter-receiver shall be ready to operate, without the necessity of any external connection being made. The transmitter-receiver equipment shall be designed to operate in conjunction with the train equipment in such manner that neither shall cause any malfunction in the operation of the other.

13.4.2 REQUIREMENTS

13.4.2.1 Same as 13.2.2.1

13.4.2.2 Transmitter-Receiver Unit

13.4.2.2.1 General

a. The transmitter-receiver unit shall be so constructed that it may be easily removed from the train by unlocking the lock on the rack. The case shall be of rugged construction throughout and shall be designed with no ventilation openings so as to protect the internally mounted equipment against the degrading effects of dust, foreign particles and splashing water. The unit shall incorporate a handle for carrying of the unit when removed. The weight of the portable unit shall not exceed twelve (12) pounds.

b. The transmitter-receiver shall be equipped with solid-state components to minimize battery drain and maximize life expectancy of the radio equipment in keeping with good engineering practice. Construction shall be that each stage shall be accessible without the necessity of removing other stages. Sufficient test points shall be provided so that stage-by-stage performance can be evaluated.

c. The transmitter-receiver unit shall be operated on a frequency of 161.565 MHz. All tuneable circuit adjustments shall be readily accessible. With the housing removed, adjustment of the equipment shall be possible, without the necessity of any special patch cords or intercabling between the unit and the housing. The manufacturer shall provide a suitable test set for convenient testing and tuning of the equipment.

13.4.2.2.2 Controls and Indication

a. The transmitter-receiver unit shall be provided with an "ON" indication light, which shall be illuminated when the battery feed to the unit is energized by the motorman activating a console. A "Transmit" indication light shall be illuminated when the unit is operating in a transmit mode.

b. Adjustable volume and squelch controls shall be provided externally on the transmitter-receiver unit for ease of operation.

c. The unit shall include a spring return switch to provide a properly attenuated audio signal into the train line public address system. The audio signal fed into the train line public address system from the receiver shall be a fixed voltage of 0.9 t0 1.0 volts r.m.s. fed into an impedance of 10 ohms. The switch, "ON" indication light and "Transmit" indication light shall operate in parallel with similar units on the motorman's console as specified in Section 13.4.2.3.

13.4.2.2.3 Transmitter Section of T-R Unit

a. The duty cycle for the transmitter shall be 5 minutes on and 15 minutes off for a period of 7 hours.

b. The interstage coupling coils between each multiplier stage shall use reactance tuning and efficient shielding methods to obtain maximum harmonic suppression and minimum over-all spurious radiation.

c. A variable reactance in the oscillator shall be provided for the purpose of adjusting the crystal circuit to the exact operating frequency.

d. The rated RF power output of the transmitter when operated at the minimum battery voltage shall be not less than 8 watts.

e. The transmitter radio frequency output circuits shall be designed to operate with a minimum standing wave ratio into a nominal 50 ohm load. Adjustable coupling and a variable reactance shall be provided.

f. The transmitter microphone power supply shall provide adequate current to allow full modulation of the transmitter using normal voice levels directed into the microphone or the console telephone hand set.

g. The transmitter shall include a time cut-out circuit, which will cause the transmitter to automatically discontinue after being keyed for 30 seconds. Provision shall be made for automatic reset after keying is terminated.

13.4.2.2.4 Receiver Section of T-R Unit

a. A double superheterodyne type of receiver shall be used, with each frequency conversion crystal-controlled. All tuned circuits shall be completely independent of the transmitter section. For reliability, miniaturization and low power consumption, transistors only shall be employed in the receiver. The duty cycle for the receiver shall be continuous.

b. There shall be at least two (2) transistorized limiter stages preceding the discriminator. Essentially, noise excitation alone shall saturate the second limiter at all times.

c. A variable reactance shall be provided in the local oscillator, for the purpose of adjusting the crystal circuit to the exact operating frequency.

d. The antenna input circuit shall utilize multiple tuned circuits of the variable reactance type. The RF input impedance at the antenna terminals shall be designed to operate from a 50 ohm source.

e. A noise compensated squelch circuit shall be employed to reduce noise during standby periods. This circuit shall provide a noise compensated type adjustable sensitivity with continuously variable control. The squelch shall open at levels of 0.35 microvolts or less.

f. All tuneable circuit adjustments required shall be available from one side of the chassis and readily accessible. No complicated tools shall be necessary to service or align the receiver. If alignment tools are required, they shall be supplied. For routine field and laboratory checks, the only test equipment necessary shall be a standard radio and intermediate frequency signal generator without modulation requirements and designed for use in metering sockets.

g. With all tuneable stages detuned, complete realignment of the receiver as described in the instruction manual shall be accomplished within 20 minutes and the receiver shall meet all stated specifications after such realignment.

13.4.2.2.5 Voltage Regulator

A voltage regulator shall be provided for use in conjunction with the 32-volt power supply for the radio equipment. The regulator shall be an integral part of the transmitter-receiver and must have provision for transient voltage spikes up to 1000 volts with a duration up to 0.2 milliseconds.

13.4.2.3 Radio Indication Lights and Controls

The radio section of the communication panel shall be provided with a radio transmit indication light and a "Radio-to-PA" spring return switch. The "Radio-to-PA" switch shall allow properly attenuated radio transmissions to be broadcast over the PA system.

13.4.2.4 Speaker

An approved four-inch oval speaker shall be provided on the vertical section of the console. The speaker shall be activated at all positions of the mode selector switch.

13.4.2.6 Transmitter-Receiver Mounting Bracket

A mounting bracket shall be installed on the bulkhead wall of the equipment cabinet in the operating cab of each car as shown on the drawings.

The mounting bracket shall not protrude more than two (2) inches, except for connector plug, with the transmitter-receiver unit removed in order not to obstruct operating personnel. The bracket shall be equipped with a lock to prevent unauthorized opening of the unit.

13.4.2.7 Train to Wayside Radio Antenna

The antenna shall be of the rigid railroad mobile type. The impedance of the antenna, after being mounted on a car, shall be such to maintain a VSWR of less than 2:1 over a frequency range of 3 mhz centered on an operating frequency of 161.565. The antenna shall be concealed behind the fibre glass "F" end of the cars 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.

SECTION 14

AUTOMATIC TRAIN CONTROL SYSTEM

(NOT APPLICABLE)

SYSTEM SUPPORT

15.1 RELIABILITY

15.1.1 GENERAL

In addition to meeting the performance requirements, the vehicle shall incorporate high standards of reliability to insure that the operating cost and on-time performance goals are achieved. The vehicle and subsystem quantitative reliability requirements are established in this section.

15.1.2 VEHICLE RELIABILITY GOALS (Not specified)

15.1.3 SUBSYSTEM RELIABILITY GOALS

The reliability of the SOAC cars is to be at least as good as that specified for the BART System. The BART specified MTBF's are shown in the following table. Also shown are equivalent Mean Miles per Failure (MMPF) based on an assumed average speed of 25 mph for the SOAC cars.

	MTBF (Hrs.)	MMPF (Miles)
Propulsion	1400	35,000
Friction Brake	4300	107,500
Auxiliary Electrical	1400	35,000
Door	1500	37,500
Air Conditioning	2500	62,500

15.1.4 RELIABILITY PLAN (Not specified)

15.1.5 RELIABILITY ANALYSIS (Not specified)

15.1.6 RELIABILITY DEMONSTRATION TEST (Not specified)

15.2 MAINTAINABILITY

15.2.1 GENERAL

The objective of the maintainability program is to minimize maintenance costs (labor and material), vehicle down time and the need for specially or highly skilled repairmen.

15.2.2 VEHICLE MAINTENANCE GOALS (Not specified)

15.2.3 SUBSYSTEM MAINTENANCE GOALS (Not specified)

15.2.4 MAINTENANCE PLAN (Not specified)

15.2.5 FAULT ISOLATION/TROUBLESHOOTING PLAN (Not specified)

15.2.6 MAINTAINABILITY CHECKLIST (Not specified)

15.2.7 MAINTAINABILITY DEMONSTRATION TEST (Not specified)

15.3 VALUE ENGINEERING (Not specified)

15.4 SYSTEM SAFETY

15.4.1 GENERAL

The Seller shall perform a safety analysis of the causes for loss of control signals. The results of the safety analysis shall be submitted to the Buyer prior to the critical design review.

15.4.2 SYSTEM SAFETY PLAN (Not specified)

15.4.3 SYSTEM SAFETY CRITERIA (Not specified)

15.4.4 SYSTEM SAFETY PRECEDENCE (Not specified)

15.4.5 HAZARD ANALYSES

15.4.5.1 Preliminary Hazard Analysis (Not specified)

15.4.5.2 Subsystem Hazard Analysis (Not specified)

15.4.5.3 System Hazard Analysis

15.4.5.3.1 Loss of Braking Effort

All conditions or events that could result in the loss of braking effort shall be identified. Safeguards or design approaches used to eliminate or reduce the possible loss of braking effort shall be defined. Corrective action taken as a result of identifying possible causes of the loss of braking effort shall be defined.

15.4.5.3.2 Loss of Control Signal

All possible causes of the loss of control signals (cab signal) or loss of the signal from the cab control (motorman's lever) shall be identified. Safeguards or design approaches used to eliminate or reduce the probability of control signal loss shall be defined. Any corrective action taken as a result of this analysis shall be defined.

15.4.6 SAFETY TESTING (Not specified)

15.5 HUMAN FACTORS ENGINEERING
(Not specified)

15.6 SPARE AND REPLACEMENT PARTS

A replacement parts list shall be provided.

