STATE OF CALIFORNIA
Department of General Services - Office of Procurement
PURCHASE ORDER

Form GSOP 1-PIN (04/98)

Purchase Order No.	Rev.	Date
62214		6/30/2008

Supplier No.	Solicitation No.	Delivery Date	FOB Point	Invoice Terms
811868	56811	As Specified	Destination	

KUSTOM SEATING UNLIMITED
3000-3003 MADISON STREET
BELLWOOD, IL 60104-2219

Phone: 708-547-7000

Ship To:
DEPT. OF TRANSPORTATION
DIVISION OF RAIL MS 75
1415 11TH ST
SACRAMENTO, CA 95814
Attn: LEO HOYT 916 654-6327

Charge To:
DEPT. OF TRANSPORTATION
DIVISION OF RAIL
1120 N ST RM 3400
SACRAMENTO, CA 95814

Agency Billing	Agency Purchase Estimate	Purchase Estimate	Revision
60011	22-0434KM	67026	1

Agency Contact	Phone	Date Received
KATIE MCCLAIN	916-227-5668	

Item No.	Quantity	Unit	Commodity Code	Description	Unit Price	Extension

THE GENERAL PROVISIONS FOR NON-IT COMMODITIES ARE HEREBY INCORPORATED BY REFERENCE. THESE GENERAL PROVISIONS CAN BE OBTAINED BY PHONING (916) 375-4400 OR BY ACCESSING OUR WEBSITE AT:

www.documents.dgs.ca.gov/pd/modellang/GPnonIT0407.pdf

THE FOLLOWING INFORMATION IS PROVIDED FOR AGENCY USE ONLY:

PRIME CONTRACTOR: NS

FISCAL YEAR: 2007/2008

FOR THE PURPOSE OF THIS AWARD, ONLY F.O.B. Destination will be accepted.

This Purchase order has been registered into the state contact and procurement registration system (https://www.scprs.dgs.ca.gov/). The registration number is:

NOTE: Attachments accompany this PO as follow:

SPECIFICATIONS
ATTACHED - FEDERAL RAILROAD ADMINISTRATION (FRA) REVISION 2.

- 9-101, REVISION E (RAILCAR SEATS), DATED JUNE 10, 2008.
- 9-103, REVISION C.1 (SEAT FABRIC), DATED MAY 6, 2008
- DRAWINGS- TITLED, SEAT TRACK REFERENCE DIMENSIONS, REVISION A.

This purchase order covers the estimated two (2) year requirements of of the State of California, Department of Transportation (DOT) for RAILCAR SEATS . The contract resulting from this purchase order will be a MANDATORY contract for the effective period.

Item No.	Quantity	Unit	Commodity Code	Description	Unit Price	Extension
1	824	EA	2240-999-9910-4	RAILCAR COMPONENT (AS DESCRIBED) 2P STANDARD SEAT ASSEMBLY	3,652.0000	3,009,248.00
2	83	EA	2240-999-9910-4	RAILCAR COMPONENT (AS DESCRIBED)	2,964.0000	246,012.00

Sales and/or use tax to be extra unless noted above

Buyer	Phone	BOC Number
EVONNE ROGERS	916-375-4346	

STATE OF CALIFORNIA

Department of General Services - Office of Procurement

PURCHASE ORDER CONTINUATION

Form GSOP 2-PIN (04/98)

Purchase Order No.	*Revision*	*Date*	*Supplier No.*	*Supplier Name*
62214		6/30/2008	811868	KUSTOM SEATING UNLIMITED

Item No.	*Quantity*	*Unit*	*Commodity Code*	*Description*	*Unit Price*	*Extension*
				1P STANDARD SEAT ASSEMBLY		
					Total Value:	3,255,260.00

SPECIFICATION COMPLIANCE:

All products offered must conform to the attached State of California Bid Specification Number 9-101, Revision E (Railcar Seats), dated June 10, 2008. Bidders must indicate proposed Product Manufacturer, Fabric Type Offered and Lining Type Offered on the attached specification 9-103, Revision C.1 (Seat Fabric), dated May 6, 2008

Delivered products not meeting all specified requirements will be deemed non-compliant to specifications and will be returned at the contractor's expense. The contractor shall replace all rejected/ non-compliant products with fully compliant new stock, at no cost to the State.

CERTIFICATE OF COMPLIANCE:

Contractor must send a Certificate of Compliance with each shipment. The certificate shall indicate the manufacturer's lot number and must be signed by the manufacturer of the railcar seats certifying that the materials and workmanship involved complies in all respects with the requirements of this solicitation.

Products shall be free from defects that will affect the appearance and serviceability. Products shall be warranted for two years from date of purchase against defects in workmanship and materials. Contractor shall provide a warranty per the; Department of Transportation's Rail Equipment Warranty Plan.

QUANTITIES:

The State will not be obligated to purchase contractor's excess inventory if actual purchases vary from the anticipated purchasing pattern. The State reserves the right to order more or less of any line item in this purchase order.

INCREASE:

THE STATE RESERVES THE RIGHT TO INCREASE THE QUANTITY OVER THE TERM OF THE RESULTING CONTRACT FROM 907 SEATS (824 DOUBLE SEATS, 83 SINGLE SEATS) TO 2900 DOUBLE SEATS, 300 SINGLE SEATS FOR A TOTAL OF 3200 SEATS.

CONTRACT TERM:

Any contract resulting from this purchase order will be for a two (2) year term. The contract will contain an extension option for two (2) one year or portion thereof. The terms, conditions, and prices for the contract extension option shall be by mutual agreement between the successful supplier and the State. If a mutual agreement cannot be met, the contract may be terminated at the end of the current contract term and/or contract extension(s).

DELIVERY:

STATE OF CALIFORNIA

Department of General Services - Office of Procurement

PURCHASE ORDER CONTINUATION

Form GSOP 2-PIN (04/98)

Purchase Order No.	*Revision*	*Date*	*Supplier No.*	*Supplier Name*
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Item No.	*Quantity*	*Unit*	*Commodity Code*	*Description*	*Unit Price*	*Extension*

Delivery shall be made to the Department of Transportation facility within California. Delivery locations will be specified on individual orders. Delivery is to be completed in full as follows:

For Sacramento Distribution Warehouse deliveries, the contractor shall contact the warehouse by telephone at (916) 324-1190 or by fax at (916) 322-7016 at least two (2) working days in advance to schedule a delivery time. Unscheduled deliveries are subject to rejection. The warehouse accepts deliveries from 7:00 AM to 12:00 PM and from 12:30 PM to 3:00 PM Monday - Friday, except for State holidays. The Warehouse(s) address is as follows:

Amtrak Material Control
Oakland Maintenance Facility
1303 3rd St
Oakland, CA 94607

Amtrak Material Control
Los Angeles Maintenance Facility
2460 Enterprise St
Los Angeles, CA 90021

Stanton Hunter
Rail Passenger Car Technology Branch
Caltrans Division of Rail
916-761-5205 (mobile)

Note: In accordance with Paragraph 15 of the General Provisions entitled "Delivery," the contractor shall strictly adhere to the delivery terms and completion schedule as specified in this solicitation. Failure to comply with the delivery requirements, as stated, may be considered a breach of contract and subject the contractor to General Provisions 26, entitled "Rights and Remedies of the State for Default."

PACKAGING:

The items shall be individually wrapped in plastic. Each individually wrapped package shall have a label permanently affixed to the top portion, front exterior of the package. Each label shall indicate the following information: commodity description and CalTrans number (CT#).

All packaging and shipping cartons shall conform to applicable Federal and State Regulations and conform to standards of the industry. Exterior of the carton shall indicate product and quantity.

Delivery will be made in cartons durable enough to withstand shipping. Shipments that require palletizing shall be in accordance with the attached State of California wooden pallet specification 3990-01A-01. The size of the pallets shall be 42" x 42." Palletized cartons shall be shrink-wrapped and be placed such that the pallet load can be identified from any of the four sides.

MARKING:

Each carton shall be labeled with the commodity description, serial numbers, quantity, and manufacturer's name. Per submittal list.

CONTRACTOR RESPONSIBILITY:

STATE OF CALIFORNIA

Department of General Services - Office of Procurement

PURCHASE ORDER CONTINUATION

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Item No.	*Quantity*	*Unit*	*Commodity Code*	*Description*	*Unit Price*	*Extension*

1. Contractor shall perform all deliveries to facilities in a safe and professional manner. Contractor's equipment shall be in good working order and all personnel shall be trained in safety measures to preclude accidents endangering personnel or property.

2. Contractor must commit to delivery as requested at time stated on accepted orders, through the term of the contract.

3. Contractor shall provide office and personnel resources for responding to requests, including telephone coverage weekdays during the hours of 8:00 AM through 5:00 PM (PST).

This purchase order is being awarded on September 26th, 2008 pursuant to Government Code Section 13332.17. Any encumbrances made pursuant to this purchase order shall be construed to have been made on the last day of the preceding fiscal year.

CHANGE ORDERS:

This Purchase Order may be amended, modified or terminated at any time by mutual agreement of the parties in writing. Change orders amending, modifying or terminating the Purchase Order, including any modifications of the compensation payable, may be issued only by the State Procurement Officer. All such change orders shall be in writing and issued only upon written concurrence of the supplier. Termination, as that term is used in this section, does not include termination for default of the supplier.

9. APTA SS-C&S-016-99, Rev. 2 (Draft) Standard for Row-to-Row Seating in Commuter Rail Cars

Originally Approved March 4, 1999
Revision 1 Approved October 30, 2002
Revision 2 Approved XX-XX-XXXX
APTA PRESS Task Force

Authorized March 17, 1999
Revision 1 Authorized January 11, 2003
Revision 2 Authorized XX-XX-XXXX
APTA Commuter Rail Executive Committee

Abstract: This standard contains design guidelines, recommendations and requirements for the procurement, design, strength and testing of Passenger Seating Equipment for use in commuter rail.

Key Words: ATD, crashworthiness, injury, seat, seating

Participants

The American Public Transit Association greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of the *Standard for Row-to Row Seating in Commuter Rail Cars.*

Mike Nolan
Caroline VanIngen-Dunn
Gordon Campbell
Alexander Rechenauer

At the time that this standard was completed, the PRESS Construction & Structural Committee included the following members:

Ken Barnish, Chair

Barrie Bickle
Al Bieber
George Binns
Valerie Block
Harvey Boyd
David Bremmer
David Bremner
George Brunner
Ralph Buoniconti
Gordon Campbell
Gary Fairbanks
Glen Gardener
Liz Grimes
Michael Henderson
Ken Hesser
Kevin Hill
Leroy Jones
Larry Kelterborn
Bill Kleppinger
Steve Kokkins
Thomas Kopec
William Koran
Wayne Krahn
James Lamond
Frank Maldari
Otto Masek
Ron Mayville
James Michel
Neil Mullaney
Mike Nolan
Alain Paquet
Nicole Paulus
Tom Peacock
John Pearson
Harry Pool
Ken Reed
Steven Roman
Radovan Sarunac
Kris Severson
Vinya Sharma
Rich Shults
Tom Simpson
Phil Strong
David Tyrell
Richard Vadnal
David VanHise
Caroline VanIngen-Dunn
Bill Verdeyen
Mike Wetherell
Gary Widell
Clifford Woodbury

The following PRESS Construction & Structural Committee members contributed to Revision 2 of this standard:

Al Bieber
Michael Burshtin
Gordon Campbell
Gary Fairbanks
Leo Hoyt
Stan Hunter
Kari Jacobsen
Bill Lydon
Frank Maldari
Lowell Malo
Ron Mayville
Eloy Martinez
Mike Nolan
Tom Peacock
Michelle Priante
Kris Severson
Phil Strong
David Tyrell
Gary Widell
Clifford Woodbury

Summary of Revision 2 Changes

The following list describes the principal changes that were made to this standard as part of Revision 2:

- Added neck injury criteria for forward-facing ATDs in dynamic sled tests described in section 5.2.
- Added explicit reference to Walkover seatback attachment requirement in section 4.4.
- Added requirement for positive seat securement indicator for rotating seats in section 4.7.
- Added the same test requirements for rear-facing dynamic test as for forward-facing dynamic test in section 5.2, including head, chest, femur, and neck injury criteria.
- Require Hybrid III anthropomorphic test devices for dynamic tests described in section 5.2 in order to measure neck forces and moments.
- Require lateral and vertical attachment strength tests to be conducted dynamically, not statically or analytically, in section 5.3.
- Add reference to SAE AS8049 for acceptable crash pulse tolerance.
- Added a longitudinal seat attachment test using uninstrumented 95th percentile ATDs in section 5.3.4, which is intended to satisfy the requirements of Code of Federal Regulations, Title 49, Part 238, Section 233.

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APTA SS-C&S-016-99, Rev. 1 Standard for Row-to-Row Seating In Commuter Rail Cars

1. Overview

This standard gives design guidelines, recommendations and requirements for passenger seating equipment to be installed into commuter passenger rail cars that are part of the general railroad system of transportation.

This standard is intended to be used for the procurement of passenger seating equipment for new commuter passenger rail cars, and generally describes the qualifying processes, reviewing and submittal requirements and documentation associated with the procurement process.

1.1 Purpose

The purpose of this standard is to:

- Provide background information and design guidelines
- Provide nomenclature and definitions associated with passenger rail seating
- Establish minimum requirements for seat attachment strength
- Establish human injury criteria associated with seat design and application
- Specify minimum flame and smoke standards
- Specify minimum reporting requirements to demonstrate compliance with this standard.

The intent for complying with this standard is to provide and maintain an appropriate level of safety for commuter passengers, for that component of safety influenced by the seating. Due diligence to meet the intent of this standard shall be maintained.

1.2 Scope

This standard is intended to provide guidance for the design, manufacture and testing of passenger seating in passenger commuter rail cars. Portions of this standard are intended to provide details for meeting the requirements of *49 CFR Part 238.233 for Tier I Passenger Seating Equipment.*[1]

[1] For references in Italics, see Section 2.

1.3 Limitations of this standard

This standard is intended to apply to seating that is transversely mounted and facing in the same direction in the rail car such that the occupant faces the back of another seat as shown in Figure 1 and Figure 4.

Structural testing of seating and seating attachments are specified and recommended in this standard. In most cases, the standard refers to the attachment of the seat to the car structure. Where practical, a simulated section of a car structure should be used as a test fixture. Where it is not practical to provide a simulated car structure for testing, compliance for the car structure may be demonstrated by analysis or separate testing.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

49 CFR Parts 37, Transportation Services for Individuals with Disabilities (ADA)

49 CFR Parts 38, Americans with Disabilities Act (ADA) Accessibility Specifications for Transportation Vehicles

49 CFR Part 572, Anthropomorphic Test Devices

49 CFR Part 238, Federal Railroad Administration Passenger Equipment Safety Standards, October 2000

49 CFR Part 216 et al, Passenger equipment Safety Standards, Proposed Rule September 23, 1997

APTA RP-I&M-002-98, "Development Model for Rail Car Technical Documentation"

APTA SS-PS-004-99, Rev.1 "Standard for Low-Location Exit Path Marking"

FMVSS 208 Final Rule for Federal Motor Vehicle Safety Standard (FMVSS) 208 – Occupant Crash Protection

Mil-Std 1472E, Human Engineering Design Criteria for Military Systems, Equipment and Facilities

SAE AS8049, Revision A, Performance Standards for Seats in Civil Rotorcraft and Transport Airplanes

SAE ARP750, Passenger Seat Design Commercial Transport Aircraft

SAE J 899, Operator's Seat Dimensions for Off Road Self-Propelled Work Machines

SAE J 826, Devices for Use in Defining and Measuring Vehicle Seating Accommodation

SAE J 1454, Dynamic Durability Testing of Seat Cushions for Off-Road Work Machines

SAE J211-1, Surface Vehicle Recommended Practice

Technical Data Sheet, First Technology Safety Systems, 1992 for Models H3-5F-R, H3-50, and H3-95-R

2.1 Procurement specifications

This standard is intended to be supplemented by procurement specifications prepared by the Purchaser and directed to the Seat Manufacturer. These procurement specifications should, as a minimum, include:

- Expected environmental operating conditions and standards against which measurable results should be specified for conditions such as temperature ranges, humidity, salt atmosphere, ultra-violet radiation, static electricity and vibration.
- Normally used cleaning agents.
- Requirements for Aesthetic features such as:
  a) Fabric types and colors
  b) Finishes
- Format for Parts, Service and Maintenance Manual (see APTA RP-I&M-002-98 titled "Development Model for Rail Car Technical Documentation")

The procurement specifications may, at the option of the Purchaser, modify the requirements of this standard where special conditions make such modifications reasonable and do not unduly or unreasonably alter the intent of this standard with respect to the crashworthiness design of the seat and the safety and comfort of the occupant.

