Federal Railroad Administration
PRIIA 305 Committee
Locomotive Group

Specification Recommendations
For Procurement of Passenger Locomotives

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1.0 Scope

1.1 General

This Specification defines the system and performance requirements for the design, development, construction and testing of a passenger locomotive. The locomotive shall be a diesel-electric powered for use in intercity passenger service. .

The locomotive shall be capable of attaining a speed of 125 MPH.

1.2 Regulatory Compliance

The locomotive shall comply in all respects with the applicable standards and recommended practices of the FRA, AAR, and all applicable Federal and State laws, rules and regulations and all industry recommended practices in effect at the time of the signing of Contract. These standards and practices shall continue to apply during construction of the locomotive up to the time of acceptance of the locomotive by TBD.

If a conflict is discovered or arises among any of the above requirements, the following order of priority shall govern:

1. FRA
2. NTSB
3. Recommendations of the AAR
4. NRPC (Amtrak)
5. Purchase Agreement and Specifications

1.3 Basic Features

This section is intended as a quick guide to the basic features and requirements for a high reliability, fuel efficient locomotive for passenger rail service.

1.3.1 Body Construction

The locomotive shall of an aerodynamic streamlined design employing a light weight, high-strength monocoque structure or of a design equal. External devices such as horns, lights and grad-irons shall be recessed where possible to improve appearance and aerodynamics.

The material thickness of the car body structure shall duly be considered in the design to prevent warping of the metal. All welds shall be smoothed to produce an attractive exterior appearance.

1.3.2 Locomotive Operator's Cab

Operator's cab shall provide a clean, safe cab interior and be ergonomically designed for operator comfort.

The operator's cab shall have a state of the art desk type work console. All required instrumentation shall be located and mounted within easy access or view from the operator's console.

Interior cab noise must be within the FRA requirement of a static noise level of less than 85dba and a maximum of 87dba.

The cab shall be equipped with two full size operator's seats. The seats shall be cushions and ergonomically designed for the operator's comfort. A wall mounted jump seat or a third full size seat shall also be provided.

Full climate control shall be supplied for the operator's cab including air conditioning and heating.

1.3.3 Power Source

The propulsion power plant for the locomotive shall be a turbocharged 12 or 16 cylinder diesel engine. A minimum of 4,000 HP must be available for traction. The locomotive main engine shall meet EPA Tier IV standards. The locomotive engine shall incorporate an Automatic Engine Start Stop (AESS) system

1.3.4 Truck

A two axle two motor design with yaw dampers or approved equal.

1.3.5 Cant Deficiency

The center of gravity is to be as low as possible, as required for operation at 4 ½" to 6" imbalance through curved track.

1.3.6 Battery Charger

Redundant battery chargers shall be provided, one fed from the 48OV train line system, the other from the engine auxiliaries.

1.3.7 Brake System

An electronic air brake system with a graduated release feature shall be provided.

1.3.8 Dynamic Brakes

Locomotives shall be equipped with a normal range dynamic brake system, which can be operable separately or as a blended air / dynamic system.

1.3.9 Wheel Slip

A service proven state-of-the-art wheel slip control system shall be provided.

1.3.10 Weight

Maximum loaded weight of the locomotive shall not exceed 280,000 lbs.

1.3.11 Clearances

The proposed locomotive will be capable of operations with the following clearance diagrams.

- Customer required clearance diagrams for their operation
- The AAR Plate 'H' diagram
- Amtrak Clearance Diagram for Bi-level Passenger Car

These diagrams are included as an attachment to this specification.

1.3.12 Curve Negotiation

250 ft. radius (23º curve) while coupled to California Car equipment.

1.3.13 Cooling

All blower motors shall be AC powered. Blower wheels and fans shall be balanced.

1.3.14 Auxiliary Motors

All auxiliary motors shall be AC powered.

1.3.15 Parking Brake

A standard mechanical handbrake or approved equal shall be supplied in addition to a standard independent air brake. The parking brake shall be designed to hold the locomotive on 3% grade minimum.

1.3.16 Push-Pull / Multiple Unit Operation

The locomotives shall be capable of being utilized in push-pull operation and in multiple unit service with other freight and with intercity and commuter locomotives in the Amtrak or in other state's fleets.

1.3.17 Miscellaneous

The locomotives shall be equipped with industry standard features, such as sanding, refrigerator, and toilet. The locomotive shall further be equipped with a positive train control device and an onboard video camera recording system.

1.3.18 Drive System

Propulsion motors shall have tapered roller bearings or approved equal and lubricated gear cases. Motors shall be axle suspended. Traction motor cooling air shall be filtered to prevent entrance of moisture, snow, dust, and debris.

1.3.19 Head End Power

Locomotive shall be equipped inverter powered Head End Power (HEP) system

The HEP power source shall produce 480 VAC, 3phase, 60 Hz electric power for heating, lighting and other hotel power needs of the connected passenger cars. The HEP power source shall have the capability of producing 500 KW minimum.

1.3.20 Air Compressor

200 CFM minimum at 150 psi.

1.3.21 Fuel Capacity

The locomotive shall be equipped with a 2000 gallon minimum fuel tank integral with the carbody design. Tank shall be designed to minimize spills and be puncture resistance.

1.3.22 Battery

Locomotives shall be equipped with a minimum 400 ampere hour rating, Ni-Cad low maintenance batteries. Module batteries are preferred.

2.0 Dimensions and Weights Design Considerations and General Data

2.1 General

The locomotives built to this Specification shall be suitable in all respects for use over all lines in the Western United States where Amtrak trains have been operated for a period of 25 years. Locomotive weights, dimensions and operating performance requirements are detailed in the paragraphs following.

2.2 Track and Profile

a) Nominal gauge	4 feet 8-1/2 inches
b) Minimum horizontal curve	250 Ft radius horizontal curve (23º curve)
c) Maximum track super elevation	6 inches

Operation may be on all classes of track maintained to FRA standards, for speeds of up to 125 mph.

2.3 Clearances 2.3

Proposer shall submit documentation from relevant railroads and regulatory bodies guaranteeing that the proposed locomotive will be capable of operations specified. The California Public Utilities clearance diagram and the AAR Plate 'H' diagram are included in Appendix A for informational purposes only. The Builder shall be responsible for insuring the locomotive is capable of unrestrictive mainline passenger rail operations throughout California.

Within the 90 days following Contract Award, the Builder shall submit a detailed static outline diagram of the proposed locomotive. This diagram shall also show the dynamic movement of the locomotive and carbody about its center of gravity and roll axis, and it shall indicate the change in vertical height for each of the following conditions:

- New and fully worn wheels;
- New and broken springs;
- Static working height and fully compressed height of springs.

Also indicated on this diagram shall be:

- Locomotive length and truck centers
- Max. pilot and mid-point lateral off sets for 2° curvature and 6" super elevation
- Location of vertical Center of gravity which shall be on the center line of the locomotive.

2.4 Weights

2.4.1 Weights

The contractor shall implement a weight optimization program in order to produce the lightest locomotive consistent with the requirements of this specification and with optimal adhesion and tractive effort characteristics.

The Builder shall make every effort to reduce weight to the minimum feasible with a target weight of less than 270,000 and shall not exceed 280,000 lbs.

The weight differential over each truck at the rail of a fully loaded locomotive shall not exceed ten percent to the total locomotive weight of the unit.

2.5 Cant Deficiency

The center of gravity is to be as low as possible, as required for operation at 4 ½" to 6" imbalance through curved track.

2.6 Dimensions

The dimensions stated in this section are for guidance only. The contractor shall specify the optimum proposed dimensions based on the parameters established by existing clearances and the dynamic characteristics of its proposed locomotive.

The dimensions marked (*) are dictated by compatibility requirements or locomotive size optimization.

2.6.1 Dimensions

a) Wheel arrangement	TBD
b) Overall length over coupler faces, range	TBD
c) TOR to top of locomotive; new wheels, no supplies	Maximum height 16' – 2" Wheel diameter 40" to 42"
d) Coupler height	34+1/2" (*)
	Truck Wheel base TBD

2.6.2 Supplies and Output Characteristics

a) Continuous total power available for traction	4000 HP
b) Head End Power output	480 volt, 3 phase, 60 cycle, 500 kW minimum
c) Number of traction Motors	4 (one per axle)
d) Propulsion control	Microprocessor
e) Fuel capacity, minimum	2000 gallons
f) Water capacity	TBD gallons
g) Lube oil capacity	TBD gallons
h) Sand capacity	TBDcu. ft

2.7 Operating Performance

2.7.1 Push-pull Operations

The locomotives shall be designed and constructed to be used in push-pull operations. The electrical and communications systems shall be train lined.

2.7.2 Propulsion-Diesel

Motive power shall be supplied by a turbocharged two or four-stroke 12 or 16 cylinder diesel engine or approved equal rated at a minimum of 4000 horse power for traction.

2.7.3 Compatibility

The locomotive shall be compatible with other rail equipment owned and operated by the purchaser.