15.7 PUBLICATIONS

15.7.1 GENERAL

It is required to have publications complete in content. It is expected that maximum use will be made of commercial supplier existing manuals. Revision to existing publications may be made by the use of addendum, or changes can be made by use of marked pages. A minimum of ten sets of manuals will be delivered.

15.7.2 ORGANIZATION

It is desired to have the manuals in three general categories as follows:

(1) Motorman's Instruction Manual

(2) Running Maintenance and Servicing Manual

(3) Replacement Parts List

15.7.3 CONTENT

The Motorman's Instruction Manual shall contain all information needed for the optimum operation of the vehicle. It shall include general vehicle familiarization material; location, function, and operation of all controls, gauges, indicators and switches; and emergency procedures.

The Running Maintenance and Servicing Manual shall enable the maintainer to effectively service, inspect, maintain, adjust, troubleshoot and replace components.

The Replacement Parts List shall enumerate and describe components with their related parts, including the supplier's number, the Seller's number and the commercial equivalents where applicable.

15.7.4 SUBMITTAL

Draft copies or galley proofs of the publications shall be submitted to the Buyer for approval no later than 90 days before the deadline date for final printing. Ten copies of each document shall be delivered concurrent with delivery of the transit cars.

15.8 TRAINING
(Not specified)

15.9 UNIQUE AND SPECIAL SUPPORT EQUIPMENT

Support equipment is defined as the tools, test equipment, jacks, jigs, fixtures, hoists, cranes, etc., that are required in order to maintain and operate the cars.

The Seller will furnish to the Buyer a list of all unique and special support equipment required to operate and maintain the cars. This list shall be delivered to the Buyer prior to the critical design review. The list shall be organized as follows:

a. Tools required to perform inspections and other preventive maintenance.

b. Equipment to facilitate the movement and lifting of heavy equipment.

c. Test sets and instruments.

d. Machine shop, sheetmetal shop, upholstery shop, etc.. equipment.

e. Support equipment which is required for corrective maintenance and is not called out in any preceding category. List these items by the subsystem for which they are required.

15.10 TEST SUPPORT

The Seller shall provide the Buyer with engineers and other personnel fully qualified in the maintenance and operation of the cars and their subsystems. They shall conduct the acceptance and system tests, maintain and operate the cars at HSGTC and shall support the operational demonstrations. They shall further serve as on-site representatives of the contractor for any component failure claims or warranty claims against the contract.

SECTION 16

MANAGEMENT SYSTEMS

16.1 GENERAL

Management systems are required to enable the Buyer to determine that the Seller will meet the requirements of this specification and to enable him to monitor the contractual effort to determine the degree to which contract objectives are being achieved. The management systems should be those currently in use by the Seller.

16.2 MANAGEMENT PLAN

The management plan shall include, but is not necessarily limited to:

a. An organization chart including a definition of the responsibilities and qualifications of all personnel thereon.

b. Descriptions of the activities (both Seller and subcontractor) required to fulfill this specification, including their inter-relationships.

c. A master program schedule of all Seller and subcontractor activity showing key milestones and events.

16.2.1 DESIGN AND TEST REVIEWS

Formal reviews shall be scheduled and conducted at appropriate milestones in the development and design of the item specified in the design control media. Representatives from the Buyer and UMTA may participate in the reviews. Minutes of the review shall be recorded by the Seller and shall include action items identified during the reviews. Schedules and data packages for design reviews (both Preliminary and Critical Design Reviews) shall be submitted to the Buyer prior to the review.

16.2.2 PRELIMINARY DESIGN REVIEW (PDR)

A design approach review of engineering data shall be conducted by the Seller within 60 days after receipt of the purchase order to ensure that the design and test approach meet the system objectives and design and test requirements. Also, it is intended to ensure compatibility of design and production requirements. Concurrence with the design approach will be granted in the minutes of the Preliminary Design Review. Information to be reviewed shall include the following data to the extent available:

a. Agenda
b. Preliminary design sketches (construction)
c. Design and performance technical concepts
d. Interfaces
e. Value engineering data
f. Trade studies
g. Reliability data
h. Maintainability data
i. Human engineering design analysis
j. Identification of safety problems, safety analysis and preliminary system safety engineering plan
k. Breadboard test results
l. Preliminary qualification test plan
m. Stress analysis
n. Equipment interconnecting wiring diagrams
o. Weight
p. Support equipment recommendations
q. Recommendations for service publications
r. Supplier's estimate for spares data
s. Test requirements

Notification, in writing to the Buyer, shall be 10 days prior to the review.

16.2.3 CRITICAL DESIGN REVIEW (CDR)

The CDR is to be conducted by the Seller immediately prior to the Seller's drawing release for fabrication. This is a review of engineering data to ensure the design meets system objectives and design requirements, plus assurance that adequate requirements for verification exist. The following data shall be provided to the extent available. Other data may be included:

a. Agenda
b. Engineering drawings which define the production baseline
c. Qualification test data
d. Reliability data
e. Maintainability data
f. System safety engineering data
g. Human engineering design data
h. Electrical load analysis
i. Acceptance test procedure
j. Unique maintenance and support equipment recommendation
k. Test requirements
l. Seller's estimate for spares data
m. Material and process specifications
n. Stress analysis
o. Development test results
p. Value engineering data
q. Quality assurance

The Seller shall advise the Buyer of the review 10 days prior to its scheduled date. If the Buyer elects to attend, the Seller will be given 7 days notice. Minutes of all CDR's, whether the Buyer attended or not, shall be forwarded to the Buyer. Also, when the Buyer does not attend, a copy of the approved CDR data package will be forwarded to the Buyer.

16.3 SYSTEM ENGINEERING

The Seller shall consider the car, in its design and manufacture, as a single system rather than as an assembly of independently engineered and manufactured elements.

This requirement does not impose a specific engineering process or management technique, organizational structure, or form of internal documentation. It shall be structured to suit the project and to conform to the Seller's organization and methods.

16.4 CONFIGURATION MANAGEMENT

16.4.1 CONFIGURATION IDENTIFICATION

The Seller's technical documentation, when not specified, shall be to acceptable commercial standards and shall define the approved configuration of system and system equipment under development, test, production, or in operational use. The technical documentation shall identify the configuration to the lowest level required to assure repeatable performance, quality and reliability.

16.4.2 CHANGE CONTROL

The Seller shall apply orderly controls to the management of engineering design changes.

16.4.3 CONFIGURATION ACCOUNTABILITY

The Seller shall maintain records such that the configuration of any item being delivered is definable in terms of its component part numbers; differences between the as-built configuration and the engineering released documentation are known and accounted for; and the status of change approvals and incorporations is known and recorded at any point in product development, test, production, or operational usage.

16.5 INTERFACE MANAGEMENT

The Seller shall control interfaces as required to ensure that detail specification requirements are met.

16.6 DATA MANAGEMENT

The Seller shall apply orderly controls to the management of all data required by this specification.

16.7 REPORTS

During the performance of this contract the Seller shall submit monthly progress reports which shall be received by the Buyer no later than the eighth day of the month following the month for which the report was rendered.

SECTION 17

TESTING

17.1 GENERAL

17.1.1 TEST PLAN

An overall test program plan shall be prepared (or documented proof furnished of a test program previously consummated, if applicable) containing all tests necessary to demonstrate that the railcar will perform satisfactorily under all operating conditions specified for the designed life of the equipment. The plan shall include an outline of the test program, test equipment and facilities to be used, and any additional data required to illustrate the test program, including a detailed testing schedule listing significant milestones in the test program. The test plan shall be submitted to the Buyer for approval prior to the initiation of the test program to provide a basis for measurement of Seller technical achievement during program implementation.

17.1.2 TEST PROCEDURES

A test procedure for systems and components shall be prepared and submitted to the Buyer for review.

17.1.3 SEQUENCE OF TESTING

The order of testing to be conducted shall be prescribed in the test plan.

17.1.4 TEST COMPLETION AND STANDARDS FOR INTERPRETATION

Tests will be considered complete when the test plan per St. Louis Car proposal is completed and the test report is approved.

17.1.4.1 Test Hardware

Hardware to be used for testing must be representative of state-of-the-art hardware, made by state-of-the-art tools and using state-of-the-art methods. Any deviations from this requirement must be subject to approval from the Buyer. Changes incorporated in hardware as a result of the test shall be incorporated in deliverable and delivered hardware.

17.1.4.2 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 Seller document number and shall refer to the Seller part number and serial numbers of the test hardware. All salient test results (as well as a discussion of any deviations from the approved test procedure) shall be included in the sequence used for testing, plus photographs and any additional data necessary to support the test results. Supplier test reports shall be approved by the Seller prior to submittal to the Buyer. One reproducible and three copies of the report shall be submitted to the Buyer one month after completion of testing.

17.1.5 TEST FAILURE AND DISCREPANCY ANALYSIS (Not applicable)

17.2 COMPONENT TESTS

17.2.1 PROPULSION SYSTEM

17.2.1.1 Traction Motor Tests

a. Traction Power Capacity Tests
A chopper system and four traction motors as required shall be tested as a system to demonstrate compliance with the performance requirements of Section 2.2.1 at an input voltage of 600±10 VDC.

b. Speed Load Tests
Tests shall be run to obtain speed load curves for input voltages of 450 and 600 VDC. Test data shall include chopper input and output voltages and currents, output voltage wave forms, motor armature and field voltages and currents, and cooling air flow rates and temperatures.

c. Dynamic Braking Characteristics
Tests shall be conducted to obtain curves of dynamic braking characteristics for the full range of speed of the motor.

d. Heat Run
Tests shall be conducted to obtain temperatures of windings, commutator and bearings to verify that specified temperature rises are not exceeded.

e. Overspeed
A traction motor shall be operated at a speed of 10% above the maximum speed required to maintain a train speed of 80 mph (worn wheels) for five minutes. There shall be no evidence of failure as a result of this test.

f. Vibration
Traction motor vibration shall be measured in accordance with the procedure of NEMA Standard MGI-12.07 at maximum rated speed.

g. Dielectric Test
Following the above tests, the motor shall be subjected to an AC potential of 3500V RMS for one minute, applied between armature conductors and ground, and 2000V RMS between field conductors and ground. No breakdown shall result from application of this potential.

h. Humidity Test (Not specified)

17.2.2 ELECTRICAL SYSTEM COMPONENTS

17.2.2.1 Motor Alternator Tests

The following tests, in addition to those specified in reference manual, shall be conducted by the Seller or his supplier. Prior to conducting any tests, the Seller shall furnish a complete test plan. It shall be noted that the tests specified below are the minimum specially required and should not be construed as setting a limit beyond which the supplier need not go in assuring a quality product.