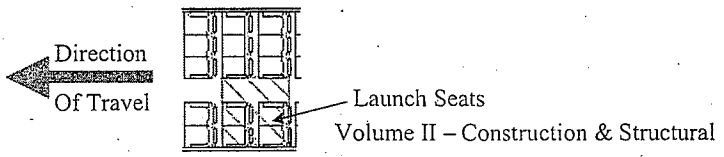
3. Definitions, abbreviations and acronyms

For the purpose of this standard the following terms and definitions apply:

3.1 Definitions

3.1.1 axial neck load, F_z: neck injury criterion indicating maximum allowable axial tension/compression force measured at the upper neck load cell.

3.1.2 compartmentalization: A strategy for seat design in which the seat provides enough stiffness to absorb all or a substantial portion of the kinetic energy of a passenger thus preventing a tertiary impact. An occupant is compartmentalized when the torso is confined within the perimeter defined by the front edge of the front row seat pan, the full width of the aisle, and the seat back surface of the launch seat. Compartmentalization is defined by the shaded area in the illustration below.



3.1.3 facing seats: Seats which are mounted in the car such that occupants face one another.

3.1.4 fixed seat: Seat which cannot be rotated, and not of the walkover type design. These seat types can only face in the direction at which they are mounted.

3.1.5 flip seat: Seats that have bottom cushions that can be flipped up to provide additional space. Flip seats are often used in areas of a car to provide wheelchair parking space.

3.1.6 g, G: An acceleration equal to 32.2 ft/sec^2 (9.8 m/sec^2)

3.1.7 H-Point: Hip Point location on the seated occupant as measured according to SAE J 826.

3.1.8 HIC: Head Injury Criterion – calculated according to the following:

$$HIC = \left[(t_2 - t_1)\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2} a(t)dt\right]^{2.5}\right]_{max}$$

where:

t_1, t_2 = Any two points in time during the head impact, in seconds

a(t) = The resultant head acceleration during head impact, in multiples of g's.

3.1.9 High Performance Photo-Luminescence: A material that is capable of emitting fluorescent and/or phosphorescent light at a high rate and for an extended period of time after absorption of light radiation from an external source by the process of photon excitation. Reference APTA SS-PS-004-99.

3.1.10 hip to knee space: A horizontal dimension from the back rest of a seat to the back of the next seat. This dimension is measured along the centerline of an occupant placement in a horizontal plane tangent to the top of the bottom cushion. See Figure 1.

3.1.11 ingress/egress space: Space available for passengers to occupy or leave an occupant space. This has importance for both normal passenger seating and also for emergency exit considerations. See Figure 2

3.1.12 lateral crash pulse: A time based acceleration curve, triangular and symmetrical in shape and having a 250 millisecond base and a 4g peak. A lateral crash pulse is in the horizontal direction and perpendicular to the normal direction of travel of the car.

3.1.13 left hand and right hand seats: Seat handedness is most easily defined by sitting in the seat. If the seat is a transverse seat and the window is on the left hand, then it is a left hand seat assembly.

3.1.14 left hand and right hand seat components: Handedness of seat components are also defined by sitting in the seat. If an armrest, for example is on the left side of the seat, then it is a left hand armrest. Seat components that are not symmetrical and only one of which can be supplied with the seat, carry the same handedness name as the seat assembly. See Figure 3 and Figure 4 for illustrations.

3.1.15 longitudinal: Descriptive of a direction parallel to the normal direction of car travel.

3.1.16 longitudinal crash pulse: A time based acceleration curve, triangular and symmetrical in shape and having a 250 millisecond base and an 8g peak. A longitudinal crash pulse is in the direction parallel to the normal direction of travel of the car.

3.1.17 Low-Location Exit Pathway Marking: Evacuation guidance for passengers and crewmembers when normal and emergency sources of illumination are obscured or inoperative. Reference APTA SS-PS-004-99.

3.1.18 N_{ij}: Neck Injury Criterion, calculated according to the following:

$$N_{ij} = \frac{F_z}{F_{int}} + \frac{M_y}{M_{int}}$$

where:

F_z = measured axial neck load

F_{int} = critical intercept values used for normalization, +1530/-1385 lbf (+6806/-6160 N)

M_y = measured flexion/extension neck bending moment

M_{int} = critical intercept value used for normalization, +229/-100 lbf-ft (+310/-135 Nm)

3.1.19 occupant: A seated passenger occupying a seat placement in a normal manner.

3.1.20 occupant placement: That portion of a seat assembly that is normally occupied by a seated passenger. For example, a two passenger seat assembly has two occupant placements.

3.1.21 passenger: A person who is within the occupied volume of a passenger rail car, whether seated or not.

3.1.22 primary impact: During a car crash, primary impact refers to the impact of the car itself.

3.1.23 purchaser: The agency or organization (transit authority or carbuilder) responsible for the acquisition of seating equipment.

3.1.24 rotating seats: Seats that are transversely mounted, and can be rotated to face the front or back of a passenger rail car.

3.1.25 row-to-row seating: Seating arrangement such that each row of seats face the same direction as illustrated in Figure 4. Also known as theater style seating.

3.1.26 seat pitch: The distance between like features on seats facing the same direction, as illustrated in Figure 1

3.1.27 seat manufacturer: The agency or company responsible for the design, specification compliance and warranty of the seat and its design.

3.1.28 shall: Practices directed by shall are required or standard practices.

3.1.29 secondary impact: During a car crash, secondary impact refers to the impact of passengers to features on the car or other passengers.

3.1.30 should or may: Practices directed by should or may are recommended practices

3.1.31 tertiary impact: Passengers who have undergone a secondary impact and have glanced off of that object to impact another object in the car.

3.1.32 tier I: Rail Equipment operated at speed not exceeding 125 mph (200 k/h) as defined in 49 CFR Part 238.

3.1.33 transverse: Descriptive of a direction perpendicular to the normal direction of car travel.

3.1.34 walkover seat: A particular type of seat design in which the seat back and bottom cushion are articulated such that the direction that occupants face can be reversed by moving the seat back longitudinally

3.2 Abbreviations and acronyms

ADA	Americans with Disabilities Act
ASME	American Society of Mechanical Engineers
ATD	Anthropomorphic Test Device (also referred to as crash test dummy - see 49CFR Part 572)
CFR	Code of Federal Regulations
FMVSS	Federal Motor Vehicle Safety Standard
HPPL	High Performance Photo-Luminescence
LLEPM	Low-Location Exit Pathway Marking
MIL-STD	Department of Defense Military Handbook
SAE	Society of Automotive Engineers
SRP	Seat Reference Point as given by SAE AS8049

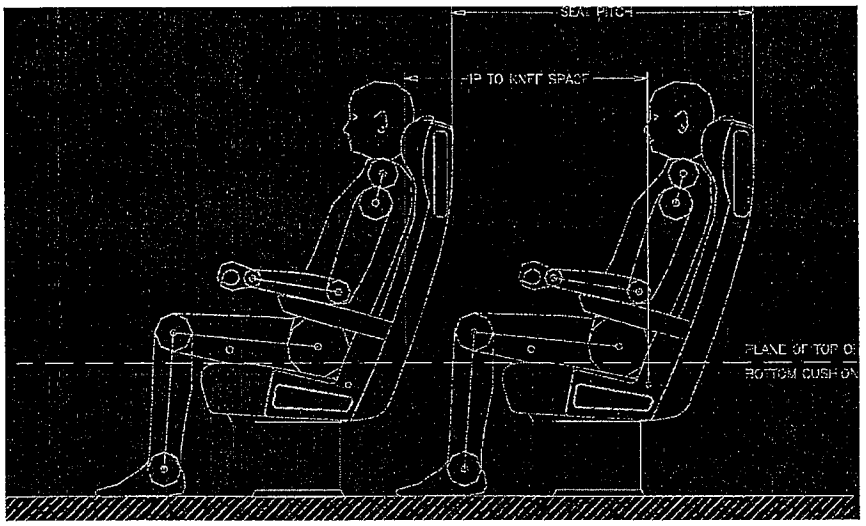


Figure 1 – Hip to Knee Space and Seat Pitch

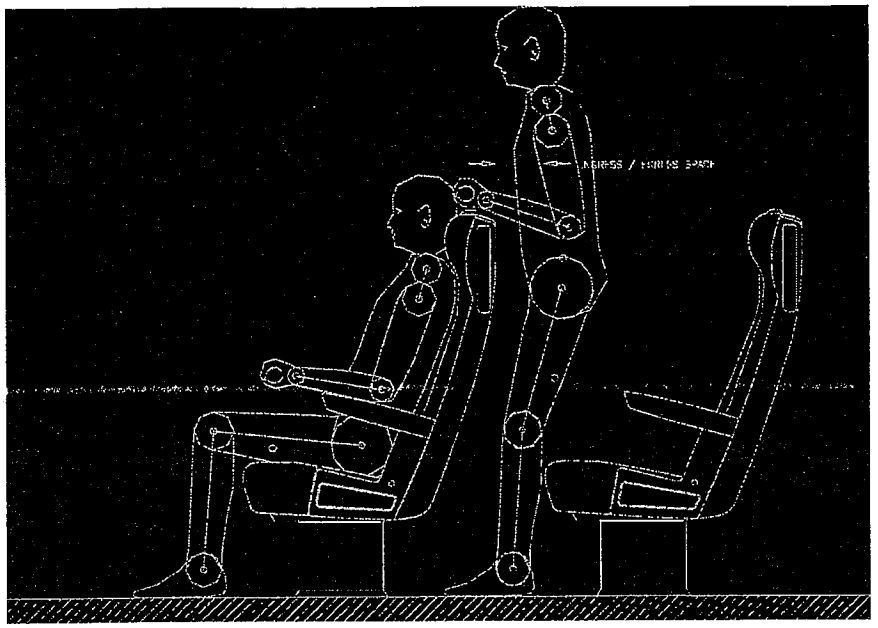
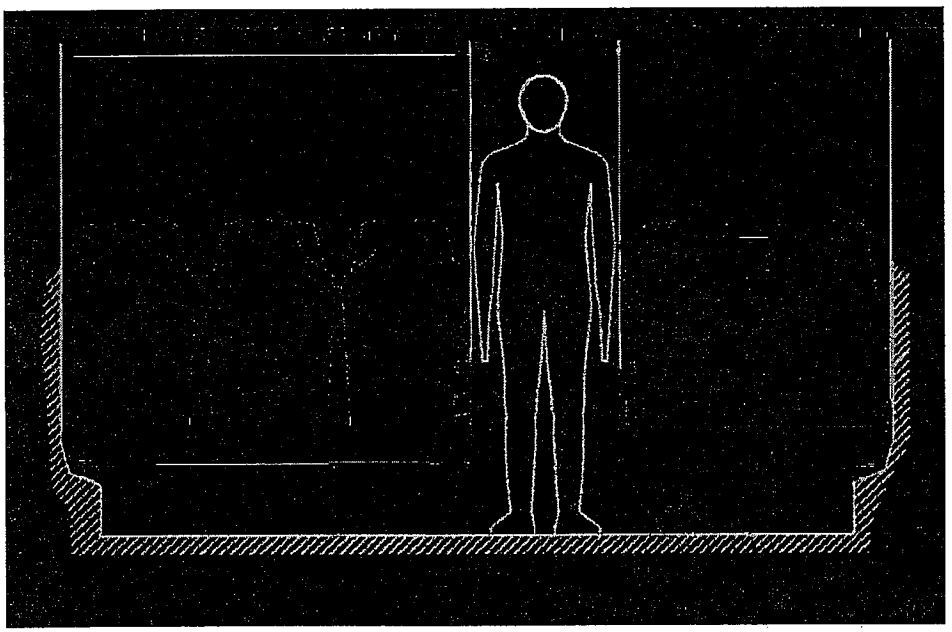


Figure 2 – Ingress/Egress Space



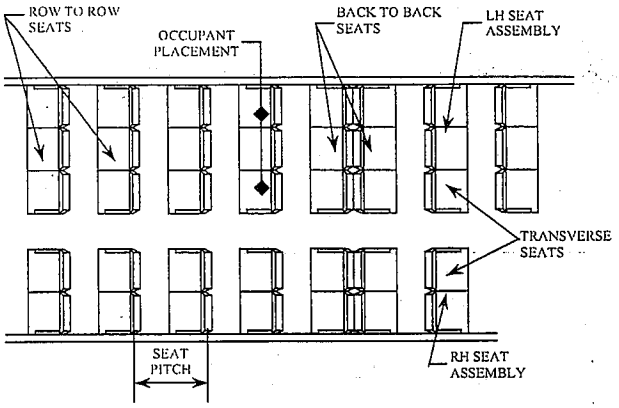


Figure 4 – Seat Arrangement and Nomenclature

3.3 Anthropomorphic test devices (ATDs)

Reference is made in this standard to a series of Anthropomorphic Test Devices (ATDs) that are designed to represent the 5th-percentile female occupant, the 50th-percentile male occupant, and the 95th-percentile male occupant. The ATDs used to meet the test requirements specified in this standard must be compliant with 49 CFR Part 572.

A table of available ATDs and their typical weights as used in testing to represent these occupant populations is given below for reference:

Table 1 – Typical Weights of ATDs

ATD	WEIGHT	
Hybrid III 5th female	110.2 lb	50 kg
Hybrid III 50th male	172.3 lb	78.2 kg
Hybrid II 50th male	168 lb	76.2
Hybrid III 95th male	223.4 lb	101.3 kg

Reference: First Technology Safety Systems, Technical data sheet, 1992 for Models H3-5F-R, H3-50, H2-50 and H3-95-R.

4. Seat design features

This section is intended to provide guidelines, recommendations and requirements regarding features commonly found on passenger rail seating equipment.

4.1 Materials and workmanship

Seating should be made of materials suitable for use in the railroad environment. All materials should be new. The seat shall be free of protrusions, sharp edges or corners that could cause injury, catch or damage the clothing of passengers or crew members. The seat should be free of rattles or loose joints that could create noise or vibration during normal operation. All parts of the seat should be interchangeable with parts of like seats. No unusual adjustments or procedures such as grinding or bending of materials should be required to replace parts that are designed to be replaced. The use of exposed fasteners should be minimized.