2.7.4 Speed

The locomotives shall be designed, constructed and tested to operate at a maximum speed of 125 mph on tracks approved by FRA for that speed.

2.7.5 Gear Ratio

Builder shall indicate gear ratio needed to attain minimum speed requirements of 125 mph.

2.7.6 Climatization

The locomotive shall be designed for trouble free operation within the normal temperature and weather extremes common to California, including cold weather temperatures down to -TBDºF, snow and ice conditions common to the country, and warm weather temperatures to +TBDºF.

2.7.7 Trucks

The truck shall have two axles. The frame shall be fabricated, cast or approved equal with a resilient bushings and pads. Where applicable, Yaw dampers may be used. Incorporate latest improvements to minimize flange wear reduce weight, and improve maintenance.

2.7.8 Conventions

All AAR conventions as to the identification of ends, sides, and wheel and bearing locations shall be used. A key plan shall be provided on all drawings to aid in the identification, location and orientation of the items depicted.

2.8 State-of-The-Art

Locomotive shall incorporate state-of-the-art components and features. Fuel economies shall be realized through the use of a highly efficient diesel engine. Maintainability and ease of access to locomotive components shall be designed into the locomotive body. No

component or system shall require less than 90 day service intervals, except for traction motor lubrication, brake shoes, fuel, sand, water and oil.

The Builder shall furnish a truck and suspension system which:

- Is optimized for adequate dynamic stability of the vehicle with safety against derailment, at all speeds and conditions of wear normal to the locomotive components
- Features least number of components and bearing surfaces
- Can be maintained readily and can be restored to service quickly

When operated at up to 15 mph in excess of the maximum speeds stipulated for FRA track classes, 4, 5, 6, and in curves at up to 10" cant deficiency, for any combination of track perturbations permitted by FRA track regulations, each locomotive shall meet the following design criteria as will be demonstrated by the Builder with the first locomotive.

a) Carbody Accelerations, max.: TBD lateral
TBD vertical

Max. Truck Force, TBD

b) L/v Ratio, TBD

c) Stability against Hunting:

d) Truck pitching resonance
Lower: TBD Hz
Upper: TBD

3.0 Couplers and Draft Gear

3.1 General

This section describes the performance requirements for couplers and draft gear.

3.1.1 Strength Requirements

Couplers and their associated apparatus shall be capable of withstanding a load of 800,000 lbs. or **TBD** in buff without permanent deformation.

3.1.2 Geometric Requirements

Locomotives, when coupled, shall maintain safe and secure coupling while negotiating the horizontal curves of 250 ft. radius (23º curve) as well as normal track irregularities at all times including the condition of adjacent car ends with broken springs.

3.2 Couplers

An AAR-type F tight lock coupler with alignment control features and anti-flip creep shall be applied to each end of the locomotive. Couplers shall be equipped with AAR-standard uncoupling mechanism for independent operation from either side of the locomotive. Coupling mechanism shall be top or bottom operated.

3.3 Draft Gear and Yoke

Draft gear shall be National Castings Division Midland-Ross Corporation type NC390 the double-acting rubber type with alignment control, at both ends of the locomotive.

Cast steel yokes shall be designed to accept the above type F alignment control coupler, and shall accommodate NC390 draft gear or approved equal.

3.4 Coupler Carriers

Coupler carriers shall meet AAR standards as well as the geometric requirements of 3.1.2. AAR standard lateral swing of coupler (13" to each side of center at the coupling line) shall be provided as a minimum. The carrier shall keep the coupler level at all positions of the coupler and a means of shimming to maintain level shall be provided. Clearance shall be allowed so that carrier is not loaded longitudinally with the unit in maximum draft or maximum buff. Locomotive coupler carriers shall comply with FRA Rule 230.457.

3.5 Pneumatic Coupling

Brake pipe and main reservoir equalizing pipe coupling between cars shall be made manual at the ends of each car and locomotive with hose connections, designed and positioned in accordance with AAR standards. Particular care shall be taken to avoid interference with other apparatus and to assure maintenance of positive coupling without

pinching or stretching hoses under all conditions set forth in 3.1.2. Dummy hose couplings and provisions for their securement when not in use shall be provided at each end of the locomotive. Securement of MU hose coupling shall be provided at each end of locomotive. In addition, MU couplings for independent brake, actuating pipe and other necessary pneumatic couplings shall be provided and secured when not in use. All hoses shall be labeled for ease of identification.

4.0 Locomotive Carbody

4.1 General

This section outlines the major technical requirements for construction of the locomotive carbody. Minimum design service life shall be 25 years. Life should apply to entire locomotive except consumables.

4.2 Materials of Construction

The entire body structure, including the exterior sheathing, may be constructed using any one of the materials or material combinations shown below.

- All stainless steel
- Stainless and low alloy, high tensile (LAHT) steels
- Aluminum and LAHT steel
- All LAHT steel
- Composite panels and materials
- All locations where aluminum is proposed to be used shall be low stress areas and are to be identified as part of the bid proposal. Aluminum may not be used as primary exterior skin.

The Builder shall employ methods of joining metals that minimize corrosion or electrolysis at the joints. Such joints shall be designed to drain free of accumulations of moisture such that joints will dry before corrosion can begin. The materials to be used shall be stipulated by the Builder as part of the structural details submitted to TBD.

4.3 Carbody Structure

The locomotive carbody structure shall be designed and constructed in full accordance with all applicable FRA, AAR, Amtrak, CPUC and NTSB rules, regulation and recommended industry practices in effect at the time of first locomotive build and the requirements of this specification.

The locomotive carbody shall be equipped with a full-width streamlined cab employing a light-weight, high-strength monocoque structure or design of equal value containing a cab and engine room.

The builder shall include in its proposal line drawings and renderings depicting its design/ style interpretation.

4.4 Structural Elements

4.4.1 Draft Stops

The carbody structure shall resist a static-end load of 800,000 lbs minimum buff applied to the draft stops without permanent deformation of nay member of the structure.

4.4.2 Buffer Beam Coupler Carrier

The buffer beam coupler carrier and coupler assembly shall resist not less than 1000,000 lbs. vertical force without exceeding the yielding point of these devices or their attachment to the carbody of any horizontal position of the coupler.

4.4.3 Collision Posts

Two vertical collision posts shall be provided at the front end of the locomotive that meet or exceed the requirements of AAR Standard S-580-Locomotive Crashworthiness Requirements.

An end nose plate assembly shall be attached to the collision posts and meet or exceed the requirements of AAR Standard S-580-Locomotive Crashworthiness Requirements.

4.4.4 Truck Attachments

Truck attachments shall be supplied to permit lifting trucks with carbody. Horizontal shear of each truck attachment in any direction shall be 250,000 lbs. minimum.

4.4.5 Anti-climbing Structure

An anti-climbing structure shall be applied on the front end of the locomotive which meets or exceeds the requirements of AAR Standard S-580-Locomotive Crashworthiness Requirements.

4.4.6 Jacking Pads

The locomotive carbody shall be supplied with four jacking pads integral with side sills at or near outer points of attachment of trucks to mainframe.

Pads are not to be obstructed by conduit, piping or cables.

The jacking pads shall be suitable to lift the locomotive either by means of jacks or overhead lifting devices, e.g. slings.

4.5 Carbody Components and Attachments

Locomotive shall meet applicable FRA safety appliance regulations.

All exterior steps and handholds shall be wrought steel unless otherwise approved by TBD.

4.5.1 Handholds

Cab entrance doors shall have full-length handholds, recessed: cab doors to exterior shall have one horizontal grab iron above each door inside cab.

4.5.2 Horizontal Grab Irons

Horizontal grab irons needed to facilitate servicing shall be recessed. Their necessity shall be reviewed and approved by TBD. Every effort shall be extended to provide servicing access from inside locomotive.

A recessed horizontal grab iron shall be located on each side of coupler front and rear.

4.5.3 Side Steps/Exterior Steps

Side and ladder steps shall be open-grating which will self-clear of snow and ice and of sufficient depth to gain secure foothold.

4.5.4 Grab Irons

Grab irons and handrails shall be of one-piece wrought steel and shall provide at least 2-1/2" minimum radius handhold clearance.

4.6 Roof Hatches Panel Doors Floor Openings

Suitable roof hatches and/ or detachable sections shall be designed and constructed as integral component of the locomotive body providing the strength and durability consistent with the rest of the vehicle. They shall also permit ready access to equipment and components within locomotive.

Panels, doors and floor openings shall make use of positive-close, quick-release buttons or lever-type latches.

Provisions shall be incorporated in the design of the cab area for emergency exit or ingress.

4.7 Floors

The floors in the equipment rooms and compartments shall be diamond plate steel sheets or approved floor finish. The floor in the operator's cab shall consist of ply-metal panels or other approved equal material covered with Nora/Endora dimple flooring or approved equivalent. The flooring material must meet current smoke and flammability requirements.