17.2.2.1.1 Capacity Test

a. The MA set shall be operated at nominal input voltage at 650V and a no-load saturation curve of the alternator line-line voltage versus exciter field current recorded. (No voltage regulator in the system for this test only.)

b. The MA set shall be run at full load at 125KW and .8 power factor until temperatures stabilize in the MA set for input voltages of 550V, 650V and 750V. Speed will be held constant by manual control of the motor shunt field current.

c. Voltage regulation of the alternator shall be measured by varying the load from zero to rated output with approximately .8 power factor. Speed of the motor shall be maintained at 1800 rpm by manual field control. Input voltage to the motor should be 650V.

d. With the automatic speed regulator controlling the motor field current, the load shall be varied as in test "c" and the speed regulation of the motor noted. Run for voltages of 450, 550, 650 and 750 input to the motor.

e. With the controls as in "d" the transient voltage excursions of the alternator shall be noted as various loads are switched on and off the alternator output.

17.2.2.1.2 Efficiency

The MA set shall be tested for overall efficiency at full-rated and half load on the alternator with 650V.

17.2.2.1.3 Fault Protection

Fault conditions of overvoltage, undervoltage, overfrequency, overspeed and underfrequency, shall be created or simulated and the MA system observed for proper protection response.

17.2.2.1.4 Dielectric Strength

Immediately after the above tests, all parts of the equipment shall withstand, without breakdown, an alternating current potential of 1000V RMS plus twice the rated voltage, applied between conductors and ground for a period of one minute, all metallic parts except conductors being grounded.

17.2.2.1.5 Heat Run

Not required. The rating of the unit to be supplied is in excess of 200% of the car power requirement.

17.2.2.2 Battery Performance (Not specified)

17.2.3 TRUCK SYSTEM

a. Truck side frame and bolster, static tests. (Castings Div., G.S.I. Test Report T-34702-1)

17.2.4 COUPLER AND DRAFT GEAR SYSTEM

Substantiated by R-44 data.

17.2.5 ATC TESTS (Not applicable)

17.2.6 NOISE TESTS - PRIOR TO INSTALLATION (Not applicable)

17.2.7 WINDSHIELD

The windshield shall be qualified by similarity, based on Swedlow tests of the BART windshield.

17.2.8 SIDE DOOR

Substantiated by R-44 data.

17.3 SUBSYSTEM TESTS

17.3.1 PROPULSION SYSTEM

17.3.1.1 Testing of Breadboard Components

a. Propulsion control system.

b. Propulsion control system plus friction brake control system.

17.3.1.2 Testing of Prototype Components

a. Prototype propulsion control, plus prototype friction brake control.

b. Prototype propulsion control, plus prototype friction brake control, plus prototype auxiliary electrical equipment.

17.3.1.3 Testing of Prototype Systems on SOAC Cars

a. Static test of prototype systems.

b. On-track running tests at HSGTC.

17.3.2 FRICTION BRAKE SYSTEM

a. Response test to dynamic brake and slip-spin control signals.

b. Braking effort versus time for constant input signal.

c. Brake system capacity.

d. Pneumatic system ultimate pressure test.

17.3.3 CAR BODY SYSTEM

a. Body compression test (substantiated by R-44 data).

b. Vertical load test (substantiated by R-44 data).

c. Watertightness

17.3.4 AIR CONDITIONING SYSTEM TEST IN CLIMATIC CHAMBER

a. Duct baffle adjustment

b. Pull-down test

c. Rated capacity test

d. (Not applicable)

e. Reduced output test

f. (Not applicable)

g. Reheat test

17.3.5 HEATING SYSTEM TEST IN CLIMATIC CHAMBER

17.4 VEHICLE SYSTEM TESTS

17.4.1 CAR CONDITION DURING COMPLIANCE AND ACCEPTANCE TESTING

17.4.1.1 All operating parts, devices, controls, and apparatus shall be tested and adjusted to proper, approved operating condition by the Seller at his expense prior to compliance testing at HSGTC tracks.

17.4.1.2 Reassembly and operational tests as required at the HSGTC site shall be performed by the Seller at his expense.

17.4.1.3 Removal from and return to the designated delivery point for correction of defects shall be accomplished by the Seller at his expense.

17.4.1.4 Upon receipt of each car at the designated delivery point and prior to final acceptance by the Buyer, the car shall be inspected by the Buyer and any part, device, or apparatus requiring adjustment, replacement, or repair shall be put in proper operating condition by the Seller at his expense.

17.4.2 TEST REQUIREMENTS

The following system tests shall be conducted by the Seller at HSGTC, Pueblo, Colorado:

Tests	Frequency of Tests
Vehicle check-out tests	Two cars
Propulsion/Traction System Prototype Test	Once
Brake System Tests	
Friction Brakes	Two Cars
Handbrake Specification	First Car
Handbrake Function	Two Cars
Friction Brake Forces	First Car
Stopping Distance	Two Cars and two-car train
Performance Tests - Standard Train	
Acceleration	One Train
Speed	One Train
Deceleration	One Train
Sample Service-Use Schedule	One Train
Performance Tests - Single Car	
Acceleration	Two Cars
Speed	Two Cars
Deceleration	Two Cars
Sample Service-Use Schedule	Two Cars
Service Duty Cycle Tests	
One Standard Train	Once
Car Weighing	Two Cars

The following tests shall be conducted by the Buyer at HSGTC:

Drift Tests	One Car and Two-Car Train
Ride Quality Tests	One Car and Two-Car Train
Noise Tests	One Car and Two-Car Train
RFI Tests	One Car

17.4.3 TEST FACILITIES

17.4.3.1 Vehicle system tests shall be conducted by the Seller and the Buyer at the High Speed Ground Test Center (HSGTC) facilities at Pueblo, Colorado.

17.4.3.2 For purposes of specification compliance, performance tests shall be conducted on the UMTA tracks at HSGTC. Standard industry methodology shall be used as necessary to adjust recorded performance to level, tangent track equivalent.

17.4.3.3 Maintenance facilities, storage, and office space will be provided by the Buyer for the Seller during the on-site performance testing of Section 17.4.

17.4.4 ADDITIONAL TESTING BY BUYER

After final acceptance, the Buyer, at his expense, may make additional operating tests of individual cars. These tests may be witnessed by a representative of the Seller who may also participate and provide technical assistance at the request of the Buyer. Defects disclosed by such tests shall be corrected by the Seller at his expense, if within the warranty agreement.

17.4.5 REPORTS OF TEST

Written reports of all tests performed on the cars and their components during compliance and acceptance testing by the Seller shall be submitted to the Buyer. Any written reports of test shall include a description of the test, a summary of test results, and data collected during the test. These reports shall become the property of the Buyer.

17.4.6 SYSTEM TEST DESCRIPTIONS

17.4.6.1 Vehicle Check-Out Tests

a. Insulation, and High-Potential Tests

b. Controls and Wiring Operational Demonstration

c. Main Power System Traction Motor Direction Checks

d. Operational Check of Traction Control, Auxiliary Electrical, Air-Conditioning, and Coupler Systems

e. Service Brake and Handbrake Application Adjustment

f. Dimensional and Clearance Check

g. Suspension System Stability Check

h. Car Weight

i. Weight Distribution

j. Water Leak Tests of Car Body

k. Water Leak Tests of Intercar Closure (not applicable)

l. Air Conditioning Functional and Capacity Test

m. Car Interior Light Intensity and Brightness Levels

n. Operational Test of Doors, Lights, Signals, Wind-Shield Wipers, and Defoggers

o. Equalization Test of Communication Systems

17.4.6.2 Propulsion/Traction System Test

Laboratory and/or rolling tests of the propulsion/traction system prototypes, including the wheel slip-slide protection system, acceleration and deceleration rate-limiting (jerk rate) systems, and car load-weighing system shall be performed by the Seller. These tests shall prove the several subsystem functions and demonstrate subsystem compliance with the performance requirements of Sections 2.2.5, 2.2.6 and 2.2.8.

17.4.6.3 Brake System Tests

a. Friction Brake

The friction brake system and associated apparatus shall be tested and adjusted on all cars until performance complying with AAR, DOT requirements, brake subcontractor's specification, and the requirements of Section 2.2 of this specification is obtained.

b. Handbrake Specification (Not specified)

c. Handbrake Function

The handbrake on all cars shall be functionally tested with new brake shoes.

d. Friction Brake Forces

Tests shall be conducted on the friction brake system to determine the actual force produced at each friction brake location with brake cylinder pressures from 20 pounds to 100 pounds in increments of 20 pounds. The brake force produced by the handbrake when applied with a 125-pound force at the end of the lever shall also be measured. These tests will be performed on a static car.

e. Stopping Distance

Two full stops from speeds of 20 mph to 80 mph with intervals of 20 mph shall be made at each brake system combination with individual cars at weights AW1 and AW2 and a two-car train at weight AW1. The stopping

distance will be averaged for the two stops on level, tangent track. Stops showing unreasonable variation will be repeated. The stops shall be made using the following brake system combinations:

- o Service friction braking only (8 tests minimum).
- o Blended dynamic and service friction (8 tests minimum) braking.
- o Emergency friction braking only (8 tests minimum).