4.2 Industrial design

To provide a pleasing and coordinated environment within the car interior, the seat manufacturer should participate with the purchaser in a comprehensive Industrial Design Program. As part of this program the seat manufacturer should submit decorative samples of materials that form the finished exterior of the seating equipment. Human factors addressing such issues as accessibility, emergency exits, use by the elderly, hearing and sight impaired should be part of the Industrial Design Program.

Seating should be designed to comfortably accommodate the range of passengers anticipated, from the 5th percentile female to the 95th percentile male. Adequate hip to knee space should be provided for the 95th percentile male. To document the ergonomic aspects of the seat design the purchaser should ask that the seat manufacturer prepare an Ergonomic Analysis and Report as part of its work for the supply of seating equipment. Contents of the Ergonomic Analysis should address issues such as seat comfort, hip to knee space, cushion contours, armrest height, lateral passenger space, ingress-egress space, effort required to adjust and operate various seat features, and other issues involving the use of the seating equipment by passengers.

4.3 Cushions and upholstery

Cushions should be contoured to provide optimal occupant retention and comfort during normal use. Cushioning material should be durable and should be capable of passing the cushion life test described herein.

4.4 Walkover seats

Walkover seats, if provided, shall be fitted with a locking mechanism designed to prevent the seat back from moving from one extreme seating position to the other during the crash pulse shown in Figure 12. Adequacy of the lock mechanism shall be demonstrated as part of the Dynamic Sled Test given in Section 5.2. The purchaser may require additional testing of the lock mechanism according to test procedures agreed to by the purchaser and the seat manufacturer. The lock mechanism should not require any maintenance over the life of the seat. The seat back on walkover seats must be adequately fastened to the seat base such that the 4G lateral and vertical strength requirements from Section 5.3 are satisfied.

4.5 Recline

Recline mechanisms, if provided, should meet the requirements of this section. Seat back should

recline according to the dimensions specified in the Procurement Specification. Recline control should provide for infinite adjustment through the range specified. Recline mechanism design should be such that activation of the recline control does not allow a sudden change in back rest position. Reclining seat backs should return to the up position in a controlled, damped manner. Care should be taken so that reclined seats do not present obstructions for emergency egress.

4.6 Armrests

Armrests, if provided should be optimally positioned to support the range of occupants specified. The top of the armrests should be covered with a durable material as provided for in the Procurement Specifications. Armrests shall be capable of passing the Armrest Strength Test given in Section 5.1.4.

4.7 Rotation

Seat rotation, if provided should be 180 degrees. A lock capable of passing the anti-rotation test described in Section 5.3.1 shall be provided in both extreme positions. A seat securement system is required to prevent the disengagement and undesired rotation of seats. The system shall have a positive seat securement indicator that makes clear to rail operators as well as passengers whether or not the rotating seat is in a locked and secured position. The rotation mechanism should operate smoothly. Lateral offset of the rotation mechanism or seat mounting geometry should be sufficient to allow two passenger seats to be placed close to the wall for maximum aisle width. Single passenger seats may be mounted some distance from the wall to provide rotation clearance and may not have an offset feature as part of the rotation mechanism.

5. Seat testing

Seating equipment shall be subjected to a series of static, dynamic and durability tests to verify that the requirements given in this section are met. Testing shall be conducted on seat assemblies or components that are representative of seating equipment to be delivered.

5.1 Static strength testing

The purpose of static seat strength testing is to verify that the seat structure and its components meet the various loading conditions that are expected in commuter passenger rail operation. The testing should be conducted on representative samples of various configurations of the seats supplied. For example, if the supply of seating includes one, two and three passenger seats then each should be tested. Where, however, sufficient similarity between seat types exist, the purchaser and manufacturer may jointly agree to apply the results of testing to various seat types.

In general, static testing can be performed on the structural parts of a seat assembly, usually the seat frame, pedestal and other mounting equipment and hardware. Where concern exists that non-structural components can be damaged by the stresses and flexing of structural components, they may be included in the testing.

Seat frames and components shall be designed and tested to meet the individually applied static load requirements given below with no yielding of structural materials, loss of function or change in appearance of the seat or component. A small amount of yielding due to relieving of trapped manufacturing stresses (welding, forming, etc.) shall be permissible. Seats to be tested

should be mounted on a simulated car structure and all components comprising the attachment to the car shall be included. Where it is not feasible to use a simulated car structure, a rigid base may be used.

5.1.1 Backrest strength test

The purpose of this test is to establish the strength of the seat back for durability, especially against the effect of a passenger sitting behind this seat pushing his/her feet against the top of the seat back. Therefore, a load of 300 lb. (136 kg) per occupant shall be applied to the upper back of the seat frame at the midpoint of each seat back and at an elevation 3 inches (76 mm) below the top of the seat back and in a direction perpendicular to the seat back (reference Figure 5). This load is to be distributed across the seat back. Reclining seats shall be in the full upright position. A fixture may be used to distribute the load across the seat frame members. Load shall be applied for a minimum of 5 seconds. This test shall be repeated in both horizontal directions, from the back of the seat and from the front of the seat.

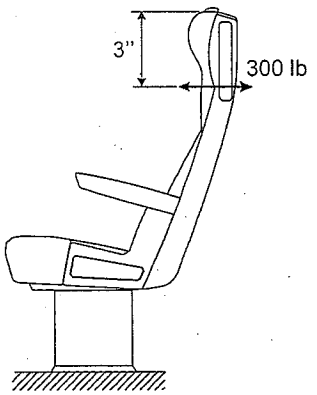


Figure 5 – Backrest Strength Test Loading Conditions

5.1.2 Grab handle strength test

A 300 lb. (136 kg) load shall be applied to the grab handle at a point near the middle of the grab handle in a longitudinal direction (reference Figure 6). Load shall be applied for a minimum of 5 seconds. This test shall be repeated in both longitudinal directions. A fixture may be used to insure that the load is properly applied and distributed onto the grab handle.

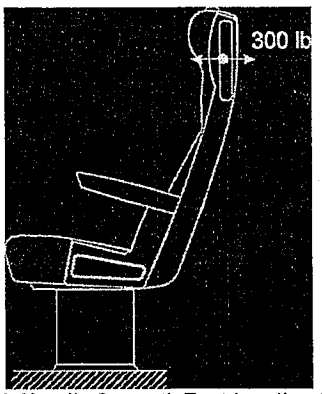


Figure 6 – Grab Handle Strength Test Loading Conditions

5.1.3 Vertical seat strength

A load of 450 lb. (204 kg) per occupant shall be applied on the seat frame near the front edge of each occupant placement in a vertical downward direction at the midpoint of each occupant position (reference Figure 7). The contact area of the applied load shall not exceed 4 square inches (26 square centimeters). The load shall be applied for a minimum of 5 seconds.

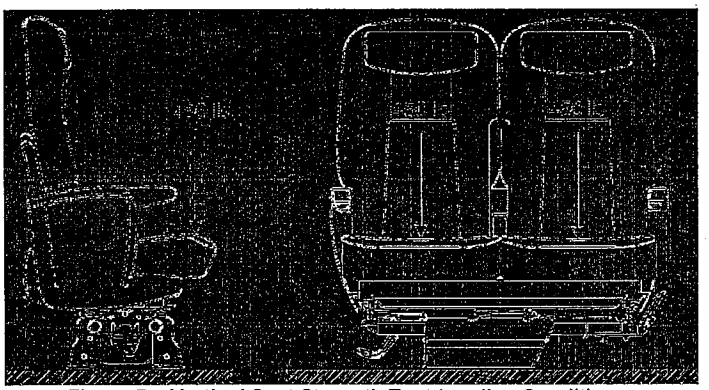


Figure 7 – Vertical Seat Strength Test Loading Conditions

5.1.4 Armrest strength

A load of 250 lb. (113 kg) shall be applied to the horizontal member of the armrest structure at a point that produces maximum stress in the member (reference Figure 8). A fixture may be used to properly apply and distribute the load. The contact area of the applied load shall not exceed 4 square inches (26 square centimeters). The load shall be applied for a minimum of 5 seconds. This test shall be repeated for the two horizontal conditions (toward the aisle and toward the wall side of the seat) and then vertically downward.

For seats with folding center armrests, the folding armrest shall be tested by applying a vertical 150 lb. (68 kg) load as near as practical to the end of the armrest. Separately, a horizontal 150 lb. (68 kg) load shall be applied as near as practical to the end of the armrest. The horizontal load test shall be repeated for both directions. The contact area shall not exceed 4 square inches (26 square centimeters) in all cases.

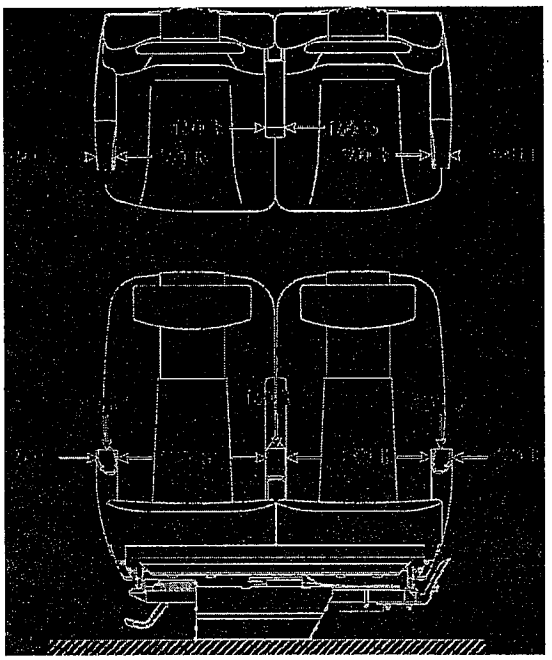


Figure 8 – Armrest Strength Test Loading Conditions

5.1.5 Footrest test

With footrest deployed in the most nearly horizontal position, a 400 lb. (180 kg) load shall be placed on the diagonal center of the footrests surface (reference Figure 9).

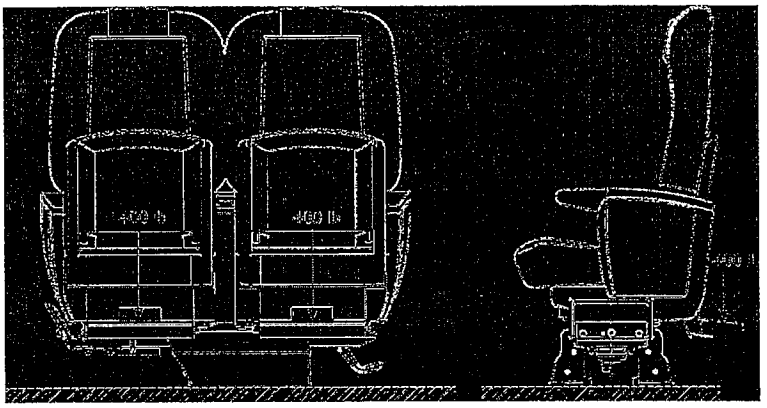


Figure 9 – Footrest Strength Test Loading Conditions

5.1.6 Legrest test

With the legrest assembly in the most nearly horizontal position, place a 65 lb. (30 kg) load distributed over an area of 25 square inches (160 square centimeters) on the diagonal center of the legrest cushion (reference Figure 10). This test is intended for footrests that have a load limiting feature to prevent passengers from using it as a step stool. Overloading of these types of footrests shall not result in structural failure or sudden drop of the load.

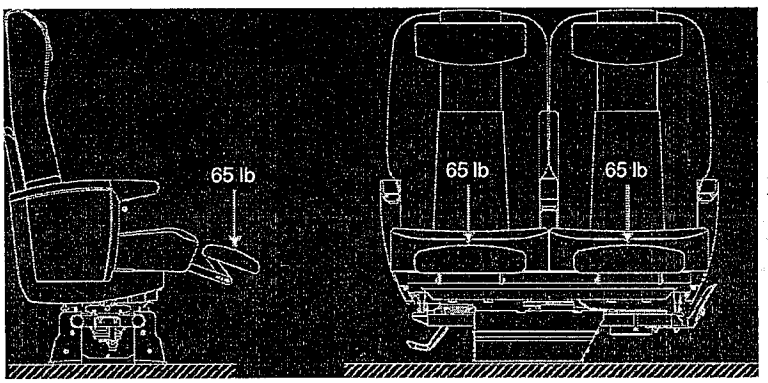


Figure 10 – Legrest Strength Test Loading Conditions

5.1.7 Tray table test

With the tray table mounted to the seat in deployed and extended position, place a 5 lb. (2.2 kg) load distributed over an area of 25 square inches (160 square centimeters) upon the diagonal center of the tray and let it remain for 10 seconds to determine the pre-load height from a reference location (reference Figure 11). Add an additional 17 lb. (7.7 kg) to the 5 lb. pre-load and let it remain for 10 minutes. The maximum temporary deflection from the reference position should not exceed 1 inch (19 mm).

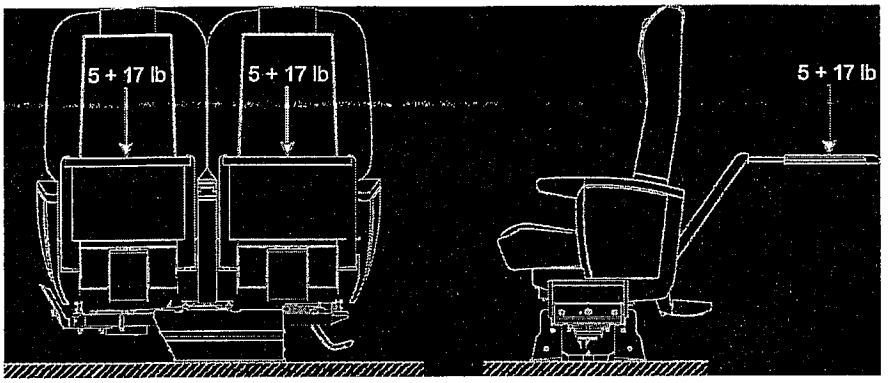


Figure 11 – Tray Table Strength Test Loading Conditions

5.2 Dynamic sled testing

The primary objectives of the dynamic sled tests in this section are to simulate a rail car crash and verify the following:

- That seat assemblies remain attached to the car
- That all seat components, including cushions, remain attached to the seat assembly
- That the seat effectively compartmentalizes the occupants
- That the seat does an effective job of minimizing human injury

There are two dynamic sled tests prescribed to measure these objectives. Each test consists of two row-to-row seats with instrumented Hybrid III 50th percentile male ATDs that will be used to simultaneously measure the seat's structural strength and human injury potential. In one test the seats and ATDs will be forward-facing. In the other test the seats and ATDs will be rear-facing.

If a seat of largely similar design to the subject seat has been previously subjected to these prescribed dynamic sled tests, then the manufacturer may provide data from these previous tests to satisfy the corresponding portion of these requirements, for approval of the subject seat by the purchaser. Due diligence to meet the intent of this standard shall be maintained.

5.2.1 Forward-facing seat attachment and human injury test

This test shall use two transversely mounted rows of seats so that occupants are facing seat backs and facing the direction of travel. If seats contain adjustable features such as recline, tray tables, footrests, these should be placed in the upright and stowed positions.

The ATDs shall meet the standards and requirements needed to comply with *49 CFR Part 572, SubpartE*[2]. The adjustment, positioning, and care of all ATDs used in the testing processes shall be in accordance to the standards and requirements needed to comply with SAE AS8049.

Each ATD shall be clothed in a form fitting, cotton stretch garment with short sleeves, and mid-thigh-length bottoms. The ATDs shall also be fitted with shoes. Each ATD shall be seated in the center of the occupant placement, in as nearly symmetrical a position as possible and in a uniform manner so as to obtain reproducible test results. The following ATD components shall be positioned as follows:

- Back shall be placed against the seat back without clearance.
- Knees shall be separated by four inches.
- Hands shall be placed on the top of the upper legs, just behind the knees.
- Feet shall be placed flat on the floor and so that the centerlines of the lower legs are approximately parallel.
- Lower legs shall be placed as close to vertical as possible.