4.8 Weatherproofing

4.8.1 Doors, windows, external hatches

Doors, windows, and external hatches shall be weatherproofed such that they seal, when closed, with an approved substantial a robust latching method against entrance of

moisture, dust, fine sand, snow, noise and combustion fumes into the operating cab and compartments.

4.8.2 Insulation

Cab insulating materials, as with paint, sealants, and other coatings, shall not constitute a potential fire or toxicity hazard.

4.9 Passageways

Minimum aisle way/ passageways shall be 20 inches unless otherwise approved.

Interior aisle ways shall be surfaced with non-skid type polyurethane paint or approved equivalent.

Handbrake, fire extinguishers, and cable slings shall not be located in the aisle ways or otherwise restrict free movement through passageways.

All doorway headers and other low clearance areas shall be protected by anti-bump neoprene strips, upholstered if not self-skinning, with the same material as the cab seat covering.

4.10 Carbody Painting and Lettering

All painting and lettering schemes shall be discussed during review and approved by TBD.

4.11 Builders Plate

A builder's plate of approved design with embossed letters shall be attached to each side sill near front end or unit using anti-theft attachment. Location of the builder's plate shall be approved by the purchaser

4.12 F-End Marking

A ¼" X 2-1/2" letter "F", cast metal F-end marking shall be located on each side of the unit, below cab side window.

4.13 Pilot

The Builder shall apply a snowplow pilot at the front of the locomotive only. MU hose access doors in snowplow shall have positive hold-down latches. Pilot shall be attached to the locomotive with grade 8 bolts. Design shall be approved by the purchaser.

5.0 Running Gear

5.1 General

The truck design shall be of a technology and design proven in revenue passenger service. The design shall incorporate two axles in a floating bolster design.

5.2 Truck Frame and Components

5.2.1 Design Requirements

- The truck frame shall be of a cast or a fabricated construction
- Truck shall provide a 30-year life based on regular maintenance and design proven over at least 1,000,000 miles of revenue service or simulated tests performed as approved by The purchaser
- Drop table removal of wheel sets; traction motors
- Axle-drive, end of-axle wheel-truing access provision
- Axle hung motors with support bearings or frame-mounted motors

5.2.2 Reliability and Maintainability

Design shall be such that failure of a component shall not cause the locomotive to become unsafe for normal operation. All truck working elements an adjustment points shall be conveniently accessible for inspection and repair without requiring the removal of trucks or any other unrelated equipment.

5.3 Brake Rigging

- Pneumatic application will apply brakes at all wheels
- Self-aligning brake shoes or approved equal correct for clearances
- Heads for composition shoes only

5.4 Wheels

Wheels shall be mono-block, wrought steel, class BR-MW or approved equal. Wheel diameter to be 40 inch to 42 inch. Wheel shall be AAR approved manufacturer. Hub stamped per AAR figure 5.3, Wheel and Axle Manual, reference-grove rims/witness grove. Wheels shall be unpainted and shot-peened as required. Wheels shall be narrow flange, AAR 1:20 single taper. Hubs shall be drilled for hydraulic-assist wheel removal.

5.5 Axle

Axles shall be AAR, M-101, Class F or better. Axle shall be splined at each end or approved equal to accommodate axle drives.

5.6 Journal Bearings

5.6.1 Type

Shall be grease-lubricated, Timken roller; NFL or approved equal. (If inboard bearings are proposed, a hot bearing detection system shall be included).

5.6.2 Service Life Design

Minimum design service life of one million miles with a rate of failure of no more than 10% in one million miles.

5.7 Suspension System

The suspension system shall be consistent with the overall performance requirements of the locomotive. The builder shall demonstrate through test results or simulations that the interfaces and integration of the system has been fully and successfully accomplished and that its dynamic performance under all operating conditions and speeds is in accordance with the requirements of this specification and the intended services.

5.8 Brake Equipment

All wheels shall be equipped with tread and or disk type brakes.

5.9 Ride Quality

Ride quality shall be at all indicated speeds up to 125 mph. The ride quality shall be equal to or better than existing purchaser owned locomotives.

6.0 Operator's Cab

6.1 Design and Layout

The locomotive shall have a full width cab. The cab shall feature a clean, safe interior design with console-type control arrangement. The entire cab interior area, including console, panels, doors, windows, equipment, etc. shall present an integrated environment consistent with modern design practices. The materials and hardware shall be easy to clean and maintain and shall provide long life and durability. No dirt collecting recesses shall be present.

All required instrumentation is to be mounted in or adjacent to the Engineers desk console. Builder's standard control instruments shall be installed. Cab shall be fully insulated throughout to achieve lowest possible cab interior noise level of less than 85dba and a maximum of 87dba.

The operator's cab design and layout shall be in accordance with the Clean Cab design recommendations by the AAR, human factors and industrial design considerations. The design and layout shall provide an environment which shall permit the use of control and operating functions in a safe manner.

Layout shall maximize free floor space, shall be ergonomically designed and shall be free of sharp edges, protruding objects, safety hazards. Two, fully adjustable, lumbar support locomotive seats and one wall mounted jump seat or third cab seat shall be supplied.

6.2 Doors

The features stated in the section are for guidance only.

6.2.1 Exterior Doors

- Cab shall have a suitable door(s) to the exterior
- Doors shall feature low and; high external handles, recessed with handhold clearance
- Doors shall be fitted with rugged, positive lockable latches. Locks shall be mounted on the lower handle assembly
- One door shall be provided for existing the engine compartment to the rear of the locomotive (*)
- Sliding doors may be proposed for approval to simplify cab layout

6.2.2 Interior Doors

- Cab Area: One or more as required reducing the engine room noise from the engine room, opening away from cab area.
- Recessed handles having adequate handhold clearance and positive latching mechanisms
- Sealed against fumes, dust and weather elements.
- Sliding doors may be proposed for approval to simplify cab layout

6.3 Windows

6.3.1 Windshield

Glass and frame shall be FRA-CFR 49 part 223 certified glazing. Design by thickness, type material, spall shield, or other approved means to be provided to prevent entrance of glass particles into cab area. Windshields shall be interchangeable where appropriate. Glass shall be electrically heated with integral heating element and have a minimum tint. All cab windows shall be water tight using seals resistant to weather and sun exposure.

Windshield shall be oriented so as to provide maximum viewing forward to the horizon, to the near track, and at an angle subject to carbody design to the right and left of track for the Engine Crew. It shall be slanted forward to reduce glare. View shall be 20º or less of locomotive front comer. It shall be installed so that it is not unduly stressed by frame or carbody flexure.

6.3.2 Side Window

Sliding windows shall be FRA-CFR49 Part 223 certified glazing.

Sideways sliding sash shall be easy to operate and can be secured at any desired opening.

Window shall be properly sealed against noise and fumes/dust/moisture when closed.

Side windows may be designed to be used as an emergency escape function in case of an accident.

6.3.3 Wind Deflectors

Retractable Prime or approved equal wind deflectors with full-length rear mirrors shall be installed forward of the left and right side windows.

6.3.4 Windshield Defrosting

Electrically heated windshield defroster controls shall be located at the engineman's station. Windshield defrosting shall be supplied to the front windows only.

6.3.5 Windshield Wipers

Windshield wipers fitted as needed to cover windshield viewing area adequately.

Electric wiper motors or approved equivalent to have variable speed controls located at engineman's and observer's stations capable of clearing water and snow at locomotive speeds of up to 125 mph. If pneumatic wipers are proposed, wiring provisions shall be supplied to enable future retrofit of electric wiper motors.

6.4 Emergency Egress and Ingress

A means for emergency egress or ingress of the locomotive cab shall be incorporated into the design of the operator's cab. Provisions shall me made for the cab occupants to exit in an emergency. The provisions shall also incorporate a means for outside emergency personnel to enter the cab area.

6.5 Interior Liners and Panels

Interior liners, masks, covers, etc. shall be designed and constructed in an integrated consistent manner and in full compliance with FRA flammability, smoke and toxic gas emissions guidelines. All edges shall be molded, and both moldings and fit finish of panels shall be to highest standards of workmanship.

6.6 Seats

Two high-back style locomotive seats and one wall mounted jump seat shall be provided in the cab. The seats shall contain ergonomic features to reduce fatigue and allow for safe train operation. The seats shall have vertical, horizontal, reclining and rotating adjustments; shall have folding arm rests and shall be upholstered. A suspension system to minimize vibrations shall also be provided.

A third or folding, wall mounted jump seat shall be incorporated into the cab design

6.7 Toilet Room

A low volume water, stainless, retention or waste treatment type toilet shall be provided. Toilet design to be to be approved by the purchaser.

No recesses on or adjacent to toilet shrouds shall be permitted which may gather dirt and debris.

Toilet compartment shall be provided in an approved location. Compartment shall be properly vented. Compartment shall have an adequate dam and drain to facilitate cleaning.

Toilet shall have a toilet paper dispenser and suitable handhold located on wall adjacent to unit.

6.8 Electrical Receptacles

Two grounded duplex electrical receptacles for 110 VAC power shall be provided in the cab area. All shall be protected to 20 amps.