Data from the following parameters shall be recorded throughout the stop for all of the above tests:

Speed
Distance
Time
Instantaneous deceleration
Brakeline pressure: 1 car
Brake cylinder pressure: 1 car (when applicable)
Dynamic brake current: 1 car (when applicable)

The foregoing tests shall be made using worn-in brake shoes such that shoe-drum contact area is no less than 95 percent of total shoe face area.

17.4.6.4 Performance Tests: Standard Train and Individual Cars

a. Compliance with the performance specifications of Section 2.2 shall be demonstrated by the Seller on each single car unit and on one unit train of two cars as defined in paragraph 2.2.1.3. The first car and first unit train shall be tested at car weight AW1.

b. For each test, the following parameters shall be recorded on a multiple-channel recording oscillograph:

Horizontal acceleration and deceleration
Car speed
Line voltage
Line current
Traction motor voltage
Traction motor current
Trainline signals (propulsion and braking for a two-car train)
Brake cylinder pressure
Time
Event marker

All charts obtained from the cited records shall be forwarded to and become the property of the Buyer. Copies of all test charts may be made by the Seller for his own use.

c. Acceleration, speed and deceleration tests of each car and the two-car train shall be made on the specified test track of Section 17.4.3. The acceleration speed and deceleration of each car shall be as specified in Sections 2.2.2, 2.2.3 and 2.2.4. The instrumentation of paragraph "b" above shall provide the data necessary to set up each car for specification compliance.

d. A sample service-use schedule of eight circuits of the DOT 9-mile track, including stops at all simulated stations from proposed regular speeds with 30-second stops at each station, shall be conducted on a single-car and one two-car train. Data from the instrumentation of paragraph "b" above shall be recorded to determine power usage and brake performance. The above maximum duty cycle shall be specified by the propulsion/braking contractor and approved by the Buyer.

   These tests shall be accomplished using the following brake system combinations:

   - Service friction braking only (four circuits)
   - Blended dynamic and service friction braking (four circuits).

17.4.6.5 Drift Tests

These tests shall be conducted by the Buyer.

The purpose of the drift tests is to verify the traction resistance and air resistance coefficients used in the performance calculations and to form a baseline resistance level for evaluation of adhesion coefficients and slip/slide system characteristics. The tests will be made using a single car and a two-car train with a car weight of 105,000 pounds. The car control system will be modified such that tractive effort can be completely removed without braking effort or brake in-shot buildup. Friction braking shall be available to stop the car following a data run. Test data runs will be made on the level tangent sections of test track only. Data will be terminated upon leaving this track section. Runs will be made in both forward and reverse directions for the two-car consist. Wind speed and direction and air temperature will be recorded.

Each test train will be accelerated to 80 mph prior to entering the test section. All power will be removed from the trucks and the train allowed to coast through the test section. During the coast period continuous recordings will be made of car deceleration and speed. Time intervals of 1/10 second and distance intervals will be marked on the recordings. The runs will be repeated by successively reducing the test section entry speed until a final exit speed of 10 mph is obtained. Target entry speeds will be determined prior to testing.

For the single car test each run will be performed at least two times. For the two-car train, each run will be performed at least once in each direction.

The test data will be reduced to speed and resistance format and compared to predicted data for the zero wind and 15 mph headwind conditions at sea level standard atmospheric conditions.

17.4.6.6 Ride Quality Tests

These tests shall be conducted by the Buyer to determine ride quality and compare it with available statistical data.

Tests of one unit (two-car) and one single-car will be conducted. The cars will be tested at weights of 90,000, 105,000 and 120,000 pounds. Ballast will be uniformly distributed along the length and width of the floor of the car.

Tests will be conducted on the six sections of the HSGTC oval track. The oval section, which designates the track configurations, will be noted for all test speed runs. Data will be recorded during steady speed runs at 20, 35, 45, 55 and 80 mph. In addition, data will be recorded on single car during a maximum acceleration to 40 mph and deceleration from 60 mph at a vehicle weight of 105,000 pounds on the welded 119-pound rail.

Vibration measurements will be made using accelerometers with the capacity and frequency range to record levels at locations as shown in Table 17-1, Ride Quality Test Instrumentation Configuration. Where possible, the test procedures outlined in GSP-064 will be followed.

TABLE 17-1

RIDE QUALITY TEST INSTRUMENTATION CONFIGURATION

Channel	Parameter	Dir.	Range	Freq.
	CAR BODY			
1	Fwd Car Floor - Truck Center Line	Vert	±.30G	30 Hz
1	Fwd Car Floor - Truck Center Line	Lat	±.30G	30 Hz
1	Fwd Car Floor - Truck Center Line	Long	±.30G	30 Hz
1	Aft Car Floor - End of Car	Vert	±.30G	30 Hz
1	Aft Car Floor - End of Car	Lat	±.30G	30 Hz
1	Fwd Car Floor LH - Truck Ct. Line	Vert	±.30G	30 Hz
1	Center Line Car Floor	Vert	±.30G	30 Hz
1	Center Line Car Floor	Lat	±.30G	30 Hz
1	Center Line Car Floor RH	Vert	±.30G	30 Hz
1	Center Line Car Floor LH	Vert	±.30G	30 Hz
1	Center Line Car Ceiling	Lat	±.30G	30 Hz
3	Car Body Angular Acceleration	Pitch	±. 4 Rad/Sec^2	5 Hz
		Yaw	±. 4 Rad/Sec^2	5 Hz
		Roll	±. 4 Rad/Sec^2	5 Hz
	TRUCK			
1	Fwd RH Wheel - Front	Vert	±25.G	30 Hz
1	Fwd RH Wheel - Front	Lat	±25.G	30 Hz
1	Aft RH Wheel - Front	Vert	±25.G	30 Hz
1	Aft RH Wheel - Front	Lat	±25.G	30 Hz
1	Fwd LH Wheel - Front	Vert	±25.G	30 Hz
1	Aft LH Wheel - Front	Vert	±25.G	30 HZ
1	Fwd RH Wheel - Rear	Lat	±25.G	30 Hz
1	Aft RH Wheel - Rear	Lat	±25.G	30 Hz

17.4.6.7 Radio Frequency Interference Tests

These tests shall be conducted by the Buyer to determine the level of compliance with the radio frequency interference requirements of Section 9.9.2.

Radio interference tests shall be performed on one car by the Buyer. The tests shall be performed with the car in all operating modes and readings shall be taken at various car electrical loads with auxiliary electrical apparatus operating and at car speeds compatible both with normal operating conditions and the spectrum analysis instrumentation employed.

The test procedures shall generally be those established in the SAE Standard J551 for measurement of vehicle radio interference except that measurements shall be taken over the complete frequency range of 150 KHz through 400 MHz. The tests shall be performed with spectrum analysis equipment.

A resonant dipole antenna and rod and loop antennas shall be used as required for the various frequency ranges. The antennas shall be mounted at a distance transverse to the moving vehicle consistent with critical areas to be encountered on the service right-of-way. Loop antennas mounted on the moving vehicle may also be used for measurements taken in the frequency range of 150 KHz to 3.0 MHz. The dipole antenna shall be polarized both vertically and horizontally to define the plane of maximum interference. Each test run shall be repeated at least twice to determine average values. Sequenced operation of car equipment shall be made to define the noise generating source in case of measurements exceeding the interference limits.

17.4.6.8 Interior Noise Tests

Interior noise tests shall be conducted by the Buyer to determine the level of compliance with the noise control requirements of paragraph 2.8.3.1, 2.8.3.4 and Figure 2-9. Interior sound levels shall be measured in one car operated singly and as one car of a two-car train. These measurements shall be made at car and train speeds of 20, 40, 60 and 80 mph.

17.4.6.9 Wayside Noise Tests

Wayside noise tests shall be conducted by the Buyer to meet the requirements of paragraph 2.8.3.2 and Figure 2-10. Wayside sound levels shall be measured with car or train stationary and while passing at 20, 40 and 80 mph.

17.4.6.10 Sound Level Test on Signals (Not specified)

17.4.6.11 Interior Lighting Intensity Tests (Not specified)

17.4.6.12 Car Weighing

17.4.6.12.1 The Seller shall weigh each complete car at time of shipment to the Buyer. Weight records shall be submitted to the Buyer with copies to be included in each car log book. Car configuration for weighing shall be empty car weight less attendant, as defined in paragraph 2.2.1.3.2.

17.4.6.12.2 The scale(s) used to weigh the cars shall be maintained with the tolerances set forth in Chapter 14, Part 5, Section C of the A.R.E.A. Manual.

17.5 ACCEPTANCE TESTING

Acceptance testing is that testing conducted on all components, subsystems and the complete vehicle to determine suitability for acceptance by the Buyer. The Buyer will retain the right to witness any or all acceptance testing as desired.

For the purpose of this two-car procurement, the system tests to be conducted by the Seller as specified in Section 17.4.2 shall be the vehicle acceptance tests.