The ATDs may be tethered to the sled, however tethering shall not restrict ATDs such that evaluation of compartmentalization is impeded.

Seats shall be subject to the following test:

- Two rows of seating shall be tested with the rear row of seats fully occupied by Hybrid III 50th percentile male ATDs, one ATD per seating position. All the ATDs shall be instrumented with head, chest, neck, and femur transducers.
- Seats shall be mounted on a rigid test fixture or simulated car mounting and at the predominant seating pitch for the seat's application.
- Seats shall be subjected to an 8g, 250 millisecond crash pulse as shown in Figure 12. The crash pulse shall comply with the requirements established in SAE AS8049 Revision A, Appendix A.

[2] For references in Italics, see Section 2

- High-speed photography shall record the occupant kinematics and assess compartmentalization effectiveness.

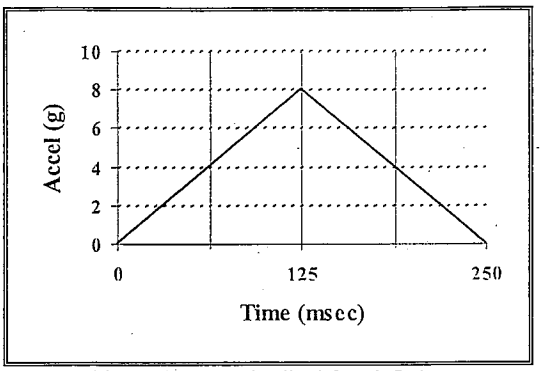


Figure 12 - Longitudinal Crash Pulse

Seat structural assessments shall include: Seats may deform but shall not tear loose from their mountings. Seat components shall not tear loose and become separated from the seat assembly such that the components become projectiles.

Human injury assessments shall include observing the compartmentalization capability of the seat back. The seat back shall compartmentalize the ATDs. After testing, the seat backs shall not be collapsed to such an extent that they present an impediment to emergency egress.

Human injury measurements shall not exceed the head, chest, neck, and femur injury criteria listed for the 50th-percentile ATD in Table 2. The injury criteria shall be calculated from test data that has been filtered in accordance with SAE J211-1, Table 1.

Table 2 – Human Injury Limits for 50th-percentile Male ATD

Criterion[3]	Maximum Value
HIC_{36}	1000
or HIC_{15}	700
Chest acceleration	60g over 3ms
Neck Fz	+937/-899 lbf (+4170/-4000 N)
N_{ij} (see Annex B.4.3)	1.0
Axial Femur load	2,250 lbf (10000 N)

(These numbers may be revised based on future research)

5.2.2 Rearward-facing seat attachment and human injury test.

The rearward-facing test shall be conducted in exactly the same manner as the forward-facing test described in the above, except that the seats are mounted to a rigid fixture and arranged so that the ATDs are facing backwards. The structural seat and human injury assessments shall be

3 ;*Reference FMVSS 208 – Final Rule for Federal Motor Vehicle Safety Standard – Occupant Crash Protection*

the same as those for the forward-facing test above.

5.3 Additional dynamic testing

5.3.1 Anti-rotation test

On seats equipped with rotation, an anti-rotation test shall be performed to insure that during a simulated car crash, the seat does not rotate inadvertently. All rotating seats shall pass an "anti-rotation" test composed of the following criteria:

- Use a complete double seat assembly.
- A pendulum shall be swung such that the combined height and weight of the pendulum deliver a total kinetic energy of 1850 foot pounds (2508 joules) of kinetic energy to the seat at impact.
- Contact points shall be the center of each seat back, at a point 1 inch (25 mm) above the bottom plane of the rotating seat frame assembly.

The locking device shall retain the seat in its locked position after attempts have been made to drive the seat in the clockwise, then counterclockwise directions via the test described above. Permanent deformation of the rotating frame and seat back are acceptable. Additionally, the seat pedestal and sidewall mounting system (including fasteners) shall survive without failure in the above test.

As an option to pendulum testing, the purchaser and seat manufacturer may jointly agree to conduct sled tests to meet this requirement. The sled tests shall be conducted using the procedure given in Section 5.2.1, except the seat shall be occupied by one 95th male ATD placed in the seating position that maximizes the load on the locking mechanism. A minimum of two sled tests shall be conducted, one tending to drive the seat in the clockwise direction and the other tending to drive the seat in the counter clockwise direction.

5.3.2 Lateral Seat Attachment Test

The objective of this test is to insure that seat assemblies remain attached to the car structure when subjected to lateral forces resulting from a simulated rail car crash. The intent of this test is to insure that the seat remains attached to the car structure when subjected to accelerations of 4g in the lateral direction acting on the mass of the seat. This test must be performed dynamically as described below.

- The seat assembly shall be mounted to a rigid test fixture or simulated car structure, as shown in Figure 13.

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- The seat shall be subjected to a 4g, 250 millisecond triangular crash pulse as shown in Figure 14. The crash pulse shall comply with the requirements established in SAE AS8049 Revision A, Appendix A.

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- The test shall be recorded using high-speed film.

Seats may deform but shall not tear loose from their mountings. Seat components shall not tear

loose and become separated from the seat assembly such that the components become projectiles.

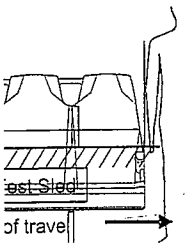

Figure 13– Seat Orientation for Lateral Seat Attachment Test

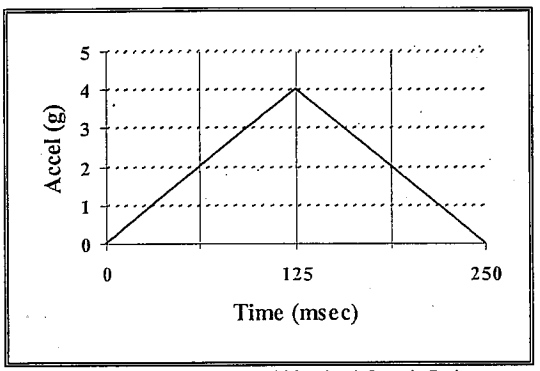

Figure 14 – Lateral and Vertical Crash Pulse

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5.3.3 Vertical Seat Attachment Test

The objective of this test is to insure that seat assemblies remain attached to the car structure when subjected to vertical upward forces resulting from a simulated rail car crash. The intent of this test is to insure that the seat and seat components remain attached to the car structure when subjected to accelerations of 4g in the vertical upward direction acting on the mass of the seat. This test must be performed dynamically as described below.

- The seat assembly shall be mounted to a rigid test fixture or simulated car structure, as shown in Figure 15.

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- The seat shall be subjected to a 4g, 250 millisecond triangular crash pulse as shown in Figure 14 above. The crash pulse shall comply with the requirements established in SAE AS8049 Revision A, Appendix A.

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- The test shall be recorded using high-speed film.

Seats may deform but shall not tear loose from their mountings. Seat components shall not tear loose and become separated from the seat assembly such that the components become projectiles.

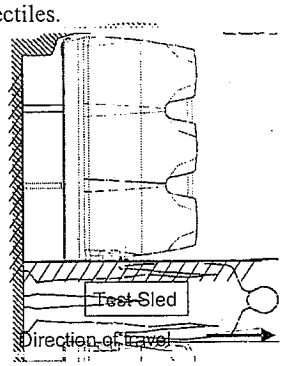

Figure 15 Seat Orientation for Vertical Seat Attachment Test

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5.3.4 Longitudinal Seat Attachment Test

The objective of this test is to insure that seat and seat components remain attached to the car structure under the following test conditions. The intent of this test is to satisfy the requirements described in the Code of Federal Regulations, Title 49, Part 238, Section 233. This test must be performed dynamically as described below.

- Two rows of seats shall be tested with the rear row of seats fully occupied by Hybrid III 95th percentile male ATDs, one ATD per seating position. The ATDs shall be forward-facing. The ATDs do not need to be instrumented.
- Seats shall be mounted on a rigid test fixture or simulated car mounting and at the predominant seating pitch for the seat's application.
- Seats shall be subjected to an 8g, 250 millisecond crash pulse as shown above in Figure 12. The crash pulse shall comply with the requirements established in SAE AS8049 Revision A, Appendix A.
- The test shall be recorded using high-speed film.

Seats may deform but shall not tear loose from their mountings. Seat components shall not tear loose and become separated from the seat assembly such that the components become

projectiles.

6. Seat durability testing

Seating and seating components should be designed to provide an optimal life as specified by the purchaser and used in the environment defined by the purchaser.

6.1 Mechanisms

Moving components and adjustment mechanisms should be tested to verify their durability. These components and mechanisms include:

- Recline
- Rotation and rotation locks
- Walkover
- Flip up Seats
- Tray Tables
- Fore/Aft Adjustment
- Other moving parts

The purchaser and seat manufacturer should jointly determine a test plan for life cycle testing of these components and mechanisms.

6.2 Cushions and upholstery

This accelerated life test is intended to simulate the wear and tear on seating upholstery. A cushion durability should be performed using SAE J 1454 as a guide. Tests should be performed on both bottom and back cushion. Test should consist of an automotive "jounce and squirm" test using a "jounce and squirm" machine similar to that shown in Figure 14. Each cushion should be subjected to the following:

- 200,000 jounce cycles @ 100 cycles per minute
- 4,000 squirm cycles @ 4 cycles per minute
- 180 lb. (82 kg.) load on bottom cushion
- 110 lb. (50 kg.) on back cushion

Jounce and squirm cycles should be applied simultaneously, although motions should be independent. Thigh and torso forms should be employed to transmit the motions to the cushions. Forms should be located as would a seated passenger, using the procedure given in SAE J 826.

As a result of testing, cushions should not show undue wear or signs of failure. Cushion

upholstery should show no signs of tearing or ripping and should remain attached to the cushion pans or structure. Upholstery stitching should show no signs of unraveling or breakage. Cushion foam should show no signs of tearing, shearing or significant loss of height.

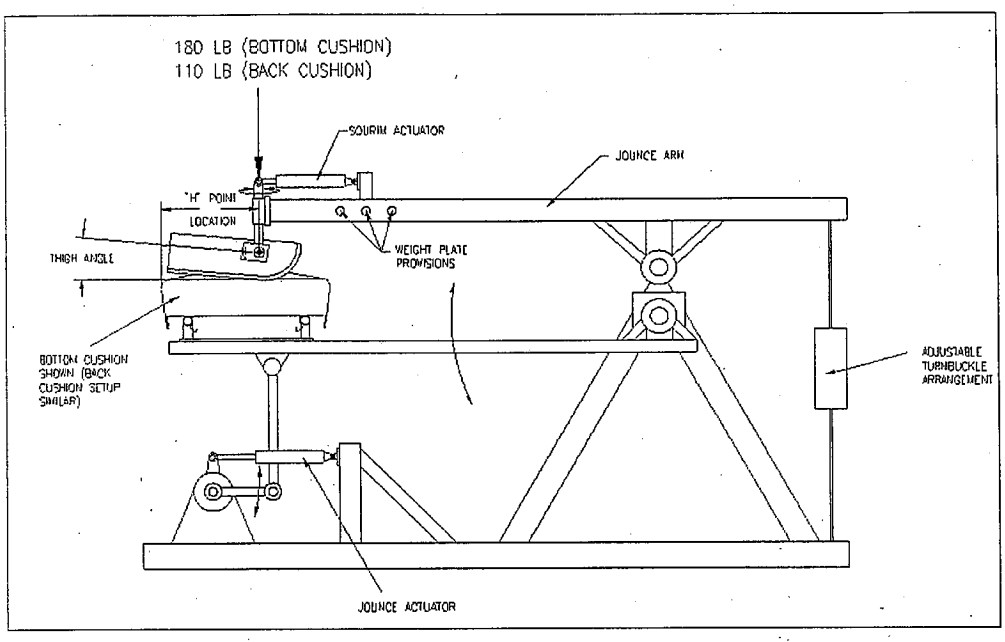

Figure 16 – Jounce and Squirm Test Machine

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7. Maintainability

The seat should be easy to maintain and clean and should require no unscheduled adjustments or lubrication for the specified life of the seat. Design of the seat should be such that parts can be replaced with the use of standard hand tools. Components of like seats should be interchangeable. Pockets where dirt and debris can collect should be minimized.

8. Test plan, procedures and reports

All seat testing performed by the seat manufacturer shall be documented with a test plan, test procedures and test reports. This shall include the procedures and reports for Static Load Tests, Seat Attachment Tests, Cushion Durability Tests and Service Life Cycle Tests.

Test plan and procedures should be submitted and approved by the purchaser prior to actual testing. Tests should be scheduled to allow the purchaser to, at his or her option, witness the testing. The purchaser may elect to accept existing test reports and procedures provided the seat to be purchased is demonstrated to be identical to that tested and the test reports and procedures meet the requirements listed below.

8.1 Test plan

Prior to seat testing, a test plan should be submitted by the seat manufacturer to the purchaser. The final test plan shall be reviewed and approved by the purchaser. The test plan shall identify the seating to be tested and the tests to be performed in order to qualify the seat design for delivery and installation into the cars.

8.2 Test procedures

Test procedures for those tests not defined by recognized standards shall be prepared by the seat manufacturer and submitted for approval to the purchaser. The test procedures shall as a minimum include:

- Test Objective
- Complete Description of Item to be tested
- Pass / Fail criteria
- List of Test Equipment
- Descriptions and/or drawings of Test Setup
- Description of Test Personnel Required
- Scheduled Time and Location of Tests
- Sequential, Step by Step Test Procedure
- Test Data Sheets (for recording data during testing)

8.3 Test reports

Test Reports shall as a minimum include:

- A copy of the test procedure meeting the requirements listed above
- Text or cover letter which gives a summary of the test results, the date and location of the test, and includes the signature of the person or person(s) responsible for conducting the test and writing the report.
- Calibration data for all test measuring equipment
- Pre and post test measurements (dimensions, adjustment activation force, etc.)
- Filled-in Test Data Sheet
- Photos of test set-up and results

9. Flammability and smoke emission

Materials used in seat construction shall meet the requirements given in *CFR Part 238, Appendix B*[4], including notes. A test report for each combustible material tested shall be submitted by the Seat Manufacturer to the Purchaser. Testing shall be performed by an independent qualified testing facility. Test reports shall be prepared by the test facility.

In certain instances, materials used in seat construction can not be configured in the sizes required for test samples. For such materials, Seat Manufacturer shall submit a waiver request from testing of this material. The waiver request shall be submitted in writing and shall include the total weight of the material to be used, the location and distribution of the material in the seat and any previous test reports available.

As part of its work for the supply of seating equipment, the Seat Manufacturer should prepare and submit to the Purchaser a Combustible Content Matrix. The matrix should include total weight of each combustible material, where used, supplier's name, flammability and smoke emission, test identity, test facility, test requirements, test results, nature and quantity of the products of combustion, and heating value in BTU/lb. (joule/kg.) and BTU/hr. (joule/hr.) should be submitted by the Seat Manufacturer.