One suitably protected 64 VDC receptacle shall be provided in the cab.

6.9 Heating, Ventilation, and Air Conditioning

- Electric cab heaters having two levels of heat/air flow, .with independent controls for engineman and helper
- Sized to maintain the area around the crew comfortably warm under all cold weather conditions, not less than 65° at up to maximum forward speed
- Heated air delivered at floor level at front and sides of cab
- Positive circulation of clean air through cab at all times
- Positive ventilation provided in toilet area, vented away from cab and engine compartment
- Cab air-conditioning shall be capable of maintaining a temperature no
- greater than 75° F at external ambient temperature of 105° F
- Manual control to be provide for cooler/warmer adjustment
- Preference will be given to single complete climate control (HVAC) unit providing heat, ventilation, and air conditioning. Unit shall be mounted inside locomotive, not in cab roof. Side wall heaters powered independent of the HEP source of power.

6.10 Cabinet Door Securement

- Suitable recessed or folding latches capable of remaining latched against normal locomotive coupling impacts and vibration
- Doors shall be hinged where possible
- Where screws or bolts are used for securement, they shall be of the type that remain in the door when unlatched and swung open
- The cab is shall be draft free and secure against air leaks from the outside

6.11 Refrigerator

Refrigerator shall be solid-state or approved equal. Refrigerator shall be cable of remaining powered if the main engine or HEP power source is not operating.

6.12 Water Cooler

A water cooler shall be provided. Water cooler shall be able to operate off the locomotive batteries if the main engine is shut down.

6.13 Rain Gutters

Rain gutters shall be installed over the side windows, where appropriate. Consideration must be given to carbody design.

6.14 Spare Knuckle Holder

Single spare knuckle holder shall be provided in a location subject to the purchaser approval; holder shall secure against movement.

6.15 Sun Visors

Visors shall be sliding-type or approved equal, one at each windshield. Visor mechanism shall be secure against vibration.

6.16 Accessories

6.16.1 Clothes Hooks

Three coat hooks shall be installed. Hooks shall be flush with wall when retracted. Hooks shall be mounted at 5' - 6" high in locations approved by the purchaser.

6.16.2 Inspection Card and Work Report Holders

Standard Prime or equal card holders with clear plastic inserts shall be installed in the operator's cab at a location approved by the purchaser. A clip to hold track warrants and other data shall be installed on the Engineer's console, and the left hand console.

6.16.3 Waste Containers

Waste containers to hold a plastic disposable liner shall be installed in the cab. Location and size to be approved by the purchaser.

6.16.4 Cup Holders

Wire-type cup holders or approved equal shall be installed at each one of the two cab stations.

6.16.5 Tool box

A tool box of an approved size and location shall be supplied for hammer and wrench for hose change out. The tool box should also be sized to store spare air brake hose and other small items. The location of the tool box shall be placed to be easily accessible.

6.16.6 Supply Box

A supply box of an approved size and location shall be supplied for fusees with a flag holder.

6.16.7 Tissue Box Holder

A stainless wall mounted tissue box holder. The tissue holder shall be within reach of the locomotive operator. The tissue shall have no sharp edge. The purchaser to approve location of the holder.

6.16.8 First Aid Kit

The cab shall be equipped with an approve Amtrak style first aid kit or approved equal.

6.16.9 Cab Window Arm Rest

Cab window arm rests shall be provided on the inside wall of the cab.

7.0 Locomotive Propulsion System

7.1 General

The power plant to be used shall be a proven product in successful revenue service operations and capable of providing reliable and efficient performance in intercity services in the State of California.

7.2 Service and Performance Requirements

The power and operating range shall be sized to operate a train with a trailing or pushing load of up to eight Passenger Cars at the maximum speed of up to 125 mph on tangent or level tracks.

The Builder shall provide a complete and comprehensive description of the proposed unit, including its past performance and experience. At the minimum the Builder shall also provide plots, charts or tables for the following as part of his bid proposal:

- Locomotive Rail Horsepower 0 - Max Speed
- Dynamic Braking Effort 0 - Max. Speed
- Traction Motor Characteristics
- 0 - Max. Speed with Short Time Ratings
- Acceleration to Maximum Speed with:

1 locomotive	+	560,000 lbs. of trailing load (3 cars + 1 cab)
1 locomotive	+	840,000 lbs. of trailing load (4 cars + 1 cab + 1 diner)
1 locomotive	+	1,120,000 lbs. of trailing load (6 cars + 1 cab + 1 diner)
2 locomotives	+	1.400,000 lbs. of trailing load (8 cars + 1 cab + 1 diner)
2 locomotives	+	1.680,000 lbs. of trailing load (10 cars + 1 cab + 1 diner)

- Pneumatic Service and Emergency Braking characteristics from 30, 45, 80, 100, 110 mph and 125 mph.
- Blended Service and Emergency Braking characteristics from 30, 45, 80, 100, 110 and 125 mph when applicable.
- Traction Motor
- Arm. Current vs. Tractive Effort (or arm. field volt & current if separately excited)

- The number of power assemblies (cylinders per engine)
- proposed
- Route Performance Calculations
- The Builder shall provide with his proposal full details of his proposed locomotive performance over the Roseville to Oakland route. Two simulations shall be provided:
    - Operation over route according to existing line speed restriction and schedule
    - Operation over route assuming no line speed restrictions
- The route details and assumptions to be made are included in Appendix E -Route Profile Data.
- The simulations shall provide as a minimum the following:
    - Speed/time graphs
    - Tractive effort/time graphs
    - Motor current and voltage/time graphs
    - Generator current and voltage/time graphs
    - Dynamic brake current/time graphs
    - Power/time graphs
    - Fuel usage
- Sufficient detail of the methods and values used in the simulation calculations shall be provided to enable accurate assessment of the data provided.
- There shall be no rating on the locomotive which is for a period of less than 3 minutes. There should be consideration given to provide a short-term boost in horsepower during acceleration.

7.3 Diesel Engine

Shall be powered by a 12 to 16 cylinder turbocharged diesel engine. Engine to be certified to EPA Tier IV standards.

The main engine shall be equipped with an Automatic Engine Stop Start (AESS) system to save fuel and reduce engine exhaust emissions.

7.3.1 Lubricating Oil System

A Builders standard lubricating oil system which utilizes engine coolant to reduce oil temperature shall be provided.

7.3.2 Fuel Preheater

A Builder's standard fuel preheater utilizing engine coolant as the heat source shall be supplied.

7.3.3 Cooling System Requirements

- The radiator shall operate without anti-freeze solution, but with an anti-corrosion solution to protect engine block, assemblies and radiators.
- The radiator shall be adequately protected. Radiators shall be of the bonded type; low profile preferred or other approved equal. No more than ten cooling fins per inch shall be used.
- Shutters, if used, shall be automatic and fully guarded with manual override feature.
- Cooling fans shall be driven by AC electric motors only. Any exceptions shall be fully detailed in Builder's proposal.
- A low coolant level indication shall be provided. Control to provide protection against loss of pump or coolant flow under all conditions shall be provided.
- Manual water drain valve shall be supplied.

7.3.4 Injectors, Pumps

Injectors or pumps shall be self-releasing from control rack if stuck so as to permit continued operation of engine.

7.3.5 Turbocharger

If a turbocharged engine is proposed, it shall be muffled in accordance with FRA Nose limit l requirements.

7.3.6 Engine Jacking

An engine jacking or rotating device shall be supplied.

7.3.7 Manual Cylinder

Cylinder relief devices shall be supplied which prevents the possibility of hydraulic lock when starting.

7.3.8 Cleaning, Drainage

The space under the engine shall be accessible for cleaning and shall be adequately drained to ground or approved equal, away from trucks, traction motors, and fuel tank.

7.3.9 Load Testing

Locomotive shall have a self-load test feature.

7.3.10 Engine Room

- The engine room of the locomotive shall be ventilated to maintain temperatures within reasonable limits.

7.3.11 Main Alternator

- Rectification by solid state devices
- Class H or other approved insulation
- Auxiliary winding for cooling fans and auxiliary systems

7.3.12 Traction Motor

- AC type traction motors shall be of a design proven in North American passenger rail service. Builder shall be guided by the following:
    - Sealed, grease lubricated bearings, anti-friction type tapered roller or equivalent
    - Class H or better insulation with vacuum/pressure impregnation of all coils, armature, field or stator
    - Fitted with quick-access inspection covers
    - Fitted with quick-disconnect cable leads or approved equal
    - Properly baffled to prevent blowing of sand and debris from rails, and to prevent motors from inhaling non-filtered cooling air, rain or snow
    - One motor shall be given all commercial tests for IEEE standards and a complete heat run prior to use in first locomotive
    - Motors shall be cooled with clean air supply. Use of inertial air filters to be employed and in no way shall cooling system permit entrance of snow into traction motors during winter operation

7.3.13 Motor Cutout Switch

Motor cut out switches shall be provided, if they are not part of Builder's microprocessor control system:

- To isolate any one traction motor or a complete truck, control from locomotive cab

7.3.14 Single-Station MU Control

Propulsion shall respond to single-station MU control.