SECTION 18

QUALITY ASSURANCE

18.1 GENERAL

This section defines the essential elements of the Seller's quality program which must be maintained to assure an acceptable level of quality. This concept of total quality assurance is based on the principle that quality is a basic responsibility of each segment of the Seller's organization and shall be evidenced by:

a. Producible and inspectable designs.

b. Establishment of firm procurement and performance specifications.

c. Firm procedure for transmission of quality requirements and standards to subcontractors and suppliers and assuring their compliance.

d. Adequate testing to assure repetitive product conformity to design requirements.

e. Total program surveillance and verification of physical conformance and configuration accountability.

18.1.1 EVIDENCE OF COMPLIANCE (Ref. Boeing Document D210-10308-1, as amended by contract)

The Seller's Quality Assurance System shall establish and maintain objective evidence of compliance with the requirements of Boeing Document D210-10308-1 "Quality Assurance Requirements for the Procurement of the Urban Rapid Rail Vehicle Systems."

SECTION 19

APPLICABLE DOCUMENTS

19.1 EFFECTIVE DATE OF DOCUMENTS

The documents specified herein shall be of the issue in effect on the date of formal invitation to bid, unless otherwise specified. Later revisions of such documents may be used subject to approval by the Buyer.

SECTION 20

GENERAL INFORMATION

20.1 DEFINITIONS AND ABBREVIATIONS

20.1.1 GENERAL

Wherever in the specifications and other contract documents the following abbreviations and terms, or pronouns in place of them are used, the intent and meaning shall be interpreted as follows.

20.1.2 DEFINITIONS

A-Car - A self-propelled car having a control cab at one end and comprising one-half of a married pair.

Addenda - Written interpretations of or revisions to any of the contract documents issued by the purchaser before the bid opening.

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

Alignment, Horizontal - The horizontal location of a track as described by curves and tangents.

Automatic Train Control (ATC) - The system for automatically controlling train movement, enforcing train safety and directing train operations. ATC includes subsystems for automatic train operation, train protection and line supervision from a wayside control center.

Automatic Train Operation (ATO) - The subsystem within automatic train control which performs the functions of speed control, programmed stopping, and door operation.

Auxiliary Systems - An auxiliary system is any mechanism or structure other than the car body, traction motor or propulsion system gearing which performs a function at some time during the operation of the car; e.g., heating and air conditioning system, pumps, car door operation, motor alternator, air compressor or hydraulic power unit and car lighting.

B-Car - A self-propelled car having a control cab at one end and carrying shared auxiliary equipment that is not on an "A" Car. Comprises the second half of a married pair.

B-10 Life - The number of hours up to which 10 percent of the bearings in a bearing population will have failed. Conversely, the bearing life which 90 percent of the bearings in a population will meet or exceed.

Bidder - Any individual, firm, partnership, corporation or combination thereof, submitting a proposal for the procurement contemplated, acting directly or through a duly authorized representative.

Blending - In braking, a simultaneous dynamic/regenerative and friction brake application with the effort of friction brake continuously proportioned to achieve the required total brake effort.

Braking, Closed Loop - Modulated braking effort under continuous direction of the automatic train control and/or manual train control system.

Braking, Dynamic - Braking supplied by the torque required to drive the traction motor as a generator when wheel speed exceeds the traction motor output speed called for by the electrical input to the motor.

Braking, Emergency - Irretrievable* unmodulated (open loop) braking to a stop usually at a higher retardation rate than is obtained with a maximum service brake application.

Braking, Maximum Service - The normal maximum unmodulated (open loop) braking effort employed to stop a train. The brake can be released and reapplied.

Braking, Open Loop - Unmodulated braking at either the maximum service brake or emergency brake effort permitted by the braking system without continuous direction from the train control system.

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*Once initiated, the brake application cannot be released until the train has stopped.

Braking, Programmed - Automatically modulated (closed loop) braking with the requirement that a stop be completed at a designated point within a specified distance.

Braking, Regenerative - Dynamic braking where the voltage generated by the traction motor (when driven as a generator) is conditioned and returned to the DC bus.

Braking System - The system of wheels, motors, driving mechanism, brakes, controls and appurtenances that retards the car in response to input control signals.

C-Car - A self-propelled vehicle not equipped with a control end.

Car Weight, Crush Load - The weight of a car with full seated passenger load plus the maximum number of standing passengers possible to contain within the car.

Car Weight, Full Load - The weight of a car with full seated passenger load plus a standing passenger load as specified by the purchaser.

Car Weight, Light - The weight of an empty car, ready to run. For I.C. and diesel-powered commuter cars, includes full fuel, lubricants and coolants.

Car Weight, Normal Load - The weight of an empty car plus the full seated passenger load.

Change Notice - A notice issued to the contractor by the purchaser specifying a proposed change to the contract documents.

Change Order - An order executed by the purchaser and issued to the contractor amending the contract drawings or specifications.

Coast - The mode of operation of a car or train in which propulsion (positive traction) is inactive and usually a certain minimum braking effort is in effect.

Component Testing - Testing planned and conducted by or under the direction of the purchaser 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. Completion of all component testing, to the satisfaction of the purchaser, will indicate whether the assembled end product is ready for system testing.

Consist - The number and specific identity of cars that make up a train.

Contract - The written agreement covering the performance of the procurement.

Contract Drawings - The official drawings listed, or amendments thereto, and supplemental drawings approved by the purchaser which show the character, dimensions and details of the procurement.

Contractor - The person or persons, firm, partnership, corporation, or combination thereof, whichhas entered into a procurement contract with the purchaser.

Contractor's Drawings - Items such as detail drawings, calculations and catalog cuts which are prepared by the contractor to supplement or detail contract drawings or specifications, and which are contractual requirements, or are prepared at the contractor's option to detail his work.

Coupler - An appliance for mechanically coupling cars together automatically by impact. Must be capable of uncoupling automatically or manually without going between the cars. Term is also applied to automatic connectors as in "Electric Coupler" and "Pneumatic Coupler" which couple electric and pneumatic trainlines together between cars.

Coupler, Retractable - A coupler which swings out of the way or retracts when not in use.

Days - Unless otherwise designated, days as used in the specification will be understood to mean calendar days.

Dispatching - The process of starting a train into revenue service from a terminal zone or transfer track.

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.

Dwell - The period of time measured from the instant a train berths at a station until the instant it resumes moving.

Engineer - The person or firm designated by the purchaser as his technical representative.

Extra Work - Work not covered by any of the items for which there are bid prices, and work specifically designated as extra work in the contract drawings or specifications.

F-End - The cab end of a car where automatic coupling exists. Also called "A" or "No. 1" end.

Failsafe - A characteristic of a system which ensures that any malfunction affecting safety will cause the system to revert to a state that is known to be safe.

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

Gauge, Track - The distance between the inside face of rails, usually measured 5/8-inch below the top of the centerline of heads of running rails and at a right angle thereto.

Headway - The time separation between two trains, both traveling in the same direction on the same track. It 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 - The prime power voltage supplied to the car by the catenary or third rail, usually between 500 and 1500 volts DC.

Indicated - As used in this specification "indicated" shall be understood to mean "as shown on the contract drawings, as described in the specifications, or as required by other contract documents."

Intercar Closure - A flexible enclosure providing a weatherproof passageway between coupled cars.

Interface - The points where two or more subsystems, systems, persons or firms must meet to assure continuity of the project.

Jerk Rate - Time rate of change of acceleration or deceleration normally measured in miles per hour per second per second.

Load Weighing - A function which measures car weight to permit control of tractive effort in order to achieve a constant effort-to-weight ratio.

Low Voltage - The voltage used for most auxiliary systems on the car, usually between 24 and 72 volts DC or 110 to 240 volts AC.

Manual Train Control (MTC) - Train movement is completely controlled by the motorman.

Married Pair - Two cars which must be operated as a unit. (See "A" car and "B" car)

Motorman - The operator of a self-propelled car, also called "attendant." In commuter cars, usually called "engineman."

Multiple-Unit (MU) - Two or more units or married pairs of cars.

Notice of Completion - The formal written notice issued by the purchaser when all of the procurement under the contract has been completed.

Performance - The measure of output or results obtained by a component, system, person, team., etc., as in "Performance Specification." Vehicle performance refers to the design requirements which must be demonstrated by operation of a car or cars, as in "Performance Characteristics" or "Performance Testing."

Profile Grade - A straight line representing an established grade line, in relation to the horizontal.

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

Proposal - The bid or offer of the bidder for the work when made out and submitted on the prescribed proposal form, properly signed and certified, and which includes the schedule of bid items.

Propulsion System - The system of wheels, motors, driving mechanism, controls and appurtenances that propels a car in response to input control signals.

Prototype - A car built to test a new design and which performs essentially the same as the production vehicle.

Purchaser - The operating agency which is procuring the cars.

R-End - The rear or non-cab end of a car where only semi-automatic coupling exists. Also called "B" or "No. 2" end. In a married pair, usually semi-permanently coupled to the other car.

Redundancy - The existence in a system of more than one means of accomplishing a given function.

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

Requirements - The criteria which must be met when designing a vehicle.

Roll - Transverse rotational motion of a car body about a longitudinal axis below the car floor.

Single Unit Car - A self-propelled car equipped with a control cab at both ends.

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

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

Specification, Detail - The document which defines the detail from which a car is designed.

Specification, Guideline - The document which defines the format, definitions and methods for the preparation of a detail specification.

Speed, Balancing - The steady state speed attained by the train when resisting forces exactly equal tractive forces.

Speed, Limit, ATC or MTC - The upper limit of train speed as endorsed by the train protection system.

Speed, Limit, Civil - The maximum safe speed allowed in a specified zone as determined by the physical limitations of the track structure.

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

Standard Train - For performance test purposes, the planned train arrangement for the transit property writing the specification. Includes number and types of cars such as single units, married pairs, non-control cars, etc.

Step Signal - A signal having a constant value prior to a certain instant and a different value immediately thereafter.