10. Parts, service and maintenance manuals

When not superseded by the requirements of the purchaser's own specifications, as part of its work the seat manufacturer shall provide a set of manuals. The manual(s) shall:

- Provide seat specifications and application data (such as weight, envelope dimensions, ranges of motion, mounting dimensions, mounting bolt sizes, grade and torque requirements, etc.)
- Provide installation and removal information
- Provide assembly and disassembly instructions and data
- Provide a list of replacement parts with part numbers and ordering information
- Provide exploded views of the seat assembly and its components
- Provide scheduled and unscheduled maintenance instructions and data, such as the periodic checking of fasteners (including torque values), lubrication instructions and cleaning instructions

Format and size of manual(s) shall be as agreed to by purchaser and seat manufacturer.

11. Engineering drawing

As part of its work and prior to the supply of seats, the seat manufacturer shall submit an engineering drawing for approval. The drawing shall, as a minimum, include the following:

[4] For references in Italics, see Section 2.

- Overall dimensions and tolerance of the seat assembly
- Weight and location of the center of gravity of the seat assembly
- Depictions of the range of motions of all adjustments and tolerances in the range of motions
- Mounting requirements including hole sizes, recommended bolt sizes and torque requirements and recommended grade of bolts to be used for mounting
- Location and operation of all seat controls and adjustments
- Forces required to operate the seat controls during normal use
- Description of materials including cushion and fabric as well as colors and model number.

12. Submittals for approval

Prior to acceptance of the seat by the purchaser, the seat manufacturer shall submit documentation listed below.

Table 3 - Submittals

Submittal	Reference Standard Section
Decorative Samples	4.2
Ergonomic Analysis and Report	4.2
Static Seat Strength Test Reports	5.1
Horizontal Seat Attachment Tests	5.2.1, 5.2.2 & 5.3.4
Human Injury Test Report	5.2.1 & 5.2.2
Anti Rotation Test (if applicable)	5.3.1
Lateral and Vertical Seat Attachment Tests	5.3.2 & 5.3.3
Mechanism Life Test Report(s)	6.1
Cushion and Upholstery Life Tests	6.2
Test Plan	8.1
Test Procedures	8.2
Test Reports	8.3
Flammability and Smoke Emission Report(s)	9
Combustible Content Matrix	9
Engineering Drawings	11

As an option, submittals from previous seating supply can be submitted to satisfy this requirement as negotiated by the purchaser and seat manufacturer. Timing of submittals of Manuals (Section 10) shall be as negotiated between the purchaser and seat manufacturer, but should be in a timely enough manner so as to serve as a reference and guide during installation of seating equipment into cars.

Annex A Bibliography

Document	Title
SAE ARP750	Passenger Seat Design Commercial Transport Aircraft
SAE J 899	Operator's Seat Dimensions for Off Road Self-Propelled Work Machines
Mil-Std 1472E	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
49CFR Part 216 et al.	Passenger equipment Safety Standards, Proposed Rule September 23, 1997
49CFR Parts 37 and 38	Americans with Disabilities Act
Volpe Contract DAAD01-98-C-0010	Commuter Rail Seat Testing and Analysis, Final Report, Document Number TR99008, Simula Technologies, Inc.
National Academy Press, Transportation Research Record No. 1989, July 1995	"Evaluation of Selected Crashworthiness Strategies for Passenger Trains." D. Tyrell, K. Severson-Green, & B. Marquis
American Society of Mechanical Engineers, AMD–Vol. 210/BED–Vol. 30, pp. 539–557, 1995	"Analysis of Occupant Protection Strategies in Train Collisions." D. Tyrell, K. Severson, & B. Marquis
DOT/FRA/ORD–96/08—DOT–VNTSC–FRA–96–11, October 1996	"Crashworthiness Testing of Amtrak's Traditional Coach Seat." D. Tyrell K. Severson
DOT–VNTSC–FRA–96–5, September 1996	"Crashworthiness of Passenger Trains."
FMVSS 208	Final Rule for Federal Motor Vehicle Safety Standard (FMVSS) 208 – Occupant Crash Protection

Annex B

(informative)

(The information in this Annex is for informational purposes only and is not required for compliance with this standard.)

B.1 Background on seat safety and crashworthiness

Passenger seating in rail cars can either improve the safety environment within the car interior or can be a hazard, depending on the details of seating design, its arrangement in the car and the strength of its attachment to the car structure.

Seating can become a hazard when:

- Seats and parts of seats tear loose from the seat or its mounting during an accident and become projectiles, cause injuries and become impediments to timely evacuation of a car after an accident.
- Seat backs that are too flimsy or too short and fail to contain the occupant and thus fail to prevent the occupant from impacting with another, possibly less friendly object in the interior.
- Seats that have hard surfaces in the wrong places, or have sharp corners and edges can contribute to injury, even in moderate accidents.

Seating can help improve the interior safety of a passenger rail car when:

- Seats and parts of seats are designed to stay attached during an accident or collision and reduce the hazard associated with loose objects during an accident.
- Seat backs are designed to mitigate injuries by containing a passenger within a defined space during a collision and absorb some of the energy that would otherwise contribute to injury.
- Seats are designed to mitigate injuries and contribute to the timeliness and efficiency of emergency evacuation efforts by increasing the likelihood that passengers can exit with little or no aid from emergency personnel.
- Seats are designed with appropriate padding and rounded corners.

During most train collisions, passenger cars are decelerated to reduce their forward speed. In such train collisions (primary impact), passengers in forward-facing seats and longitudinally mounted seats, in the absence of any restraining devices, gain a velocity relative to the car and its interior features. The magnitude of this relative velocity depends on the distance through which passengers travel before colliding with another feature or passenger within the car interior (secondary impact) and is given by:

$v = \sqrt{2as}$, where v is the relative passenger velocity, a is the deceleration of the car, if constant, and s is the distance through which the passenger travels.

The severity of the secondary impact for passengers in forward-facing and longitudinally mounted seats depends, among other things, on the relative velocity of the passenger at impact. An important fact stemming from the physics is that the kinetic energy reduction required to decrease the passengers' speed to that of the car increases as the relative velocity increases. It is the dissipation of this kinetic energy during impacts that is the source of injury for passengers in forward-facing seats. In general, this kinetic energy is dissipated by passengers colliding with features in the interior of the car

Another consideration is the possibility of passengers colliding with an object close by, such as a seat back, glancing off that object, and then proceeding to impact with another object farther away. This is known as tertiary impact, and can be a primary contributor to serious injuries.

One strategy for reducing the likelihood and severity of tertiary impacts is called "compartmentalization". According to D. Tyrell et al., (AMD-Vol.210/BED-Vol.30, "Crashworthiness and Occupant Protection in Transportation Systems", ASME 1995), "The principle objectives of this strategy are to limit the occupant's range of motion and to ensure that the interior surfaces are designed to limit injury during occupant impact."

Passengers in rear-facing seats remain compartmentalized if the seat remains attached while the car decelerates. Because there is no time delay between the primary impact and occupant-seat contact, the initial deceleration peak is higher for rear-facing occupants than it is for forward-facing occupants. The chance of injury to rear-facing occupants increases if the seat fails at its floor attachment and compartmentalization is no longer provided.

There are also issues associated with human tolerance to impact. In any discussion of overall survivability of accidents, one must take into account a passenger's ability to respond to emergency personnel, find and open emergency exit and evacuate the car and surrounding area. Often, the time associated with post-accident activities is critical. Thus, it is obvious that the fewer debilitating injuries suffered by a passenger, the higher the chances of surviving any post-accident hazards. And it follows that any overall plan to improve emergency preparedness would be more effective if passengers themselves were more capable of participating in post accident activities.

Although there is some disagreement with exact levels of human tolerance to impacts, many other transportation industries place limits on certain measurements related to criteria that have been associated with human injuries or fatalities. Anthropomorphic dummies have been refined to a remarkable level of physical resemblance to human bodies and are available in a range of sizes and with high levels of instrumentation to record forces and accelerations on the human form. Test sleds and highly sophisticated facilities are readily available to simulate certain crashes and record anticipated human responses. In addition, computer programs such as MADYMO are available to aid in the design process and have been validated against simulated crashes (see USDOT/FRA "Crashworthiness Testing of Amtrak's Traditional Coach Seat" by D. Tyrell and K. Severson, Volpe Center, for validation of MADYMO as a predictive tool). In short, there are many tools available to the designer of seating for commuter cars to help mitigate

the effects of occupant impacts with seating.

All of the discussion above leads to some guidelines for passenger rail seating. These are given below and apply (1) to transverse seats arranged so that passengers face the back of another seat and (2) to transverse, aft-facing seats. They are presented in order of importance:

1. Seats, seat components and the attachment of the seat to the car structure are to be strong enough to prevent the seat and its parts from tearing loose during a crash.

2. The seat back is to be strong enough to prevent occupants who strike the seat back from behind or are pressed against the seat back in a backward-facing seat, from completely collapsing the seat back.

3. The seat back is to be appropriately compliant, energy-absorbing and/or padded in such a way as to mitigate human injury.

B.2 Effects of seating arrangement

Another issue affecting the crashworthiness of seating is that of arrangement in the car. Most commuter passenger rail cars have the seats generally arranged transversely such that occupants are facing the back of another seat. In some places, however, occupants face one another or face a bulkhead wall. There are also situations where occupants are in longitudinally mounted seats facing the center of the car. Figure 15 illustrates many of these different seating arrangements.

Although seating arrangement issues often involve considerations for quality of service and optimizing the seating capacity in cars, the designer should be aware of the effects of arrangement on crashworthiness.

In general, the most crashworthy arrangement is when seats are arranged transversely such that occupants face another seat back. When it is necessary to arrange seats differently, there are certain things that can be done to improve the crashworthiness of the arrangement.

Facing seats could have a table, with a relatively thick and rounded edge, between the occupants. The table and its attachment to the car structure should be strong enough to withstand the impact of passengers during a crash. While it appears logical that a table would enhance the compartmentalization of occupants seated facing each other, it is not yet obvious that a rigidly-mounted table would not seriously cause abdominal injuries. Additional research is needed to determine the affect of a rigidly-attached table, both adverse and effective, on occupants.

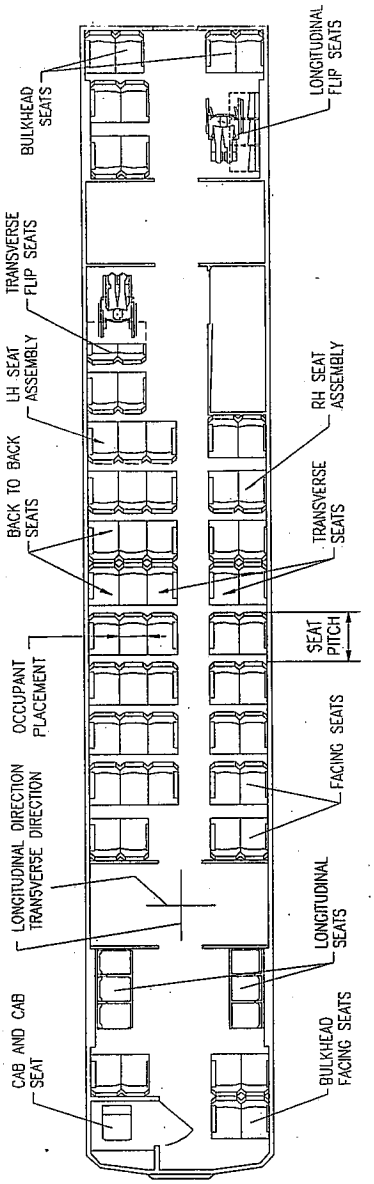

Figure 17 – Seat Arrangement and Nomenclature

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In certain types of seating (such as walkover and rotating seats) the seats can be adjusted so that they face one another. When this is the situation, some Transit Authorities may want to consider having the mechanism providing the adjustment (rotation or walkover mechanism) be designed such that control of the adjustment is done by the Transit Authority, rather than the passenger depending on the type of service they wish to provide.

If seats face a bulkhead, the bulkhead should be padded or otherwise provide protection for the occupant(s) during a crash. If longitudinal seating is used, the range of motion of an occupant during a crash should be limited by placing features along the length of the seat. These features should be padded or otherwise provide protection for the occupant during a crash.

Wheelchair parking areas should be oriented so that occupants are facing in the direction (or opposite direction) of car travel The range of motion of a wheelchair and its occupant should be limited by another feature in the car, such as a windscreen, bulkhead wall or seat. In all cases, seating arrangement should meet the requirements of the *49CFR Parts 37 and 38 (Americans with Disabilities Act).*[5]

B.3 Derivation of crash pulse

Figure 16 is taken from The FRA's Notice of Rulemaking 49 CFR Part 216 et al., published in the Federal Register on September 23, 1997. According to the notice, the peak deceleration of passenger rail coach equipment was 8g's for a head on collision during a train-to-train collision at 70 mph. For the purposes of testing, this crash pulse was idealized to the one shown in this standard. Results from recently-conducted research, particularly involving full scale crash tests, as discussed below, have shown that the measured occupant deceleration environment during a collision is different then the originally approximated. The crash pulse used in the standard and the measured occupant deceleration environments from three different full scale tests are shown in Figure 17. The computed secondary impact velocities of a forward facing unrestrained occupant for each crash pulse from Figure 17 are shown Figure 18. An ongoing study of these results is considering if the current crash pulse should be modified.

[5] For references in Italics, see Section 2.

Typical Automobile, Transport Aircraft, and Passenger Rail Car Decelerations During a Collision

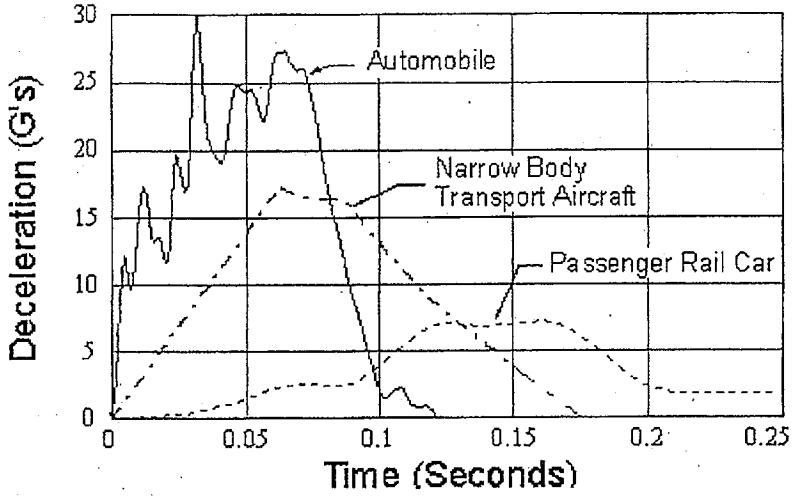

Figure 18 – Typical Decelerations During a Collision

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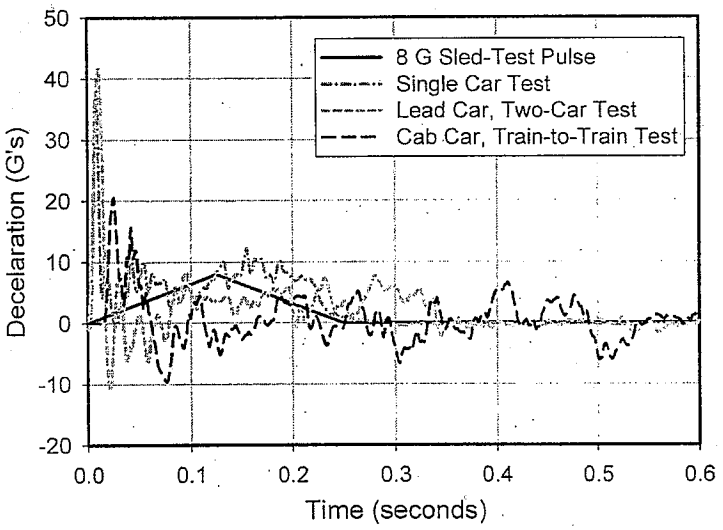

Figure 19 – Actual Decelerations Measured During Full Scale Tests

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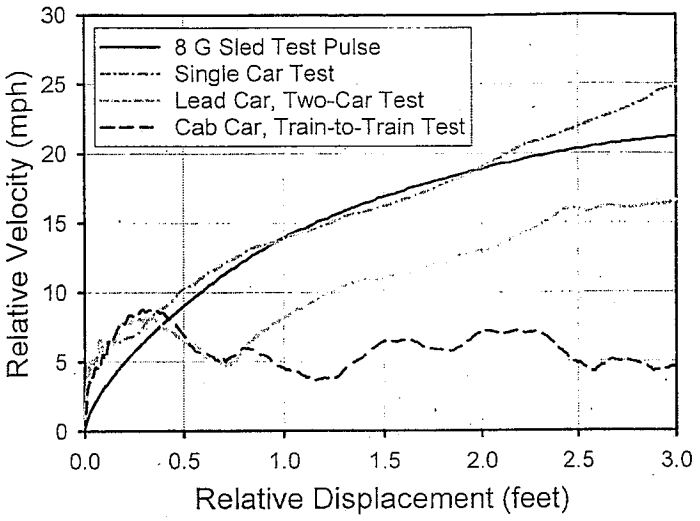

Figure 20 – Secondary Impact Velocity During Full Scale Tests

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B.4 Research programs

Simultaneous to the development of this standard, the FRA embarked on a comprehensive Rail Crashworthiness Research Program which included a series of dynamic sled tests and full-scale collision testing. At the onset, and particularly as part of the development of this standard, APTA, together with the Volpe Center (FRA) conducted analyses and a series of sled tests on representative commuter seating at Simula, Inc. in Phoenix, AZ.