7.3.15 Power Semiconductors

- Shall permit individual component replacement
- Shall be of a type which does not require individual grading and selecting of like component for exact pairing or matching
- Control circuits shall be isolated so as to prevent secondary fault escalation; optical coupling is preferred
- Air cooled unless otherwise approved by the purchaser
- Available from at least two sources, one of which is domestic to the USA

7.3.16 Resistors

All resistors (including PC-boards) shall used fixed values of resistors only. Calibration shall not use adjustable resistors or trim potentiometers wherever possible.

7.3.17 Relays

All locomotive relays shall be of one type where possible; san^ contacts and coils with full interchange ability where possible.

7.4 Jerk Limit

For all acceleration, service braking and slip/slide correction, jerk rate shall not exceed 1.50 MPHPSPS.

7.5 Wheel Slip – Slide Detection

- A state-of-the-art slip-slide protection system shall be provided by use of ' speed sensors on the traction motors and protect against both synchronous and differential slips and slides.
- The locomotive wheel slip control shall make full use of advantages provided by microprocessor techniques.
- Shall make use of available adhesion and protect against all rail conditions and be optimized or use on a lightweight passenger locomotive.
- A positive traction control type system or approved equal shall be provided.
- The slip-slide protection is to shall function in all operating conditions including dead-in-consist and isolated traction motor.

7.6 Over Temperature

Builder's standard over temperature devices and circuits shall be used to protect major electrical devices from damage such as traction motors, braking grids, high-current semiconductors. Protection shall operate to reduce traction power output rather than to interrupt power. Automatic restoration of full power capability when component temperature permits.

7.7 Automatic Speed Limiting Control (optional equipment feature)

- Automatic speed limiting control shall regulate propulsion (not braking) to accelerate to and maintain, desired train speed as selected by engineman
- Acceleration rate shall be dependent upon setting throttle handle
- Engineman's automatic speed limiting control selector shall have "off' position which will isolate the automatic speed limiting control

8.0 Train Lines MU Communication and AC Power Distribution

8.1.1 General

Electrical train line connections for locomotive MU control, communication and the three phase power shall be made by jumper cables as approved by the purchaser. All connections between cars and locomotives and between locomotives shall not pinch or stretch cables. Jumpers shall be color coded for identification of different functions. Spare jumpers shall be provided for all specified functions.

The locomotive shall be designed to operate in multiple with locomotives on the front of the train or in the push-pull concept with a control car and one or more locomotive units at each end of the train.

The pin assignments for the locomotive control train line and communication train line are as described Appendix C.

8.2 AC Power Train line

A three-phase power distribution system shall be supplied which shall have a total combined transmission capacity of 1000 KW.

The front of the locomotive shall be fitted with four 3/3 pole receptacles. The receptacles shall be standard Anderson Power Products R87 Type or approved equal.

The rear of the locomotive shall be Fitted with two 3/3 pole receptacles and two power cables terminated in 3/3 pole free plugs. The receptacles shall be Anderson Power Products Train-Lock Breakaway Type or approved equal and the free plugs shall be standard Anderson Power Products R87 Type or approved equal. The receptacles shall be located in positions #1 (extreme left) and #3 and the power cables with free plugs located in positions #2 and #4.

Both receptacles and free plugs shall utilize a design having three main power pins and three smaller low-voltage control pins each. To prevent disconnection of the power jumper under load, the control pins shall break contact first and open a contact in the 480V supply. When the train is made up, a total of four power jumpers are to be used between vehicles.

Copper cable of not less than 4/0 AWG shall be used for connection to each power pin of the power receptacles on the locomotives. Control wiring shall be 10 AWG. Phase rotation is 1, 2. 3, where pin #1 is #1 phase, #2 is #2 phase and #3 is #3 phase. The #1 control pin shall be utilized in the series-control tramline, #2 and #3 control pins are ground and shall not otherwise be used or connected to any locomotive circuit. Control logic shall be defined at first design review.

Three four-power jumper cables, Anderson Power Products Catalog R86-25D 84", or approved equal, shall be supplied for each locomotive which shall be banded and color-coded bright red. Four power cables shall be permanently fixed to the high receptacles of

the #1 and #2 end connections. The Builder shall install suitable supports at each end of the locomotive within the carbody compartment, to store four power cables.

Automatic looping at the front of the locomotive shall be provided to complete the series-control loop. This circuit shall operate when the locomotive is in the lead position and the receptacles at the front of the locomotive shall be dead (no power).

The three-phase power receptacles and control heads shall be painted bright red for easy identification. When the cables are not in use, the free end of the jumpers are to be plugged into the adjacent receptacle for storage or end-of-train" identification.

8.3 Communication Train line

Communications between the cars, control and looping circuits shall be train lined by means of one 27-point jumper at each end of each locomotive. Two 27-point receptacles, Pyle National Model WrWRF-27-AMTR, or approved equal, shall be provided at each end of the locomotive. The location of the communication train line receptacles located at the ends of the locomotive are to be approved by the purchaser.

Jumpers shall terminate at each end using Pyle National WWRF-27AMTR receptacle. One jumper shall be supplied with each locomotive.

Jumpers shall be of the minimum length necessary to meet the requirements of 8.1. Communication train line jumper control heads shall be painted blue in color to distinguish them from the car to car jumpers. Shrink fit blue color bands shall not be supplied. Communication receptacles shall be painted blue.

8.4 Locomotive Control Train line

Locomotive control shall be train lined by means of 27-point jumpers at each end of each locomotive. Two 27-point receptacles, Pyle National WWRF-27 or approved equal, shall be provided at each end of each locomotive, the location of which are to be approved by the purchaser. Jumpers shall terminate at each end in Pyle National WWRF-27 or approved equal receptacles. One Pyle National WWPCJ-2757LN S-505 or approved equal jumper cable shall be supplied with each locomotive.

Locomotive control jumpers shall have a black color control head to distinguish it from the communication and control jumpers. The receptacle shall be painted black.

Builder to provide two shielded twisted pairs with shields grounded through .47UF capacitor for possible future use in signal multiplexing.

Locomotive shall have the ability to provide load meter reading in cab control car through locomotive control train line using a spare pair of cables approved by the purchaser.

8.5 Door Control Train line

Provisions shall be made to interlock the car doors closed detection system with the propulsion system of the locomotive. The locomotive shall contain a zero speed detection system. An indication on or adjacent to the Engineer's console shall illuminate

when the system is in operation, and when all doors are closed. The doors open condition shall inhibit the propulsion system preventing motion. Manual isolation feature shall be provided.

8.6 Labeling, Coding and Stowage

Appropriate warnings and identification of all train line connections shall be prominently displayed on the outside of both ends. Simplified instructions and directions for connection, disconnection and storage of jumpers shall also be slated including safely precautions and sequence of operations. Color coding shall he used to assist personnel in the makeup of the trains. Car communication - blue jumper, blue receptacle; HEP power - red jumper, red receptacle; locomotive control - black receptacle, black jumper.

All loose tramline jumpers on the locomotive shall be stored and secured in a suitable location approved by the purchaser.

9.0 Sanding System

9.1 General

This section describes the basic requirements of the locomotive sanding system.

9.2 Locomotive Sanders

Locomotive sanders shall be electric and train lined for forward and reverse sanding. Four traps shall be supplied with cut outs provided at each orifice block or other location approved by the purchaser. Controllers and valves shall be Salem 277-2 and 500-BS. A non-latching push button and cut out shall be provided on the Operator's console to manually control sanding. A Builder's standard, individual sanding unit to correct wheel slip shall be provided. Any emergency air brake application shall initiate sanding, nominally timed for 30-second duration.

9.3 Sand Boxes

Builder's standard sand boxes of sufficient capacity for the purchaser requirements shall be supplied, two at front and two at rear. Boxes shall be integral to the body structure. Boxes shall be constructed of non-corrosion material and lined with epoxy paint or suitable corrosion-resistant material. The sand box openings shall be fitted with watertight hatch covers with latching mechanisms. Clean out openings for the sand boxes shall be located at the bottom or side of the boxes.

10.0 Battery System

10.1 General

This section describes the basic requirements of the locomotive battery system.

10.2 Batteries

A 400 A.H. or greater capacity batteries with an 8-hour discharge rate shall be provided. Batteries shall be either lead acid or gel cell-low maintenance type. Batteries shall meet the requirements of AAR standard S-508.

10.3 Battery Compartment

Battery compartment shall be self draining clear of under frame equipment and trucks. Compartment shall be fitted with ready-access cover or hatch, stainless steel grating at the bottom of the battery box with adequate venting. Battery tray, hold down, and slides shall all be stainless steel. Compartment shall be easily accessed for inspection and maintenance. Compartment shall be properly fastened to ensure battery is secured during any unsafe situations. The interior of the battery box shall be painted with acid resistant paint.