Subsystem - A major part or an assembly of parts of a vehicle.

Super Elevation - On a curve, the vertical distance that the outer rail is above the inner rail.

System - For the purpose of this specification, the vehicle, passengers, operator, maintainer, the operating and maintenance procedures and the maintenance and test equipment integrated into an operational configuration for the specified operational environment.

System Testing - This involves tests which are planned and conducted for each project end product. System testing will be conducted under controlled conditions in an environment closely approximating the conditions which would exist on an operating transit property. Completion of system testing, to the satisfaction of the purchaser, will indicate that the technical development phase has been completed and the system product is ready for operational demonstration testing in a typical normal operating environment.

Third Rail - The bus bar alongside a track that carries electric energy for the propulsion of trains, including support, insulation and coverboards.

-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 from the occurrence of a step change of the control signal to the beginning of change of the controlled variable.

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 - Time from the occurrence of a step change of control signal to the first attainment of the new steady-state value of the controlled variable, within a designated accuracy.

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 it is capable of performing its intended function.

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

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

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

Weights, Actual - The measured weights of finished cars ready to run.

Weights, Assigned - The loaded car categories assigned by the purchaser as the basis for traction system design and for subsystem and vehicle testing as indicated. Four weight categories are assigned:

AWO - Empty car, ready to run
AW1 - Normal load
AW2 - Full load
AW3 - Crush load

Weights, Estimated - The contractor's estimate of total car weight stated in his proposal for the cars.

Weight, Reference - The contractor's assigned reference weight to be used for bid evaluation.

Work - Where the context will allow, the term "work" shall mean the production of goods and services furnished in accordance with the contract.

20.1.3 ABBREVIATIONS

AAR - Association of American Railroads
AGMA - American Gear Manufacturers' Association
AISI - American Iron and Steel Institute
AREA - American Railway Engineering Association
ASME - American Society of Mechanical Engineers
ASTM - American Society for Testing and Materials
ATC - Automatic Train Control
AWG - American Wire Gauge
AWS - American Welding Society
CB - Circuit Breaker
DOT - Department of Transportation
EMI - Electromagnetic Interference
FCC - Federal Communications Commission
GSI - General Steel Industries, Inc.
ICC - Interstate Commerce Commission
IEEE - Institute of Electrical and Electronic Engineers
IRT - Institute for Rapid Transit
MTC - Manual Train Control
NEMA - National Electrical Manufacturers Association
NYCTA- New York City Transit Authority
RF - Radio Frequency
SAE - Society of Automotive Engineers
TSC - Transportation Systems Center, DOT
UL - Underwriters' Laboratories, Inc.
UMTA - Urban Mass Transportation Administration
USAS - United States of America Standard

20.2 INTERPRETATIONS

The contract documents are complementary and are intended to provide for a complete product. Should it appear that the work to be done or any of the matters relative thereto are not sufficiently detailed or explained in the specifications or the contract drawings, the contractor shall apply to the Buyer for such further written explanations as may be necessary.

20.2.1 DEVIATIONS TO SPECIFICATION (Not applicable)

20.2.2 ARRANGEMENT DRAWINGS (See Section 2.1.3)

20.2.3 APPROVALS AND CLEARANCES GRANTED BY THE BUYER

This section defines the various approvals and clearances granted by the Buyer for those items requiring qualification.

Approvals are only "type approvals" and do not relieve the Seller of the responsibility for ensuring that each individual item produced complies with requirements of this purchase order, design control media, the general requirements document, and is suitable for its intended use.

In order to avoid program delay it is sometimes necessary for the Buyer to grant interim approval (clearance) to authorize receipt and/or use of a limited number of items prior to the issuance of tentative or final approval. These items can be conditionally accepted pending the granting of final approval.

20.2.4 DELIVERY

The Seller shall not ship cars from his final assembly plant until release of the cars has been authorized in writing by the Buyer.

The Seller shall be responsible for making all necessary arrangements, including labor and materials at his own expense for shipping the entire car order, spare apparatus and documents from his final assembly plant to the HSGTC at Pueblo, Colorado. They shall be placed on rails ready to operate.

20.2.5 ACCEPTANCE

Upon delivery of each car, and after successful completion of all systems tests, and if the cars have been completed and delivered in accordance with the requirements of this specification, a Certificate of Acceptance will be issued by the Buyer to the Seller certifying the acceptance and the date of acceptance.

20.2.6 DELIVERABLE ITEMS

Item 1. Two Rapid Rail Transit "A" Cars

Item 2. System tests to be conducted at HSGTC, Pueblo, Colorado.

Item 3. Spare parts to support system tests and operational demonstrations.

Item 4. Unique maintenance and support equipment.

Item 5. Maintenance and operational demonstration support services.

Item 6. Maintenance, Repair and Operating Manuals.

Item 7. Reports consisting of:

7.1 Monthly Progress Reports
7.2 Draft Final Report
7.3 Final Report
7.4 Other data as set forth in Boeing Vertol RFP 8-3045-1-1209 dated 7/6/71.

20.3 PRECEDENCE OF DOCUMENTS

20.3.1 The intent of the contract drawings and specifications is to describe complete items to be procured. When the contract drawings or specifications describe items in general terms but not in complete detail, the best general practice shall be followed and only materials and workmanship of first class quality shall be used.

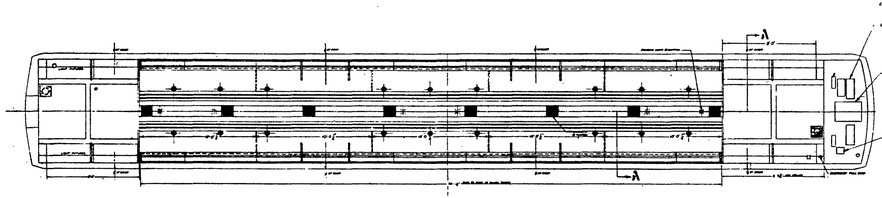
20.3.2 In the event of discrepancies between the specifications and the drawings, the specifications shall be used.

20.3.3 In case of differences between small and large-scale drawings, the large-scale drawings shall govern. Schedules on drawings shall take precedence over conflicting notations on drawings. In the event of discrepancy between any drawing and the figures written thereon, the figures, unless otherwise directed, shall govern over scale dimensions.

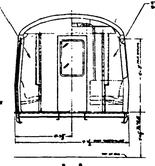
APPENDIX I

DRAWINGS

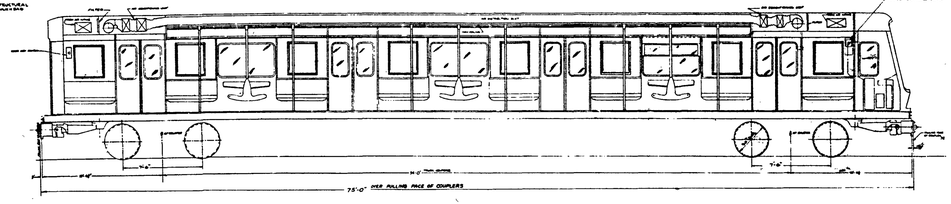
GENERAL ARRANGEMENT
HIGH DENSITY CAR

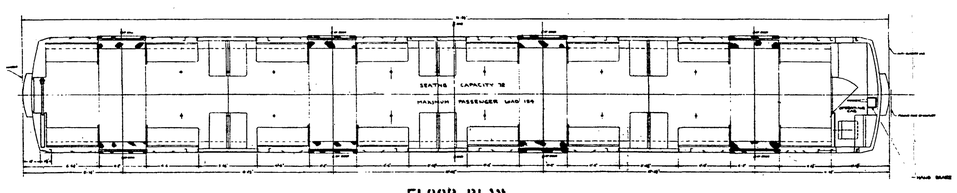


CEILING PLAN

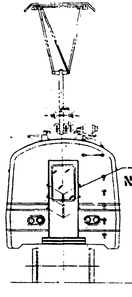


A-A





FLOOR PLAN



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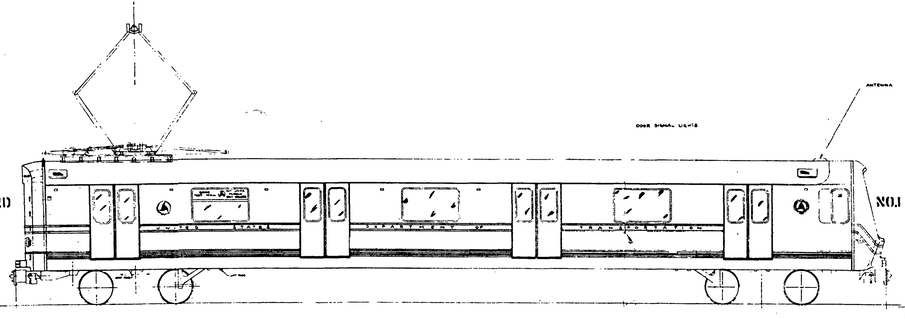

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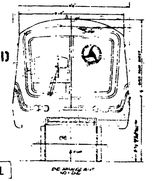
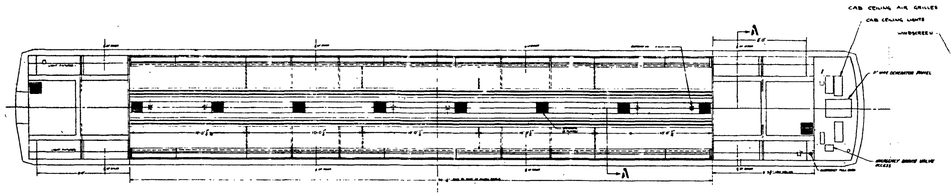