B.4.1 Dynamic sled testing program

The intent of the dynamic sled testing was to provide a better understanding of how traditional commuter seating behaves in a crash environment in terms of both the seat and dummy response.

Two test programs have been conducted. One program tested three types of row-to-row commuter seats as shown in Figure 19, and the other program tested a typical facing seat system. Table 4 below is information about the application of these seats:

Table 4 – Description of Seats Used in Test Program

Seat Tested	Comments
2 Passenger LIRR C-3 Seat	This seat was selected because it represents the only cantilever mount commuter seat configuration in current use. Pedestal mount versions of this seat are also to be placed in service during 1999 at PCJPB and NVTC.
3 Passenger Walkover Seat	Used be NJT. Two passenger versions used by METRA and PCJPB.
3 Passenger M-Style Seat	Used in various configurations by Metro-North, LIRR, SEPTA, MBTA, NICTD, MARC and others.
2 Passenger Facing Seat	Manufactured by Bombardier for their bi-level commuter train. Other properties are preparing to install the facing configuration in their cars: San Diego, Vancouver, Florida, SCRRA, Dallas, Seattle.

Prior to testing, a series of analyses was conducted using MADYMO models of each seat. To help develop the models of the seats, each seat was subjected to static loads across the seat backs to determine the stiffness of the seat backs. Evaluations were made by placing different size occupants in different locations in the seats. As expected, this resulted in different dummy responses depending on the mix of dummies in the seat and the location of the dummies. The analysis on the facing seats included variations with and without a table between the seats.

After seat testing, comparisons were made between test data and the values predicted by the modeling. In general, seat/occupant computer models correlate well with the test results and showed that using a tool like MADYMO can reasonably predict the response of seating and occupants during sled testing.

All of the seat frame structures remained attached to the test fixtures. Cushion detachment during dynamic testing proved to be the primary source of flying objects in the row-to-row series of seat tests and was especially noted on the M-Style seat. In the facing seat testing, the upper part of the seatback (the headrest) typically fractured due to the impacting dummy. This seat failure did not occur when the table was installed between the seats.

The stiffer LIRR C-3 rail seat showed improved passenger compartmentalization and cushion attachment, but, because of the increased stiffness, showed an increased likelihood of neck injuries caused by the dummies impacting the seat in front.

The more compliant seat(s), the M-Style and Walkover seats, increased the risk of passengers ejecting from the seats, but reduced the risk of injuries caused by the dummies impacting the seats in front. Thus the testing showed that to optimize passenger safety, seat backs need to be designed to be stiff enough to provide effective compartmentalization, but not so stiff as to increase the likelihood of injury. The results for the facing seats are similar. Placement of a table

between the seats also proved to be an effective method of compartmentalizing occupants if the table remains attached.

The seats and table were all rigidly attached to the test fixture in an effort to eliminate an unpredictable variable during testing, i.e., the rail car floor or wall strength. The consequence of rigid seat attachment was a more repeatable test, however, the tests could not account for any energy that may be absorbed by the rail car floor or wall structure.

All row-to-row seat tests were conducted under conservative spacing conditions; specifically a 32-in. seat pitch. However, commuter seats in the field are typically attached with a 33-in. to 34-in. seat pitch. The computer seat models were all run with a 32-in and a 33-in. seat pitch to compare the difference in occupant injury data. The results suggest that the difference is very slight. Computer results did show that as seat pitch increased to 48 in. the predicted injury loads increased. Therefore, injury outcomes identified from these tests will likely become worse as the seat pitch increases. The facing seat tests were conducted with a 65-in spacing between the seats. Test dummies were not seated in the aft-facing seat during testing. Computer modeling and/or additional testing should be conducted to determine the ramifications of occupants facing each other.

B.4.2 Full-scale rail collision testing

In addition to the commuter seat sled testing and analysis programs, a series of full-scale commuter rail collision test programs has been in progress. To date, three tests have been conducted:

1. a single car traveling at 35 mph into a rigid barrier
2. two coupled cars traveling at 26 mph into a rigid barrier.
3. a train-to-train test involving a cab-car led, 4-car consist trailed by a locomotive colliding at 30 mph into a stationary locomotive coupled with two ballasted freight cars.

In all three of these tests, a series of seat/occupant experiments were installed inside the railcars to compare with the outcomes of the dynamic sled tests. In each full-scale test, one or more ATDs measured neck load(s) that exceeded the neck injury criteria and in all but the train-to-train test, one ATD in each full-scale test measured femur loads that exceeded the femur criterion. None of the head and chest accelerations exceeded injury criteria. These results suggest that it would be reasonable to add the neck injury criteria as a requirement in this standard.

In addition to providing data for the seat/occupant response to the impact forces of a train collision, these full-scale tests provide realistic crash pulse data that may be used to update the current crash pulse described in this standard.

The crash pulse defined in this standard and used in the seat testing described above (250 msec, triangular pulse with 8G peak) was originally derived from computer analyses by the Volpe center. While this pulse appears to produce reasonable seat/occupant responses, it will eventually be validated with the crash pulse data produced through full-scale passenger rail car crash testing. Some features of the crash pulses produced to date from full-scale crash testing, and not

currently described by the derived crash pulse, include an initial high peak longitudinal acceleration approximately 25 G followed by an average constant acceleration of approximately 5 G, plus an additional vertical acceleration pulse and possibly a lateral acceleration pulse, see Figure 17 for the crash pulses obtained from the recent full scale testing..

B.4.3 Neck Injury Criteria

During all these research programs, the ATD neck loads have been recorded along with head, chest and femur loads. It is quite noteworthy that neck loads are the predominant measurements recorded that exceed the given injury criteria. Based on research results from the FRA Rail Crashworthiness Research Program, discussion within the C&S Subgroup, and changes adopted by the automotive industry, neck injury criteria established by NHTSA in FMVSS 208 (10-1-02 edition) have been added to this standard in Revision 2, as shown in Table 5.

Nij is a criterion to access neck injury, where "ij" represents indices for the four injury mechanisms; namely N_{TE}, N_{TF}, N_{CE}, and N_{CF}. The first index, i, represents the axial load (tension or compression) and the second index, j, represents the sagittal plane bending moment (flexion or extension). The criterion can be written as the sum of the normalized loads and moments, where F_z is the axial load, F_{zc} is the corresponding critical intercept value of load used for normalization, M_y is the flexion/extension bending moment computed at the occipital condyles, and M_{yc} is the corresponding critical intercept value for moment used for normalization.

Table 5 – Human Injury Limits for Hybrid III 50th-percentile Male ATD

Criterion	Maximum Value
Neck Fz	+937/-899 lbf (+4170 N/-4000 N)
Nij, where: Neck Fzc (critical intercept values) are: +1530/-1385 lbf (-6806/-6160 N) Neck Myc (critical intercept values) are: +229/-100 ft-lbf (+310/-135 Nm)	1.0

The following related reports and papers describing the testing are available through the FRA website:

Tyrell, D., Severson, K., Perlman, A.B., March, 2000, "Single Passenger Rail Car Impact Test Volume I: Overview and Selected Results, " U.S. Department of Tranportation, DOT/FRA/ORD-00/02.1.

VanIngen-Dunn, C., March 2000, "Single Passenger Rail Car Impact Test Volume II: Summary of Occupant Protection Program," U.S. Department of Tranportation, DOT/FRA/ORD-00/02.2.

Tyrell, D., Severson, K., Perlman, A.B., Brickle, B., VanIngen-Dunn, C., "Rail Passenger Equipment Crashworthiness Testing Requirements and Implementation," Presented at the 2000 International Mechanical Engineering Congress and Exposition, November 6, 2000, Orlando, Florida.

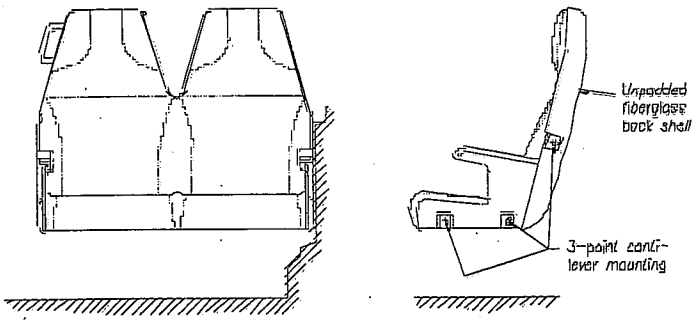
Tyrell, D., Zolock, J., VanIngen-Dunn, C., "Rail Passenger Equipment Collision Tests: Analysis of Occupant Protection Measurements," presented at the 2000 International Mechanical Engineering Congress and Exposition, November 6, 2000, Orlando, Florida.

VanIngen-Dunn, C., Tyrell, D., Occupant Protection Experiments for the Federal Railroad Administrations' Single-car and Two-car Passenger Rail Impact Tests, Final Report, Volpe National Transportation Systems Center, Cambridge, MA, Contract No. DAAD01-99-C-0012, Simula Technologies, Inc. Phoenix, Arizona, September 8, 2000.

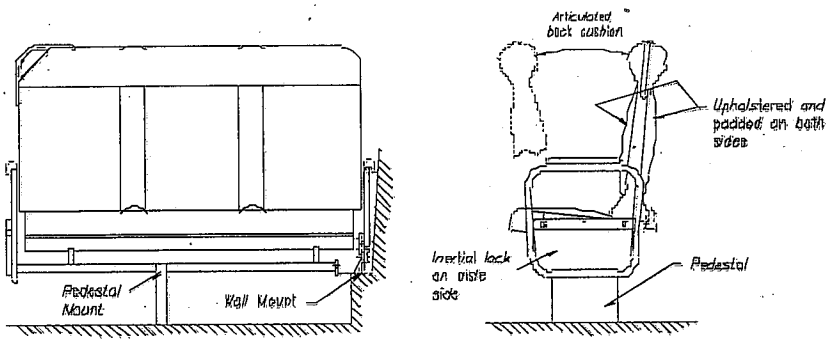
Commuter Rail Seat Testing and Analysis, Final Report, USDOT, Volpe National Transportation Systems Center, Contract No. DAAD01-98-C-0010, Simula Technologies, Inc., Phoenix, Arizona, April 6, 1999.

A report on the analysis and testing of facing seats is yet to be released by the FRA:

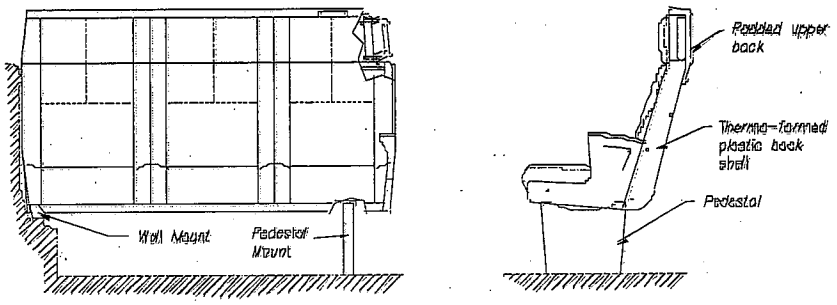
Commuter Rail Seat Testing and Analysis for Facing Seats, Final Report, USDOT, Volpe National Transportation Systems Center, Contract No. DTR S57-99-D-00096/TO3, Simula Technologies, Inc., Phoenix, Arizona, December 2000.



2 Passenger LIRR C-3 Seat



3 Passenger Walkover Seat



3 Passenger M-Style Seat

Figure 21 – Seats Tested

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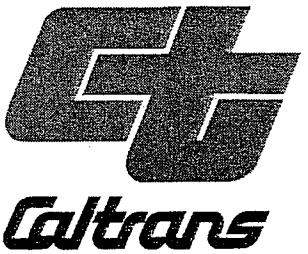

California Department of Transportation
Division of Rail
Rolling Stock Procurement Branch

Technical Specification

For

The Design, Manufacture and Acceptance of Passenger Seating for Intercity Rail Cars

Specification 9-101

Revision E

June 10, 2008

Table of Contents

1.0 Overview

The objective of this specification is to define the design criteria, as well as the technical characteristics, for the passenger seats to be installed in intercity rail cars owned by the California Department of Transportation (the Department) and operated by Amtrak.

2.0 Regulations, Standards, Specifications and Drawings

APTA

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

ASTM

ASTM D 6193: *Standard Practice for Stitches and Seams*

California Department of Transportation (Caltrans)

Specification 9-103: *Seat Fabric Pattern, Color and Material Specification*

Drawing D-9-901: *Seat Track Reference Dimensions and Specification*

FRA

49CFR Part 238.103: *Fire Safety*

Appendix B to 49CFR Part 238: *Test Methods and Performance Criteria for the Flammability and Smoke Emission Characteristics of Materials Used in Passenger Cars and Locomotive Cabs*

49CFR 238.233(a): *Interior Fittings and Surfaces*

3.0 Scope

The different types of seats to be designed and manufactured in accordance with this specification are those listed below:

1. Two-Passenger Non-Rotating seats ("double seats")
2. Single-Passenger Non-Rotating seats ("single seats")

This specification does not apply to the following types of seats:

1. Flip-up seats for use at wheelchair parking locations ("flip-up seats")
2. Lounge seating in food service or café cars ("lounge seating")
3. Crew seats in the operating compartment of cab control cars ("cab seats")

Abbreviations and Glossary

APTA: American Public Transportation Association

CFR: Code of Federal Regulations

Department: California Department of Transportation

FRA: Federal Railroad Administration

SIV: Secondary Impact Velocity

4.0 General Conditions

4.1 General Characteristics

This specification shall govern the design and manufacture of row-to-row passenger seats for revenue use on intercity rail passenger cars. Each seat unit shall consist of a frame, pedestal, seat bottom cushion, seat back cushion, armrests, seat back tray table and footrest. The seat back tray table, magazine pocket and footrest shall be designed for use by a passenger seated behind the seat unit. "Double seats" shall have two seat units, divided by a center armrest.