10.4 Battery Charging

A Builder's standard locomotive-type solid state charger or approved equal shall be provided. A zero-center ammeter shall be provided on the control panel in the Operator's cab. The Batteries shall have the capacity to start the main engine under all environmental conditions.

11.0 Heating, Ventilation, and Air Conditioning (HVAC)

11.1 11.1 General

This section describes the basic requirements for the HVAC system in the locomotive cab.

11.2 11.2 Air Intake and Exhaust

Except for cooling air for radiators and dynamic brake grids, cooling air shall be filtered. Provisions for dry warm air to traction motors if recommended by the Builder shall be included for winter operation.

Electrical compartments, where necessary, shall be vented positively to exclude dust and sand.

Cooling air intakes shall be located at sides of roof: exhausts shall be at a suitable location to ensure that air is not discharged into other locomotive cab compartments or at passenger platform levels.

11.3 Cab Ventilation

Positive air circulation and fresh air ventilation of the cab compartment shall be designed to prevent the entrance of dust, sand, fumes, liquids or precipitation into the locomotive cab with doors and windows closed.

12.0 Braking System

12.1 General

The locomotive shall be equipped with a standard 26L brake system, capable of operating in MU consists. A blended automatic brake system, using an optimal combination of pneumatic and dynamic braking shall be available by means of the automatic brake valve.

12.1.1 Optional Equipment Feature

As an option proposer shall provide an electro-pneumatic microprocessor controlled brake system with diagnostics. This system shall meet all performance requirements of this specification.

12.2 System Requirements

The brake system shall provide penalty application and permanent suppression in conjunction with cab signal, overspend and vigilance control. "Break-in-two" strategy shall be to drop load and return to idle, apply service braking.

A centralized single manifold grouping of the major brake components and valvular devices shall be located in an air brake compartment inside the locomotive below the Operator's cab. A layout drawing detailing apparatus location shall be provided.

Valves and components shall be tagged or identified by nameplate.

A diagram showing location of all cut-out cocks shall be provided. Cut outs to be located for easy accessibility.

12.3 Pneumatic Schedule

A standard air brake system with graduated release feature or approved equivalent shall be furnished. System shall have adjustable feed valve set for 110 psi brake pipe pressure.

Emergency brake provisions shall be as follows:

- Automatic brake pipe charging cut off
- #8 vent valve or equivalent
- Emergency valve on fireman's side in cab
- Automatic penalty service-rate braking (from cab signal and alertness control with reduced permanent suppression based on a cumulative reduction of 17-19 psi brake pipe)
- Penalty application shall reduce traction power to zero at a rapid but controlled rate;
- Penalty application shall not draw brake pipe to zero, but shall self-lap when a full-service application is achieved;
- Recovery from penalty and penalty feature shall be in accordance with individual apparatus requirements. A full suppression application shall always be necessary.

12.4 Blended Brakes

12.4.1 Dynamic Brake

Independent control of dynamic brake shall be provided and controlled by throttle brake position. Automatic blending with air shall be provided via automatic brake valve, at any time the throttle is not in a power position or dynamic braking and no independent brake is called for.

Braking rates shall be properly coordinated with the rates provided by the California Car.

12.4.2 Performance Criteria

- Full-service, air-only braking shall not be less than 1.3 MPHPS
- Emergency, air-only braking shall not be less than 1.6 MPHPS
- Full-service, blended braking shall not be less than 1.6 MPHPS
- Emergency, blended braking shall not be less than 2.0 MPHPS
- Air-only brake shall be used below 5 mph, and immediate motoring shall be available to engineman between 0-5 mph
- Blended brake shall be available when throttle is in idle
- Pneumatic priority shall be given in emergency and dynamic priority on service-rate applications, pneumatic brake shall be fail safe against loss of dynamic brake
- Wheel slide detection/correction shall be in conjunction with dynamic and pneumatic brake during blending
- Brake Cylinder Pressure (B.C.P.) shall be limited to emergency maximum when independent brake valve is applied during blending

12.5 Air Compressor

Compressor shall be electrically driven or approved equal with on and off capabilities upon demand. Main reservoir pressure shall be maintained at 140 psi (130 psi to 150 psi operating range) with 200 CFM minimum.

12.6 Air Dryer

System shall be equipped with two-stage auto air dryer system with a coalescing oil removal filter.

12.7 Main Reservoirs

Two 25,000 cubic inch minimum steel locomotive air reservoirs shall be provided. Suitable protection against debris damage for #1 main, #1 and #2 drain valves, and piping shall be provided. Oil and water content in air to reservoirs shall be sufficiently low to ensure reliable operation of all pneumatic components.

12.8 Accessory Valves

12.8.1 Safety Valves

Safety valves provided shall be J-l safety valve, 155 psi trip, #1 main reservoir inlet. Builder's standard intercooler safety valve or approved equal shall be supplied.

12.8.2 Check Valves

Salem 596 or approved double check valves, Prime 301-2 or equivalent orifice check valve main reservoir tramline for break-in-two protection shall be provided.

12.8.3 Automatic Drain Valve

Salem 880 or equivalent drain valves at #1 and #2 main reservoir flange connections shall be provided. Salem 872 timer or equivalent, nominal 3 minute cycles shall be provided.

12.9 Air Gauges

Suitable gauges shall be provided on the engineman's console lo display air brake functions and status. Beacon 503-A, or approved equal air gauge, shall be located at air compressor.

Note: B.C.P. take off shall be connected at a point between the brake cylinder and its associated cut-out cock.

If the option for consolidated cab electronics is exercised, the electronic gauges shall be incorporated in the screen displays.

12.10 Angle Cocks

Smith, Sloan, or equivalent ball-type angle cocks shall be used at each end of brake pipe. Builder's standard cut-out cocks shall be behind pilots and readily accessible to operating personnel.

12.11 Air Piping

Air piping shall be extra-heavy wrought steel using 300 lb. AAR rated fittings (under carbody). Brake pressure and car supply train line piping shall be 1.25 I.P.S. Builder's standard piping and tubing shall be approved by the purchaser.

12.12 Connections

- MU connections shall be at both ends, both sides of the coupler
- Main reservoir hoses shall be Aeroquip 1531-16 with LS4 or equal
- Other MU hose shall be WABCO 543006 or equal
- All MU train lines shall be identified by metal tags or approved equal
- Brake Cylinder hoses, shall be Aeroquip 152110-12-16-32 3/4 wire reinforced

- Brake pipe shall be Builder's standard 22" AAR
- New hoses shall be furnished, all to be less than 1 year old from date of manufacturer
- Dummy couplings shall be furnished to support the hoses when not coupled.

12.13 Independent Brakes

An independent brake valve, set for 72 psi B.C.P. except as otherwise approved (45 psi Appl. Release train line) shall be provided.

13.0 Head End Power System

13.1 General

The locomotive shall be equipped with a head-end power (HEP) source which shall produce 480 VAC, 3 phase, 60 Hz electric power for heating, lighting, and other hotel power needs of connected passenger cars. The HEP power source shall be capable of producing 500 kW at 0.8 to 1.0 power factor at 480 volts, 60 Hz. The control and distribution system for the HEP shall utilize the 480 VAC power distribution train line.

13.2 HEP Control

The output of the HEP power source shall be controlled by a static voltage regulator and suitable engine governor capable of maintaining voltage on the hotel alternator to within 3% of 480 volts between no-load and full load, and 3% or better variation in engine rpm, except that 10% voltage variation shall be tolerated for not more than two seconds for an increase of up to 75 kW in the hotel load. Overloads from initial load during start up of a 10 car consist shall be automatically controlled by voltage reduction, to an acceptable level, to avoid overloading of the diesel engine for the duration of the heavy load. A 0-600 V ac scale voltmeter and 0-1000A scale ammeter with isolation transformers, switchable to any of the three phase legs, and a 0-100 Hz frequency indicator shall be included as part of the head-end power plant control panel. A wayside power interlock relay shall also be included in this panel.

The HEP controls shall be equipped with train line voltage relays (TLV) and train line complete relays (TLC) which determine when the HEP generator can energize the 480 V tramlines. The TLC relay shall prevent having an energized empty HEP receptacle.

13.3 Control and Distribution System

The HEP power plant control and distribution system shall be electrically isolated from the locomotive propulsion system.

The head-end power distribution system shall be capable of the following modes of operation:

- To distribute onboard generated 480 VAC power through the train line.
- To distribute 480 VAC power from a locomotive or wayside power source from one end of the locomotive to the other end through any or all of the train lines.

Sufficient numbers of power disconnects of the approved type shall be furnished such that distribution train lines can be disconnected from the plant.

The main line breakers between the alternator and the 3 phase bus shall be sized to trip open whenever the demand load becomes excessive for the alternator or other plant components, and when an over or under frequency, or over or under voltage condition occurs.