D-1

GENERAL ARRANGEMENT
LOW DENSITY CAR



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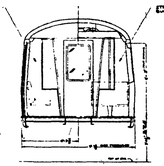
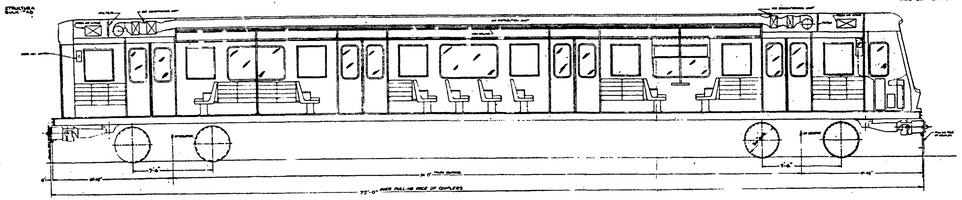
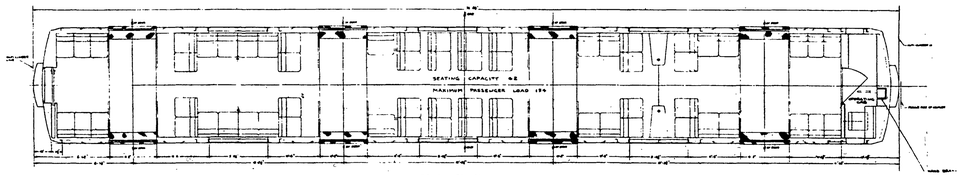
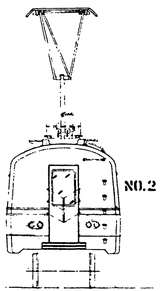


A-A





FLOOR PLAN



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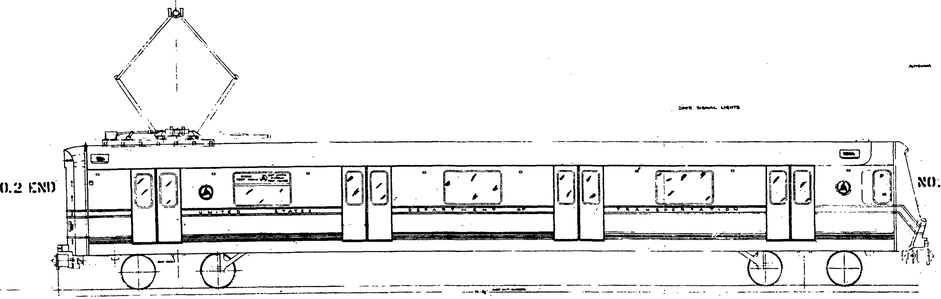

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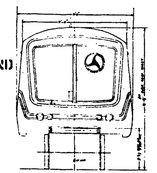
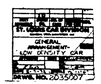
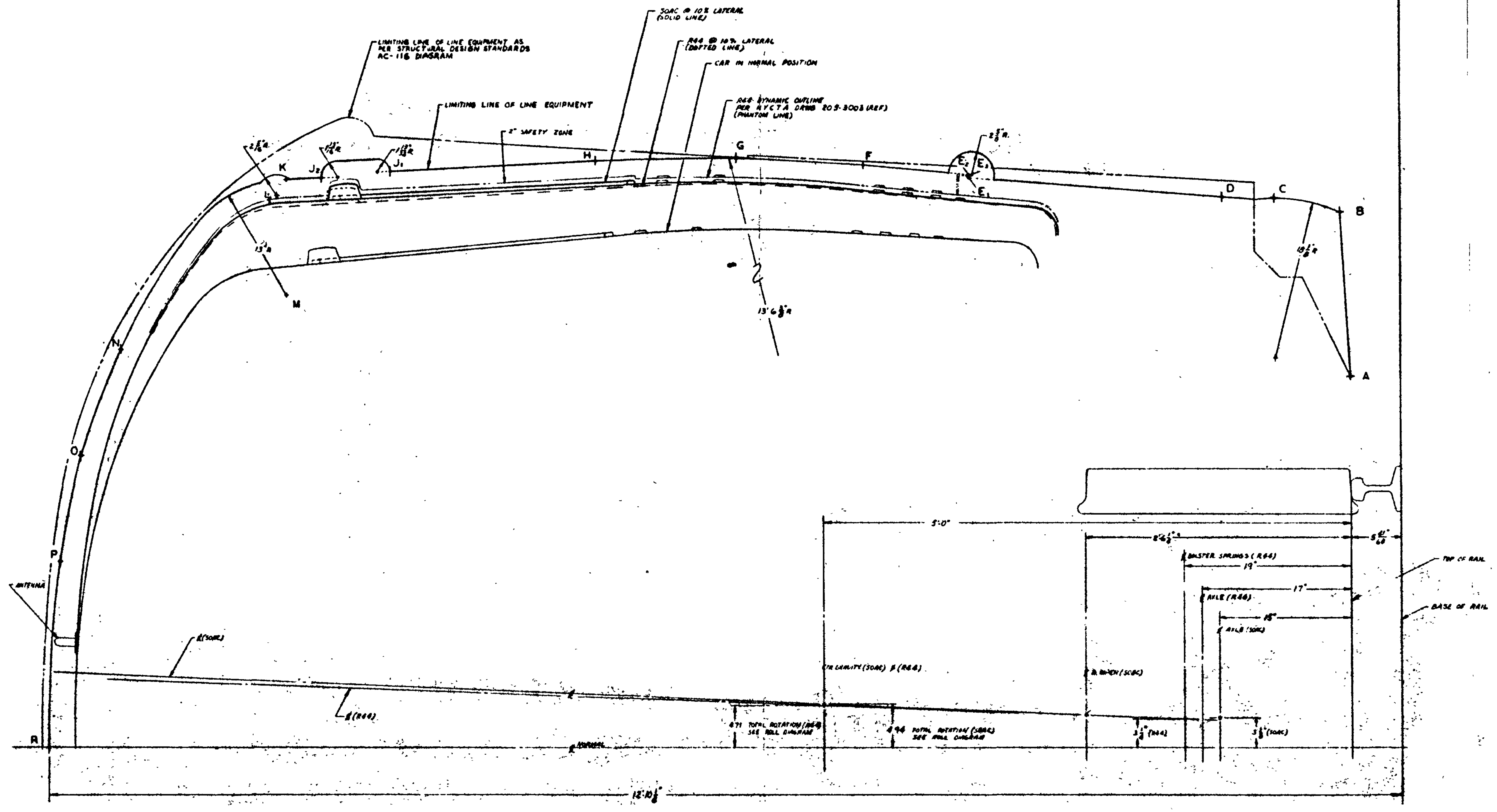
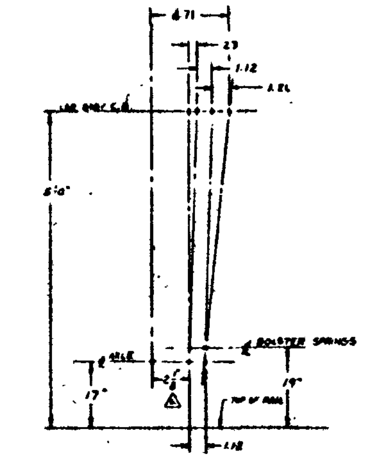


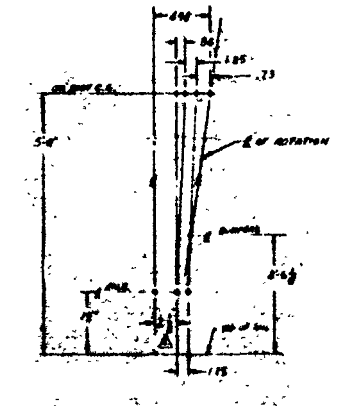


D-2





R44 ROLL DIAGRAM



SOAC ROLL DIAGRAM

	DIMENSIONS PLOTTED FOR LIMITING LINE OF LINE EQUIPMENT	
	FROM ℄ CAR	FROM BASE OF RAIL
A	3'-6"	0'-5[illegible]"
B	5'-0[illegible]"	0'-6[illegible]"
C	5'-[illegible]"	1'-2[illegible]"
D	5'-2[illegible]"	1'-8[illegible]"
E1	5'-4[illegible]"	4'-0[illegible]"
E2	5'-4[illegible]"	4'-0[illegible]"
E3	5'-4[illegible]"	4'-0[illegible]"
F	5'-5[illegible]"	5'-0[illegible]"
G	5'-6[illegible]"	6'-3[illegible]"
H	5'-6[illegible]"	7'-7[illegible]"
J1	5'-5[illegible]"	4'-6[illegible]"
J2	5'-4[illegible]"	10'-[illegible]"
K	5'-[illegible]"	10'-6[illegible]"
L	5'-2[illegible]"	10'-7[illegible]"
M	4'-3[illegible]"	10'-6[illegible]"
N	[illegible]'-9"	12'-1[illegible]"
O	2'-9"	12'-6[illegible]"
P	1'-9"	12'-8[illegible]"
R	0'-0"	12'-10[illegible]"

NOTES:

WHEEL & TRACK CONDITIONS COMMON TO SOAC & R44

1. WEAR ON WHEEL FLANGE — 3/8"
2. CLEAR BETWEEN NEW FLANGE & RAIL — 3/16"
3. VARIATIONS IN TRACK GAUGE — 1/2"
4. CONSTRUCTIONAL VARIATIONS — 1/2"

$1\frac{[illegible]}{16}$"