The seats shall comply with all applicable requirements for passenger comfort and safety. The factors regarding ease of maintenance and interchangeability of parts are fundamental requirements. Quantity of different parts should be kept to a minimum.

Seat design and manufacture shall insure snugness between seat elements, thus eliminating rattling or vibration while the train is in motion.

Seats shall be designed to accommodate the safety, comfort and ergonomic needs of passengers over the size range from the 5th percentile female to the 95th percentile male.

4.2 Structural Requirements

The seat shall meet all design, testing and passenger safety requirements of APTA Standard SS-C&S-016-99, Rev. 1, as applicable, except as where noted otherwise within this specification.

The seat assembly, pedestal and mounting system shall meet the attachment strength requirements of APTA Standard SS-C&S-016-99, Rev. 1, as well as the requirements of 49CFR Part 238.233(a).

4.3 Health and Safety Requirements

The seats shall not have sharp or protruding parts or edges or any other potentially harmful elements that may cause passenger injury. There shall be no pinch points or finger hazards during deployment or use of the recline mechanism, footrest or tray table, or during removal and installation of the seat back and seat bottom cushions.

Combustible components of the seat shall be tested in accordance with 49CFR Part 238.103 and Appendix B to 49CFR Part 238.

The seat frame and all attached parts shall be designed and manufactured to eliminate locations where food particles, trash and debris may collect. The design shall facilitate easy cleaning in accordance with Amtrak standard cleaning procedures.

The upper surfaces on the rear of the seat back or headrest (facing a passenger seated behind the seat unit) shall be individually padded with appropriate-density foam to minimize secondary impact velocity (SIV) injuries, in accordance with applicable APTA standards and FRA regulations.

4.4 Dimensions & Weights

Dimensions are in inches (millimeters) unless otherwise noted.

Item	**Single Passenger Seat** Inches (millimeters)	**Two Passenger Seat** Inches (millimeters)
Total height of seat back, including headrest (from floor to top)	Min 43 (1092) to max 47 (1194)	Min 43 (1092) to max 47 (1194)
Total overall width of seat assembly, max.	26 (660)	45 (1143)
Seat bottom height (top of front edge of cushion above floor)	17 to 17.5 (432 to 445)	17 to 17.5 (432 to 445)
Overall seat depth (from front of cushion to rear of back), max. (when upright and excluding deployed footrest)	27 (686)	27 (686)
Space between armrests (width of bottom cushion), min.	21 (584)	19 (483)
Width of outer armrest, max.	2.5 (63)	2.5 (63)
Width of center armrest, max.	n/a	2.0 (51)
Seat bottom depth (front edge of cushion to backrest)	17 (432)	17 (432)
Max. weight of seat assembly	120 lbs (55 kg)	200 lbs (91 kg)
Max. weight of any component that must be lifted when the seat is installed into or removed from a rail car	100 lbs (45 kg)	100 lbs (45 kg)
Seat pitch (for testing purposes)	46 (1168)	46 (1168)

5.0 Design Description

5.1 Mounting and Installation

The seat must be able to be mounted in the existing seat mounting system in the Department's fleet of *California Cars* and *Surfliners*, as well as being installed in new equipment using an equivalent installation system that will permit use of one design of pedestal for all car types. The seats are mounted in the rail cars using an adjustable floor and wall track, with a pedestal and wall bracket providing the required properties of durability and stability to the entire seat unit. Seat track dimensions and specifications are identified in Department Drawing D-9-901.

The pedestal and wall bracket must be removable from the main seat frame. The pedestal shall be as narrow as structurally feasible. The maximum allowable pedestal width is 2.25" (57 mm). The lower half of the pedestal shall have an integrated stainless steel surface to prevent cleaning equipment from chipping paint or powder coating off of the pedestal. The stainless steel surface shall have a #4 brushed finish in the horizontal direction. The side of

the pedestal facing the wall shall have an access panel that is removable to access the mounting hardware. Clearance between the underside of the pedestal cross member or seat frame and the floor shall be not less than 5" (127 mm) at any point between the pedestal and wall.

The wall bracket must be removable from the main seat frame. The same wall bracket shall be used for all seats, regardless of the direction facing or width of seat. The wall bracket shall have a provision for adjustment to account for minor variations in seat track dimensions, and to accommodate the different single seat track dimensions between upper and lower levels, as shown on Department drawing D-9-901.

The seat shall be designed to be mounted in a fixed position and shall not include a mechanism for rotating the seat on the pedestal to face the opposite direction. The seat frame shall be designed so that the same seat may be used on either side of the car, or face either direction, without requiring modification to the seat or seat frame. The seat assembly may use non-symmetrical fiberglass or plastic shrouds for appearance and access for maintenance and cleaning provided that these shrouds are easily removable and installable so that a seat may be deployed in a different location in the car with minimal effort. Seats facing opposite directions on the same side of the car shall be able to use the same pedestal. When installed in a rail car, no part of the seat assembly shall make contact with the interior wall of the car except the wall-mount bracket. Interior wall clearance at seat mounting locations is shown on drawing D-9-901.

The seat shall be designed so that the maximum weight of any single component or assembly that must be lifted in order to install the seat in, or remove the seat from, a rail car shall not exceed 100 lbs (45 kg) for single and double seats, in order to allow the seats to be installed in a rail car by two persons, each carrying no more than 50 lbs (23 kg). The seat manufacturer shall specify the installation sequence and procedure for single and double seats and the weight of each component or assembly.

5.2 Recline

The seats shall include a recline mechanism. The recline mechanism shall be operated by a positive control system, such as a lever or pushbutton, that is activated by the passenger and will hold the seat in any position between full upright and full recline when released. During recline, the bottom cushion shall slide forward. The lower part of the seat back shall move along with the seat cushion throughout the reclining motion. Reclining the seat back shall not intrude on passengers seated behind the seat. The recline mechanism shall be such that the seat may be placed directly against a bulkhead wall and still have full functional recline capability as any other seat in the car. A decal or label shall be provided that instructs the passenger how to recline the seat.

The seat back when in the most upright position shall measure (at a minimum) 16 degrees when measured from the vertical. The total recline of the seat back should be a minimum of 10 degrees from the upright position (26 degrees from vertical, minimum).

Neither the framework of the seat or any part of the seat unit shall have sharp edges or wear points that can cause damage to any part of the seat unit, including seat fabric or cushions, during the reclining operation. The seat recline mechanism shall not create a pinch hazard during any part of the seat recline range of motion.

5.3 Cushions

The seat back and bottom cushions must be easily removable from the seat frame without tools. The seat covers shall also be removable from the cushions without tools to allow for easy removal and replacement using a positive mechanical securement design. All seat parts, including seat cushions, shall be able to withstand deceleration forces in compliance with 49CFR 238.233(a) without coming loose from the seat frame, regardless of recline position or direction of travel.

The cushions should be contoured to provide optimal occupant retention and comfort, incorporating ergonomic design as specified in APTA Standard SS-C&S-016-99, Rev. 1. The cushions shall be covered with fabric as specified in Department Specification 9-103.

The seat back and bottom cushions shall be symmetrical and completely interchangeable between left and right on all double seat units. Seat backs may incorporate an integrated headrest, or use a separate headrest that is mounted to the top of the seat back. If a separate headrest is used, the headrest shall be removable from the seat back without having to remove the seat back from the seat frame.

A strip of Velcro-style hook fastener material, 1" wide x 8" long (25 x 204 mm), perimeter stitched, shall be sewn on the top of the seat back cover or headrest to attach an antimacassar.

The seat foam shall be fully encapsulated with a fire barrier material, which shall be sewn with 100% Kevlar 69 lb. thread (or equivalent) and should be firmly joined to the cushion foam. An approved fore barrier fabric is 6.4 oz. yd. min. quilted Nomex®/Kevlar® FRQh fabric with Nomex®scrim, DuPont, Merge #17253, Style #4311 (or equivalent). Alternative fire barrier materials will be considered. All fire barrier materials used shall pass the following tests:

Test Identification	Test Description	Test Pass/ Fail Criteria
14 CFR 25.853 Appendix F, Part I (b) (vertical test):	Flammability	Flame time ≤ 10 seconds 10 seconds Burn length ≤ 6 inches No flame dripping or running
ASTM E662	NBS Smoke Chamber	Ds @ 1.5 min. ≤ 100 (worst mode) Ds @ 4 min. ≤ 200 (worst mode)
ASTM D3884 (CS-10 wheel, 1000 gm wt.)	Abrasion Resistance	≥ 150 cycles @ 50% wear through
ASTM D2261	Tear Resistance	≥ 15 lbs (in both the warp and fill directions)
FTMS 191A Method 5122	Burst/ Puncture Resistance	≥ 200 lbs

Durability of the seat cushions shall be demonstrated as specified in APTA Standard SS-C&S-016-99, Rev. 1.

All finished upholstery covers shall include an identification label. The label shall be constructed of durable plastic-based fabric paper and shall include the upholstery manufacturer, manufacturer's part number, and date of manufacture in 3/16" high lettering. The label shall be attached to the upholstery cover with stitching on two opposite sides of the label and shall be located on the under side near the nose of the bottom cushion and on the backside near the bottom of the back cushion. Labels shall be attached on the inside of the upholstery covers and shall not be visible when the cushion is installed on the seat.

5.4 Armrests

All armrests shall be no wider than the width shown in section 4.4. Outer armrests shall be interchangeable from one position to another (left to right). Center armrests between seat backs on double seat units shall fold up and recess flush with the seat backs at all angles of recline.

For the purpose of facilitating the action of aiding a passenger into a seat on the train (particularly at a table), the seats shall be equipped with folding armrests at the aisles and between the passenger placements on double seat units.

The armrests shall be durable and comfortable to the passenger. The armrests shall meet the strength requirements of APTA SS-C&S-016-99, Rev 1, Section 5.1.4.

Armrests shall be securely mounted to the seat frame, and shall be removable without requiring the disassembly of the seat in order to replace a damaged armrest.

The armrest structure shall be covered with foam. Foam used on armrests may be stiffer than that used on seat cushions. All of the armrests shall have an easily replaceable armrest cover of a material and color as specified in Department Specification 9-103. The design of the armrest shall be such that the foam and cover cannot twist relative to the armrest structure.

5.5 Tray Table

Each seat shall have a tray table mounted on the back for use by a passenger seated behind the seat. The tray table shall be designed and tested to be simple, easy to use and safe. The tray table shall be of the fold-down style and not require that any portion of the tray table be pulled up vertically to deploy. The mechanism should be simple and durable, and shall not be spring loaded in any manner. The tray table shall have a lip or raised edge to contain spilled liquids.

The tray table shall be constructed of a material that provides fire safety and crashworthiness as specified in 49CFR Part 238. Deployment or storage of the tray table shall not present any pinch points or reveal any sharp corners, edges or protrusions on the seat frame.

The tray table shall be tested to withstand a static vertical load of 35 lbs (16 kg) without damage or material failure.

The tray table shall be retained in the upright (stored) position by a positive, easy-to-use latch or keeper that will prevent the tray table from unintentionally deploying in the event of an accident.

Each tray table shall rest at a horizontal level (+/- 2 degrees from horizontal) when deployed and be stable at that position without requiring any adjustment. The tray table shall remain horizontal when deployed regardless of whether the seat is reclined or not.

The minimum dimensions of the tray table shall be 16" (406 mm) wide by 12.5" (318 mm) deep. The nominal height above the floor for a deployed tray table shall be 24" to 27" (610 to 686 mm).

Each tray table shall include a 3" (75 mm)-diameter indent, no less than 0.375" (10 mm) deep and located in the upper right corner of the tray table when deployed, for a beverage cup/can to minimize risk of it slipping off of the tray table.

An additional cup holder, located elsewhere on the seat, may be incorporated into the seat design so that passengers using the tray table as a work surface may securely store a beverage

container in a location not on the tray table. This cup holder must not create an unsafe condition for passengers, nor interfere with the operation of the seat recline mechanism or tray table.

5.6 Footrest

The back of each seat shall have a footrest for passenger use. The footrest shall be able to fold up against the back of the seat. There shall be a spring mechanism for maintaining the footrest in the stowed position until deployed by a passenger, and the spring mechanism shall be damped sufficiently so that the footrest shall not slam against the seat back when being stowed or deployed. The footrest shall meet the load requirements of APTA SS-C&S-016-99, Rev 1, Section 5.1.5.

5.7 Passenger Convenience Step

The seat manufacturer may propose a passenger convenience step to facilitate a passenger's ability to reach up into overhead luggage storage areas. The top surface of the step shall be between 7 and 12 inches (178 to 305 mm) above the floor, and shall be equipped with an anti-slip surface. The step shall be designed so that it does not present a hazard to passengers walking down the aisle past the seat. It shall not catch or pinch a passenger's foot or present a safety hazard. The step shall be designed to accommodate a minimum 400 lb (182 kg) vertical load. The step may be integral to the seat frame or may be removable for left-to-right interchangeability.

5.8 Seat Back Magazine Pocket

A seat back pocket shall be incorporated into the back of each seat so that its contents may be seen by a passenger seated behind the seat. The seat back pocket shall be easy to remove and install, and be designed to prevent the accumulation of dust and be easily cleaned. The seat back pocket shall be sized appropriately to accommodate a 9" x 12" (230 x 305 mm) magazine or cardstock flier and a tri-fold passenger safety card. The tray table shall not hide the contents of the seat back pocket when stowed, nor shall interfere with the removal or insertion of the material stowed in the seat back pocket.

5.9 Seat Back Passenger Handhold/Wear Pad

Each seat back shall incorporate a durable handhold or wear pad to prevent passengers from discoloring or wearing out the top corners of the seat back when used for stability by passengers while walking through a moving train. The handhold or wear pad may be located on the headrest as an alternative location if the headrest has sufficient width, but must be located as far as possible from the head of a seated passenger. Handholds shall be made of durable material. Wear pads shall be resilient. Handholds and wear pads shall be made of material that is easy to clean and presents a complementary color and texture to the seat fabric. Wear pads or handholds shall either be located symmetrically on seat backs to preserve interchangeability, or may incorporate a provision for the removal and installation of the handhold on one corner of a seat back as needed for aisle-side locations. Handholds shall not present a potential point of injury to seated or standing passengers in the event of an accident or sudden deceleration.

5.10 Paint and Coverings

The seat frame and all exposed metallic parts shall be powder coated. Color shall be specified by the Department.

Metallic parts that are not exposed shall have a corrosion-resistant protective coating.

Components that are made of polyester or other resin-like material should be dyed or painted to match the color of the seat frame.

5.11 Plastics and Fiberglass

The seat structure may incorporate fiberglass or thermoplastic shrouding for aesthetics. Fiberglass is not allowed in areas where it may be structurally damaged. Durability of all plastic or fiberglass components must be demonstrated to the Department. The shrouding shall be supported by the frame in critical areas. The shrouding should be easy to remove and install. All plastic and fiberglass components shall incorporate metal sleeves in fastener holes to prevent damage from fasteners.

All fiberglass or plastic parts must be tested for, and be compliant with, all applicable flammability, smoke density and toxic gas emissions standards as specified in 49CFR Part 238.103.