The control system shall be designed to prevent closure of the line breaker and application of power to train lines if the train lines are already energized from another source of 3 phase power. The control system shall also prevent closure of breakers and application of power if the series-control train line loop is not electrically complete. The control system shall function to immediately open breakers and remove power from train lines upon interruption of the series control train line loop continuity. A single-dual bus switch shall be supplied.

13.4 Control Panel

The locomotive shall be equipped with an electronic control panel located close to the HEP power plant, to control the HEP power source. The functions of the control panel should include the following:

- Controls and switches as required to start and stop the HEP
- Controls and/or switches as required to reset tripped safety appliances
- Meters and switches
- Circuit breakers to protect meters
- Indicators as follows:
    - Main breaker closed (green) (one per breaker)
    - 480 volt external feed (red)
    - Main power breaker (or breakers, as required)

All the above mentioned controls and appurtenances mounted on or in the control panel shall be mounted free from vibration and is of a high quality. The location and installation of the above controls shall be reviewed and approved by the locomotive operator.

A digita1, solid-state l control system shall be required.

Shut-down of the power plant shall also be controlled remotely from the operating cab panel. An isolating switch with a stop push button shall be provided. The stop push button shall function under any condition of plant operation to immediately open breakers, reduce alternator excitation, and remove all power from the distribution train lines. The emergency shut off shall also operate the shut down sequence.

In addition, power plant shut-down shall be possible from the control cab of the cab car via train line control signals.

13.5 Connection for Train line

Train line power connections shall be provided which are compatible with Amtrak F40PH locomotives.

13.6 Control Interlock Circuits

Interlock circuits shall be as provided on Amtrak F40PH locomotives.

13.7 Maintenance

The HEP package shall be designed in such a way as to be removed easily from the locomotive as a unit. Quick-disconnect fittings shall be used wherever possible.

The floor under the HEP plant shall be arranged so that any liquid drips or leaks shall be collected in the head end power engine sump.

The electrical control panel shall stay with the locomotive when the power plant is removed. Quick-disconnect fittings shall be provided, subject to review and approval by the Engineer. The HEP shall have as a minimum a 90 day maintenance cycle.

14.0 Train Communication

14.1 Radio

The following features shall be incorporated in the operator's cab radio:

- Motorola Spectra radio with internal MIC option, 96-channel or approved equal
- A 4" low-profile antenna, WABCO 25AN-1 or approved equal
- RG8U cable w/2-PL259 connectors
- A transceiver and handset shall be furnished
- As an option Builder shall supply radio hookups on the fireman's side of the cab.

14.2 Antenna

Radio antenna on the locomotive roof shall be located to maximize reception and minimize clearance vulnerability. GPS and Cellular antennas shall also be accommodated in the design.

15.0 Operator's Cab Controls

15.1 General

This section describes the engineer's control station and console which shall be provided on the right side of the cab when viewing forward from the cab. The console layout shall follow Amtrak and AAR "clean cab" guidelines. Gauge and indicator orientation shall eliminate glare and reflections. The indicator lens scheme shall conform to the following:

- Green "GO" Status (Limited Use)
- Amber "WARNING" Status
- Red "NO-GO" Status, system malfunction or system disabled
- White "INFORMATION" Status (Limited use)

The Builder shall submit drawings including perspective renderings, as required, illustrating the console arrangement for approval by the purchaser.

15.1.1 Console

A "clean cab" desk-type console shall be provided.

15.2 Controls and Switches

The controls and switches located at the engineman's console are those related either to his use of operating station, or those which control this and train lined locomotives. There shall be no foot operated controls unless approved by the purchaser. The controls and switches to be located at the engineman's control station and console shall include, but are not limited to the following, to be numbered, lettered, or colored as shown:

Control Levers	**Type or Label**	**Location**
Master-Controller	Single-handle controller with eight notches of power, idle, eight notches of dynamic braking	Desk
Reverse Lever	Forward/Neutral/Reverse/Off with locking and handle removal in Off	Desk
Automatic Brake with independent brake valve	Two Handle Controller	Desk
Switches		
Headlight Control	Off-Dim-Bright-Crossing	Console

Headlight Select	**Front-Rear-Trail**	**Console**
Sanding	Momentary contact, forward/reverse sanding	Console
Gauge Light Switch		Console
Gauge Light Dimmer		Console
Cab Light		Console
Train Order Light		Console
Strobe Selector		Console
Cab Signal Cut Out		Provision
Cab Heater/Defroster		Console
Windshield Wipers		Console
Automatic Speed Limiting Control		Console
Number Lights		Console
Ditch Lights		Consoles
HEP Electrical Reset		At or near electrical cabinet or Console
HEP Start		Cab
HEP Stop		Cab
Electric Defrosters (Heated windshields)		Console
Push Buttons		
Attendant's Call		Console
Alertness Reset		Console
Acknowledgers		
Cab signal acknowledger and Alerter Reset shall be		

combined in a "mushroom" push-button

Communications Control

Air Horn	Lever Operated	Desk
Air Horn (Grade Crossing Sequence)	Foot Operated	Floor
Radio		Desk
Public Address Control Head		Console
Control/ Fuel Pump		
Generator Field		

15.3 Gauge Functions and Indicators Engineman's Station

The control console shall include essential train operation controls, gauge functions and indicators. Design of control devices, indicator panels, auxiliary control panels, and other items within the operators cab shall follow accepted principles of human/machine interface engineering and shall be demonstrated by mock-up and approved by the purchaser.

All gauge functions and indicators shall be grouped logically. Critical indicators including locomotive air brake pressure data, traction motor current and locomotive speed, as well as various status indicators, shall be directly forward of the console, mounted approximately vertically.

Provision for a cab signal display on the center post between windshield halves shall be made.

15.3.1 Gauge Functions and Indicators - Left Side Console

The left side console shall contain a speed indicator, a horn control and a bell control, all in a similar position to that on the engineer's side together with an emergency brake valve, a timetable light switch, and windshield wiper defroster controls for the left windshield.

15.4 Alarms

The Builder shall furnish and install the following alarms within operating cab environment which shall function in accordance with the schedule in figure 1:

Audible Indicators	**Functions**
Main Alarm Bell	Ground Faults, Attendant's Call, HEP No Power
Buzzer	Conductor's Signal
Sonalert	Cab Signal Penalty Brake Application Warning
Klaxon (yelp)	Alertness Control

As an alternate, a time coded or multiple tone single sound source arrangement may be used to simplify the alarm system

The alarms shall function as shown in Figure 1.

Event	**Audible**	**Train lined**	**Visual**	**Train lined**	**Effect**
Ground, Propulsion	Bell	Yes	yes	No	Propulsion power off
Ground, HEP	Bell	Yes	Yes	No	Indication only
Wheel Slip/Slide	-	-	Yes	Yes	Reduced propulsion
Dynamic Brake Overload	Bell	Yes	Yes	No	Removes power from affected circuit
Motor Circuit Overload	Bell	Yes	Yes	No	Removes power from affected circuit
Alertness Control	Klaxon	No	Yes	No	Impending penalty brake
Cab Signal/ATC	Sonalert	No	-	-	Impending penalty brake
No Battery Charge	-	-	Yes	No	Indication only

Power Off (PCS)	-	-	Yes	No	Propulsion power off
Locomotive Over speed	-	-	Yes	No	Impending penalty brake
No Speed	-	-	Yes	No	Indication only
Emergency Strobe Activated	-	-	Yes	No	Indication only

15.5 Head End Power Plant Control Panel

The Head End Power Control Panel shall be mounted on the High Voltage Cabinet and shall contain the following indicators and switches. Electrical systems, when tripped, shall be resettable from the cab.

HEP T.L. Comp

HEP Cut Out (Right)

HEP ON

Thermal Overload

Inst. O.L. Trip

480 Volt External Feed (red)

High Crankcase Press

Low Lube Oil Pressure

Hot Engine

Engine Overspend

Volt Trip

HEP System Ground

Freq. Trip

HEP Source Switch

HEP Train line Set-up Switch

HEP ON Switch

HEP OFF Switch

HEP Cutout Switch

Low Oil Level

Low Water Level

High Water Temperature

Main Breaker Closed (green)

Generator hi/low voltage

Generator hi/low frequency

16.0 Lighting

16.1 General

All lighting shall be supplied from the 64-74 VDC battery system. Engine room lighting shall be suitable for operating and maintenance personnel.

16.2 Exterior Lighting

The exterior lighting of the locomotive shall be equipped with all light fixtures and intensity performance in accordance with FRA and AAR Standards, railroad operating practices and the requirements of this Specification. The following exterior lights will be supplied as a minimum:

16.2.1 Headlights

Twin PAR56, 30VDC 200-watt sealed beam shall be supplied at each end. Access for bulb replacement shall be from inside the locomotive if possible. "OFF-DIM-BRIGHT-Crossing" control switch shall be installed in the Operator's console, readily accessible and easy to operate. A headlight control switch shall also be provided for the rear headlight.

16.2.2 Crossing Lights

Crossing lights shall be installed on the front of the locomotive and controlled through the Front Headlight switch.