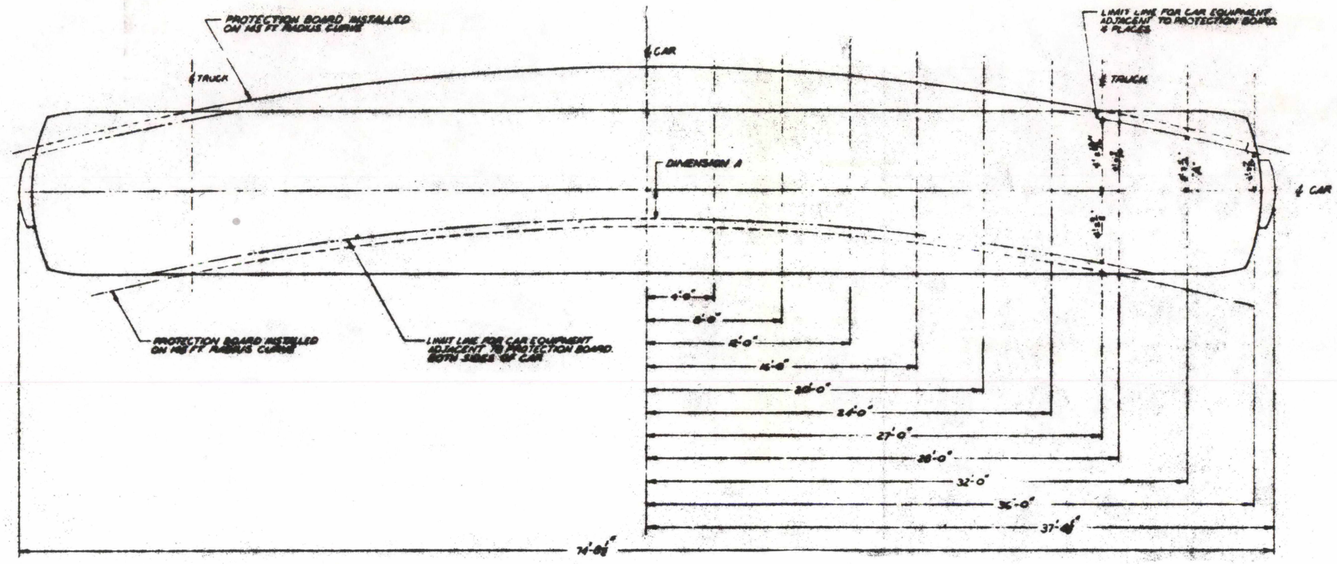
5. LATERAL DUE TO CAR NOSING (SE-DISPLACEMENT AT CORNER OF CAR DUE TO 1[illegible]" DISPLACEMENT AT BOLSTERS IN OPPOSITE DIRECTION.) — 7/16"

△ TOTAL LATERAL MOVEMENT $2\frac{1}{8}$"

DYNAMIC CLEARANCE DIAGRAM

D-3

ST. LOUIS CAR DIVISION
DYNAMIC CLEARANCE DIAGRAM 75'-0" SOAC CAR
DRWG. NO. 2895016



EQUIPMENT ENVELOPE		R44 AND SOAC			R44		R44 AND SOAC	SOAC	
SOAC DIM F	SOAC DIM E	DIMENSION A			DIMENSION B	DIMENSION C	200' VERT CURVE	DIM B	DIM C
		DISTANCE FROM ℄ CAR TO ℄ TRUCK	EQUIP. LIMIT LINE - INSIDE OF CURVE	EQUIP. LIMIT LINE - OUTSIDE OF CURVE	HEIGHT FROM TOP OF RAIL	HEIGHT FROM TOP OF RAIL		HEIGHT FROM TOP OF RAIL	
19 7/16	22 1/4	0'-0"	19 1/8 A	A	10 3/16"	10 7/16"	1 24/64	17 7/8"	10 1/8
19 7/16	22 3/16	4'-0"	20 3/16		10 5/32"	10 13/32"	1 5/32	17 27/64	10 3/32
19 3/16	22 13/16	8'-0"	22 1/8		10 1/32"	10 9/32"	1 3/32	17 23/64	9 31/64
19 3/16	22 11/16	12'-0"	21'-1 1/8"		17 31/32"	10 3/32"	1 1/64	17 7/64	9 29/64
20 1/16	22 7/16	16'-0"	21'-0 3/8"		17 7/16"	9 13/16"	1 1/32	17 1/4	9 1/2
20 15/16	23 3/32	20'-0"	21'-0 1/8"		17 7/32"	9 15/32"	25/32	16 27/64	9 3/64
20 7/16	23 5/16	24'-0"	21'-0 1/8"		16 29/32"	9 1/64"	12 1/2	16 1/2	8 31/64
21 1/4	23	27'-0"	21'-0 1/8"	4'-3 13/16"	16 7/16"	8 11/16"	—	16 1/16	8 3/8
		28'-0"	A	4'-0 3/4"					
		32'-0"		3'-8 11/16"					
		36'-0"		2'-3 7/16"					

NOTES:

1. "A" DIMENSIONS INDICATE THE MAXIMUM MEASUREMENTS FROM THE LONGITUDINAL CENTER LINE OF THE CAR TO THE LIMIT LINE OF CAR EQUIPMENT ADJACENT TO THE PROTECTION BOARD. THESE DIMENSIONS INCLUDE A LATERAL DEFLECTION CONSISTING OF 7/8" PLAY IN TRUCK PLUS 1 1/2" SWING IN THE BOLSTER: TOTAL = 2 3/8". (NYCTA = 3 3/4" TOTAL)
2. "B" DIMENSIONS INDICATE THE MINIMUM MEASUREMENTS FROM TOP OF RAIL TO THE LIMIT LINE OF CAR EQUIPMENT ABOVE THE PROTECTION BOARD. THESE DIMENSIONS INCLUDE THE FOLLOWING VERTICAL DEFLECTIONS:

	NYCTA R44	SOAC
BOLSTER SPRINGS MAX. DEFLECTION	2 3/4"	2
EQUALIZER SPRINGS SOLID	1 1/2"	1 1/2
SIDE BEARING CUSHION	1/4"	1/4
BOLSTER SPRING CUSHION	—	—
EQUALIZER SPRING CUSHION	1/16"	—
EQUALIZER DAB CUSHION	1/16"	3/16
WHEEL WEAR HEIGHT ADJUSTMENT (AT 1/2 APPROX. WEAR)	1/2"	1/2
RAIL WEAR	1/2"	1/4
TIE DEPRESSION	1/2"	1/4

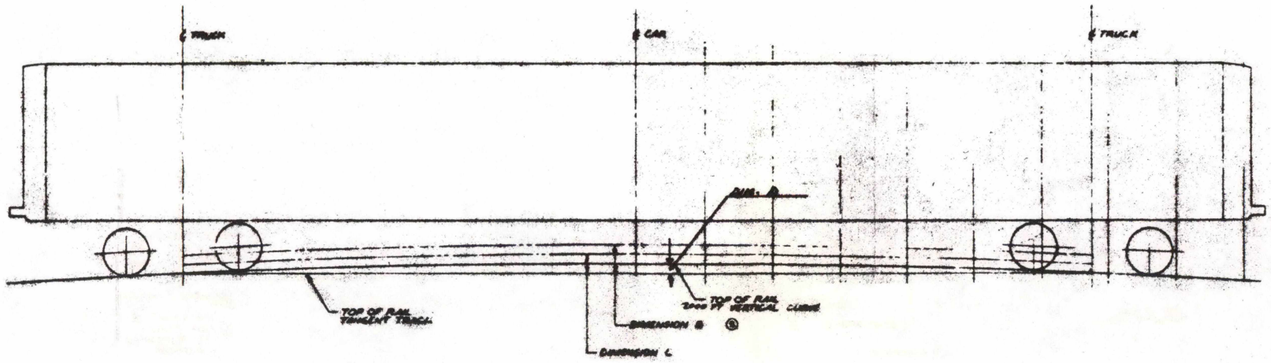
3. "C" DIMENSIONS INDICATE THE MINIMUM MEASUREMENTS FROM THE TOP OF RAIL TO THE LIMIT LINE OF CAR EQUIPMENT UNDERNEATH THE CAR. THESE DIMENSIONS INCLUDE THE FOLLOWING VERTICAL DEFLECTIONS & ALLOWANCES:

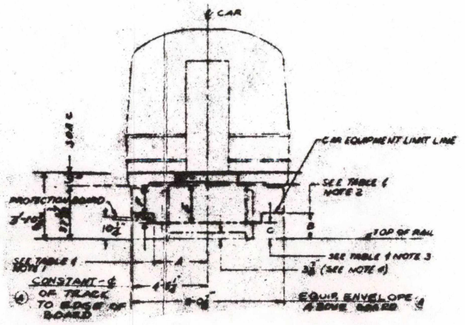
DEFLECTIONS SAME AS IN NOTE 2	2 1/2"	2 1/2 PER TOL FOR SOAC
TRACK TOP	1/2"	1/2

4. 3" DIMENSION IS THE MINIMUM MEASUREMENT FROM THE TOP OF RAIL TO THE LIMIT LINE OF TRUCK EQUIPMENT HUNG ON THE AXLE & INCLUDES THE FOLLOWING DEFLECTIONS & ALLOWANCES:

WHEEL WEAR	1/2"	1/2
TIE DEPRESSION	1/2"	1/2
RAIL WEAR	1/2"	1/2
SWITCH HOUSING	1/2"	1/2
MINIMUM CLEARANCE	1/2"	1/2
	3"	3

REFERENCE:
DWG. T2080-8 ASSEMBLY OF 150 LB. CONTACT RAIL & PROTECTION BOARD } TRACK DIVISION (NYCTA)





CAR EQUIPMENT CLEARANCES
DWG. NO. 2D 45044