5.12 Seat Frame Marking and Identification

Each seat frame shall be marked with an identification plate that lists the following information:

Manufacturer of seat assembly

Serial number of seat assembly

Manufacturer part or design number and revision level

Date of manufacture

Information on the identification plate shall be stamped, etched or raised lettering. The identification plate shall be made of durable plastic or metal, and shall be mounted in a consistent location on each seat frame, under a seat bottom cushion so that the identification plate may be easily seen by removing one seat bottom cushion. The identification plate shall not be visible when the seat bottom cushion is installed. Serial numbers shall be unique and shall not be duplicated by any other serial numbers used by the manufacturer.

5.13 Thread, Stitching, Zippers and Seams

All thread, stitching, seams and zippers used in the construction of the seat cushions shall be in conformance with the following:

1. Eyelets where used shall be brass with plain washer face, .315" inside diameter, Astrup code 233221-1, or approved equivalent.
2. All thread employed to attach fabrics, zippers, straps, and hook & loop shall be "Nylbond" 69 lb. nylon thread, or approved equivalent. The thread color shall either compliment or contrast the finish upholstery fabric. Samples of finished upholstery seams shall be forwarded to the Department for approval of thread color.
3. Serging thread shall be "Daspun" 50/3 spun polyester thread, or approved equivalent.

4. All upholstery seams shall be constructed per ASTM D 6193.
5. All finish cover upholstery seams shall be constructed employing Type SSa-1 seams with one (1) row of flat stitching and one (1) row of top stitching, six (6) stitches per inch minimum.
6. All zippers shall be attached with a Type SSaz-1 seam, a single row of stitching, six (6) stitches per inch minimum. Ends must be locked.
7. All fire barrier cover attachment seams shall be lockstitched, single row of stitching, seven (7) stitches per inch minimum. Stitching thread shall be 100 percent Kevlar, 69lb. Final joint (joint remaining after cushioning form is inserted into cover) may be bonded rather than stitched providing a flap with a 2" minimum overlap.

6.0 Testing Requirements

A representative production seat of each design shall be tested in conformance with the testing requirements specified in APTA Standard SS-C&S-016-99, Rev. 1. For testing and simulation of secondary impact velocity (SIV) injuries, seat pitch shall be tested at 46 inches (1168mm) for front-to-back seats. The seat pedestal and mounting hardware shall be simulated using the seat track and hardware components as identified on Department Drawing D-9-901. The pedestal may yield to absorb energy but shall not fail or separate from the mounting track during any of the required tests.

Test procedures and results shall be submitted to the Department for review and approval prior to commencement of production of the seats. Submittals shall be made in accordance with section 12 of APTA Standard SS-C&S-016-99, Rev. 1, unless otherwise directed by the Department.

7.0 Documentation and Submittals

Supporting documentation for the seats shall be submitted to the Department for review and approval, and shall include the following at a minimum:

1. Maintenance Manuals (Running and Heavy Maintenance);
2. Illustrated Parts Catalog;
3. Installation drawings and instructions;
4. As-built component and assembly drawings for all seat types;
5. Contact information for all component suppliers;
6. Test results for fire barrier materials as specified in Section 6.3; and
7. Submittals as identified in APTA Standard SS-C&S-016-99, Rev. 1, Section 12.

* End of Specification *

California Department of Transportation
Division of Rail
Rolling Stock Procurement Branch

Technical Specification

For

Seat Fabric Pattern, Color and Material for

Passenger Seating for Intercity Rail Cars

Specification 9-103

Revision C.1

May 6, 2008

Table of Contents

1.0 Overview

The objective of this specification is to define the technical characteristics of the upholstery fabric to be used on passenger seats installed in intercity rail cars owned by the California Department of Transportation (Caltrans) and operated by Amtrak.

2.0 Regulations, Standards, Specifications and Drawings

APTA

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

California Department of Transportation (Caltrans)

Specification 9-101: Technical Specification for the Design, Manufacture and Acceptance of Passenger Seating for Intercity Rail Cars

FRA

49CFR Part 238.103: Fire Safety

Appendix B to 49CFR Part 238: Test Methods and Performance Criteria for the Flammability and Smoke Emission Characteristics of Materials Used in Passenger Cars and Locomotive Cabs

3.0 Scope

This specification designates the color, pattern and material to be used on passenger seating as follows:

1. Single seats (single-passenger revenue seats)
2. Double seats (two-passenger revenue seats)
3. Flip-up seats (handicapped seating)
4. Lounge seating (non-revenue seating in passenger areas of food service cars)

Seats used on intercity passenger cars not covered by this specification:

1. Cab seats used in the operating cabs of locomotives or cab cars
2. Jump seats in galleys for use of food service employees

4.0 Abbreviations

APTA: American Public Transportation Association

CFR: Code of Federal Regulations

FRA: Federal Railroad Administration

SAE: Society of Automotive Engineers

5.0 Applications

Primary fabric for seat cushions: Pattern fabric for use on bottom and back cushions of single, double and flip-up seats.

Companion fabric: Solid-color fabric for use on seat cushion sides, headrests and rear face of seat back.

Armrest material: Durable material for use on right and left (outside) armrests for double and single seats, and center armrest and center cushion between seat bottoms on double seats.

Lounge seating: Pattern fabric for use on bottom and back cushions for bench-style lounge seats.

6.0 Fabric Specification

6.1 Primary Fabric

Supplier	Lantal Textiles, Inc.
Part Number and Name	F072510044GRL Blue Wave with Gore-Tex Backing
Content	90% Wool / 10% Nylon
Weight	15.0 oz/sy (+/- 10%)
Width	54"
Ends per Inch	88.8
Picks per Inch	55.0

6.2 Companion Fabric

Supplier	Lantal Textiles, Inc.
Part Number and Name	F072500044PN Blue Wave Companion
Content	90% Wool / 10% Nylon
Weight	16.4 oz/sy (+/- 10%)
Width	54"
Ends per Inch	88.8
Picks per Inch	55.0

6.3 Armrest Material

Supplier	Uniroyal Engineered Products
Part Number and Name	Phoenix Line #PH55 Royal Blue
Content	100% Naugahyde

6.4 Lounge Seating

To be determined.

6.5 Equivalency

Alternate suppliers may be identified for the above-referenced fabric materials provided that the alternate fabric meets all specified colors, physical properties, patterns, wear resistance, maintainability, composition and dimensions for those identified. Equivalency must be demonstrated to the Department's satisfaction.

7.0 Performance Requirements

7.1 Wear Requirements

Upholstery fabric shall be tested for durability per APTA SS-C&S – 016-99, Revision 1, section 6.2, and the testing requirements of SAE J 1454.

Material shall not require overhaul or be shabby in less than four years.

Upholstery shall not experience stretching, pilling, puckering, shrinking, rippling, zippering, fading or other adverse affects to appearance or function due to normal use or periodic cleaning and maintenance, which may vary from daily to every 90 days.

7.2 Flame, Smoke and Toxicity Requirements

All upholstery fabric shall meet minimum safety criteria for flame per 49CFR Part 238.103 and Appendix B to 49CFR Part 238.

8.0 Manufacturer Cleaning Instructions

Seat fabric shall be cleaned per the manufacturer's recommended practices:

1. Vacuum to remove dirt.
2. Clean liquid spills immediately using paper towels.
3. Treat any spots with an upholstery spot cleaner or fabric-safe detergent solution and let sit for one minute. Flush cleaner out of fabric with clean water and blot dry.
4. For greasy or oily spills, blot as much of the spill as possible using a clean cloth. Use upholstery spot cleaner or fabric-safe detergent solution.
5. Never use cleaners that contain bleach or other chemicals that discolor fabrics.

9.0 Documentation

Supporting documentation for the seat fabric shall meet all contractual requirements for deliverables per the specification, and shall include the following at a minimum:

1. Flame, smoke & toxicity reports for combustible materials showing compliance with the requirements of 49CFR 238.103 and Appendix B to 49CFR Part 238.
2. Test report showing compliance with wear and durability testing requirements as set forth in APTA SS-C&S – 016-99, Revision 1.
3. Documentation showing compliance with this specification and all applicable APTA standards.

Documentation shall be submitted per the terms of the contract and technical specification.

* End of Specification *

Prior to Bid Submission:

1. All qualified bidders shall attend a mandatory pre-bid meeting to review the seat specification, installation requirements, and operating environment in which the seats will operate. Bidders must attend this pre-bid meeting in order to be considered for this procurement.
2. Location and date of the pre-bid meeting shall be determined by the State of California and will permit access to the rail equipment that the seats will be installed in.
3. Submittal of written questions will be permitted. All bidders in attendance will receive copies of all questions submitted and the answers provided by the State of California. Any information provided verbally and not in writing shall be considered informational only and non-binding.

To Be Included With the Bid Submittal:

1. Contractor shall provide submittals for single and double seats for all steps of process:
   a. Conceptual drawings for proposed seats, including details regarding recline, tray table, footrest, pedestal and installation.
   b. Draft of materials specification, including structural steel, plastics or fiberglass, foam, fabrics and coatings.
   c. Draft of test plan for the seats (or a test report for seats already tested if existing design is being proposed).
   d. Draft schedule for engineering, design review, test and production.
   e. Contractor's QA plan, warranty plan, and other relevant guiding documentation.
   f. List of suppliers and subcontractors to be used on the project (if any), and the scope of supply for those suppliers.
   g. Summary of Contractor's relevant experience in the manufacture of seats for commuter and/or intercity rail cars, including:
      i. Customer list, including contact information;
      ii. Number, type and description of seats manufactured for rail operator; and
      iii. Performance history of seat projects, including on-time delivery, fleetwide modifications (if required) and warranty failure rates.

Pre-Production Conference:

1. No more than 60 days after Notice To Proceed (NTP) and prior to the start of production, the Contractor and the State of California will meet at the Contractor's facility to jointly discuss and review:
   a. Draft engineering drawings, specifications and calculations for the seats.
   b. Final materials specification for all components of the seat assembly.
   c. Proposed test plan including finite element modeling and real-time sled testing.
   d. Specification compliance plan, including a section-by-section analysis of the specification and supporting documentation, and a description of the method of achieving compliance.

Final Design Review:

1. No more than 90 days after the Pre-Production Conference, the Contractor and the State of California will meet again to review:
   a. Final engineering drawings, calculations, material specifications and production documentation.
   b. Final test plan and schedule.
   c. Final engineering calculations.
   d. Seat assembly weight, including installation procedure and weight of each major component and assembly.
   e. Final production and delivery schedule.

Prior to Production:

1. A full scale mockup of a single and a double seat shall be assembled at the Contractor's facility for the State of California to review:
   a. Mockups shall accurately simulate seat design, features, operation and installation.
   b. Must be functional and shall be strong enough to sit in and operate.
   c. Contractor shall ship the mockup to Oakland for trial installation in a rail car.
2. Upon the State of California's approval of the mockup, the Contractor shall assemble a production prototype for each type of seat, to be used for testing.
3. Tests shall be performed on seats manufactured to approved production design and process, and shall accurately reflect a production seat in terms of materials, assembly method, welding and attachment, colors and fabrics, fire resistance, stress and weight carrying capacity, functionality of tray tables and recline mechanism, removal of cushions, and mounting and installation.
4. Tests shall demonstrate compliance with all applicable requirements and tests identified in the specification.
5. The State of California shall have the opportunity to witness any and all certification tests. The State of California shall be notified at least 30 days prior to the test date to make travel arrangements. The Contractor shall be responsible for certifying the seats as compliant whether the State of California witnesses the tests or not.
6. Contractor shall provide all required certifications that the production prototype passed all tests. All seats and components used in testing (except where the seat component is consumed in the test, such as fire resistance) shall be preserved by the Contractor for post-test inspection by the State of California until the completion of the contract.

First Article Inspection (FAI):

1. The State of California shall review and approve first production unit of each type after the production prototypes have passed all tests. These seats shall serve as the First Articles for this procurement.
2. These seats establish the standard for all production units, and are preserved by the Contractor until completion of production.

Pilot Production and Field Evaluation of Design:

1. Upon acceptance of the FAI, the Department shall provide the Contractor with written authorization to begin production of the seats.
2. Contractor shall deliver two carsets of seats for field evaluation program.
   a. One set each shall be delivered to the Amtrak maintenance facilities in Los Angeles and Oakland.
   b. Seat installation shall be performed by a contractor as determined by the State of California and at the State's expense.
   c. Contractor shall supervise the installation of the seats for the pilot program to verify that the seats are installed in accordance with Contractor instructions.
   d. Each carset shall consist of 5 single and 42 double seats.
3. Seats shall be operated in revenue service for 120 days.
   a. Seats shall be monitored during field evaluation to ensure compliance with provisions of the specification.
   b. At the completion of the 120-day field evaluation period, the Contractor and the State of California shall jointly conduct an analysis of the performance of the seats during the field evaluation. This will consist of a visual inspection of all seats, and a complete teardown of 10 seats from each car (8 doubles and 2 singles), selected by the State of California. The seats will be inspected for compliance with the specification with a specific emphasis on the provisions for wear, adjustment, cleaning and pinch points.
   c. All instances of seats performing in a noncompliant manner during the field evaluation period shall be analyzed to determine the cause of the failure. The Contractor shall take appropriate action to resolve the deficiency, and shall propose corrective action to the State of California for approval.

Production, Delivery and Acceptance:

1. Upon completion of the field evaluation program, the State of California will provide the Contractor with written authorization to begin delivery of seats.
2. The State of California will not provide inspection resources for pre-shipment inspection of the seats, but reserves the right to perform production and/or pre-shipment inspections if deemed necessary.
3. Seats shall be shipped in carset lots: 42 doubles and 5 singles per shipment. Contractor shall provide the State of California with written notification of intent to ship no less than 10 business days prior to release of shipment. Seats shall be shipped to Amtrak's Oakland and/or Los Angeles maintenance facilities per the direction of the State of California. Shipment documentation shall include a list of all seat units by serial number.
4. The State of California shall take acceptance of each shipment of seats no more than 30 days after delivery.
5. The State of California shall be responsible for providing resources for installation of seats in cars. Installation of each shipment of seats shall be completed no more than 30 days after acceptance of that shipment.

After Delivery of Seats:

1. Warranty
   a. The warranty period for each seat shall be for a minimum of 2 years from date of installation and shall be administered by carset (as identified by the car number in which the seats are installed). The State of California will provide written notification to the Contractor as to the start date for each carset of seats.
   b. The warranty for the seats shall be administered in accordance with the Department of Transportation's Warranty Program and the Contractor's warranty plan, as approved by the State of California.
2. Spare parts
   a. The Contractor shall furnish as part of this contract the following spare parts:
      i. Two carsets of seat cushions (back and bottom) for each type of seat;
      ii. Four carsets of seat covers (back and bottom) for each type of seat;
      iii. 30 tray table assemblies;
      iv. 30 footrest assemblies; and
      v. 30 armrest assemblies of each type (left, right and center).
   b. Spare parts shall be delivered to a location as designated by the Department. All spare parts shall be delivered to the State of California no later than 120 days after acceptance of the first shipment of seats.
3. Fleetwide failure and retrofit
   a. Definition of a fleetwide failure
      i. A fleetwide failure is when 25 separate failures have been documented through the warranty process that are identical in nature.
      ii. Once a fleetwide failure has been identified, the Contractor will investigate the failures, make a determination of the cause of failure, and propose corrective action to the State of California.
   b. Once approved by the State of California, the Contractor shall take corrective action to resolve the fleetwide failure, including redesign of the seat or components as necessary, and implement a field modification to apply the redesign to all seats as applicable.

Prior to Completion of Contract and Release of Retention Funds:

1. All warranty claims have been resolved and closed.
2. All fleetwide failures have been corrected.
3. All deliverables have been provided to the State of California.
4. All spare parts have been delivered.