16.2.3 Truck Lights

Incandescent lights shall illuminate the truck area to facilitate inspection. Location of lights and switches subject to the purchaser approval.

16.2.4 Step, Ladder and Ground Lights

All steps, exterior platforms, and ladders shall be indirectly lighted. Location of lights and switches are subject to the purchaser approval. Lighting at ladders will also illuminate the ground area immediately below the ladders and steps.

16.2.5 Number Boards

A digital display illuminated, number board located at both ends of the locomotive shall be required.

16.3 Interior Lighting

The following interior lights will be supplied as a minimum:

16.3.1 Operating Cab Lights

Two main ceiling lights, one each right and left side of cab or one florescent overall cab light shall be provided. Two over the console lights with a narrow beam shall be provided to light engineman's and fireman's desk area. LED lighting is preferred.

16.3.2 Engine Room Light

The engine room shall have sufficient fluorescent or LED lights. The lights or LED lighting shall be fitted with a 30 second off delay. Switch locations to be approved by the purchaser.

17.0 Fuel System

17.1 General

This section describes the basic requirements for the locomotive fuel system.

17.2 Fuel Tank

A 2000 gallon minimum fuel tank shall be hung or made integral to the locomotive carbody design subject to the purchaser's approval. The tank design and location shall provide for constant weight distribution regardless of fuel level.

Tank shall be designed for fueling at a minimum rate of 250 gpm and shall be fitted with suitable washout plugs and drain valves.

The tank shall be protected against road and debris damage by an approved means. Particular attention shall be given to both ends and the leading 1/3 of tine bottom area and tine trailing 1/3 of the bottom area. Provision to equip the fuel tanks with liners or other means to prevent leaks due to external damage shall be provided.

17.3 Fill Pipe

One 2 1/2" I.D. fill pipe, one located on each side, at or about tank center shall be provided. Pipes shall be fitted with Snyder II fuel fitting or approved equal. Each fill pipe shall have "Fuel" stenciled above at side sill.

17.4 Fuel Gauges

Fuel level gauges, one at each side near fill shall be provided. A Nathan 8" Glo-Rod sight glass or approved equal at end of tank, one on each side shall be provided. Electron fuel level gauges may also be proposed.

17.5 Emergency Cutoff

Emergency cutoff shall be electrically operated, remote control, arranged for remote reset.

There shall be at least four cutoff stations:

- Right hand and left hand sides, below platform and near fill pipes, easily accessible from ground level, completely waterproof
- In operator's cab
- Near governor or start switch

18.0 Safety Accessories

18.1 General

This section describes the safely accessories required for the locomotive.

18.2 Speed Recorder and Indicators

Provide a speed control system indicator and a basic event recorder subject to the purchaser approval.

18.2.1 Optional Equipment Feature

As an option, provide a state-of-the-art fully integrated microprocessor event recording system which would integrates consolidated cab electronics display panels.

18.3 Alertness Control

An electronic alertness monitoring system shall be provided with the following resets:

- Throttle
- Use of Bell or Horn
- Use of Dynamic Brake
- Console Reset Button (c/sig. ack.)
- Metal "Touch-Off" or other approved equal

A B.C.P. of 20 psi or more shall suppress alertness control. Control shall be completely inactive (no audible alarm) in "trail" position. Provision for standing test of system shall be provided. If optional equipment feature event logging system is fitted, the alertness control shall be integrated per Amtrak Specification #554 - Appendix D.

18.4 Crossing Bell

An electronic crossing bell shall be provided. It shall be located below the deck for maximum sound dispersal fore, aft, and sides of unit.

18.5 Air Horn

A Nathan K5LA or electronic equivalent air horn shall be provided in the forward direction. The horn shall be protected or located to avoid plugging with airborne snow or debris in the slip stream over front nose of unit; recessed in carbody and easily accessible for maintenance and replacement. Horn shall be located as far from cab as possible at a location approved by the purchaser.

18.6 Fire Extinguishers

Three dry chemical type 3A-80 B C fire extinguishers or equal shall be supplied; one in cab, two in engine room. Quick-release clamps shall be used to secure the fire extinguisher in the equipment room and cab area.

18.7 First Aid Kit

An Amtrak standard first aid kit shall be provided or purchaser's supplied.

19.0 Environmental Characteristics

19.1 Noise Emissions

19.1.1 External Noise Limits

Locomotive will meet the following external noise requirements. At 100 ft. fore, aft., sides, 48 inches above ground:

- Idle 67 **TBD** dBA max.
- Full Self-Load 87- **TBD** dBA max.
- Idle, Full Horn to meet FRA Requirements
- HEP only **TBD** dBA max.

Noise tests will be conducted on the first unit.

Horn shall be as far from the cab as possible. Noise level shall be sufficient to comply with FRA requirements.

19.1.2 Inside Cab

The cab interior noise shall be measured on the "A" scale on a time weighted, duty cycle basis, with the prime mover diesel in any throttle position and any load on the hotel power diesel engine. The noise shall be measured with all the cab windows closed and the HVAC system fan running at full speed.

Noise inside cab in dynamic brake notch 8, under self-load test, with dynamic brake blowers operating, will be less than **TBD** dBA. Cab will be fully insulated to reduce noise to lowest possible level.

20.0 System Assurance

20.1 General

This section defines activities required to ensure the quality, reliability, availability and maintainability of the locomotives.

20.2 Quality Control

The Builder shall submit an independently verifiable complete Quality Assurance Plan, describing the Builder's and its subcontractors' QA/QC policies, processes and procedures, including procurement processes, materials, components and systems selection.

It shall be the responsibility of the Builder to maintain an adequate system of quality control, covering manufacture in his own plant as well as that in plants of equipment Contractors. This system may include internal inspection by Contractors, but the Builder shall make periodic checks to verify the adequacy of Contractors quality control. The Builders quality control group shall have fully independent authority to reject unsatisfactory material, equipment, subassemblies, regardless of any effect on the progress of the work. The Builder's quality control plan including in-house controls, Contractors surveillance, record keeping, etc. shall be submitted for approval.

20.3 Reliability and Availability

Builder shall develop and submit a progressive maintenance program which shall ensure 90% availability for scheduled service and no failures which would interfere with scheduled service (including safety, comfort or delay related failures).

20.4 Strength and Reliability

The locomotive, trucks, apparatus and equipment furnished under this Specification shall be of the best engineered design for the service intended. Unless stresses, deflections, or properties of structural sections are specifically required herein, the Builder shall use his best judgment and experience in determining the stresses imposed by the type of operation, and he shall provide for these stresses with an adequate margin of" safety. In no case may design stresses exceed those considered acceptable in the industry.

20.5 Maintainability

The vehicle shall be designed and constructed for ease of maintenance. Special consideration shall be given to such concerns as access to equipment, repair and/or replacement procedures, tools to be used, safety of operation, access doors, panels and hatches, and space around the component being repaired or replaced. Special consideration shall also be given to the human factors aspect of equipment maintenance.

The Builder shall identify any components in the proposed design which may not comply with the objectives of this specification.

The Builder shall list any equipment, subsystem or component requiring two hours or more to be disconnected and removed from the locomotive. The Builder shall also list equipment, tools, and the conditions required to perform these tasks.

21.0 Tests

21.1 General

The Builder shall conduct all tests required by this specification, except where the test required to be performed by an independent party. All tests shall be arranged by Builder, who shall be responsible for all testing costs, unless otherwise approved. Test procedures shall be submitted to the purchaser for approval at least 30 days before first test date.

The following tests shall be performed on the locomotives and their components by the Builder and/or Contractors:

Air Conditioning Tests			
Functional Test	All locomotives	Builder	21.7.7
Heating Tests			
Functional Test	All locomotives	Builder	21.7.8
Brake Tests			
Blended Brake Test	All locomotives	Builder	21.7.4.2
Air Brake Test	All locomotives	Builder	21.7.16.1
Parking Brake Test	All locomotives	Builder	21.7.16.2
Road Brake Test	One locomotive	Builder	21.7.4.1
Electrical Tests			
Locomotive Sequence Test	All locomotives	Builder	21.7.17
Locomotive Electrical Test	All locomotives	Builder	21.7.15
Carbody Water-tightness Test	All locomotives	Builder	21.7.6

Clearance Test	One locomotive	Builder	21.7.12
Miscellaneous			
Truck, Coupler and Cable Clearance Test	One locomotive	Builder	21.7.11.1
Headlights, Misc. Light Adjustment	All locomotives	Builder	21.7.11.2
Fuel Fill	One locomotive	Builder	21.7.11.3
Locomotive Track Test	One locomotive	Builder	21.7.20
Qualification Test	One locomotive	Builder	21.7.5
Body Compression Test	One locomotive	Builder	21.7.9
Collision Post Test	One Assembly	Builder	21.7.10
Wheel Slip/Slide Test	One locomotive	Builder	21.7.14
Sound Test	One locomotive	Builder	21.7.18
HEP Test	One locomotive	Builder	21.7.19
Emissions Test	One locomotive	Builder	19.2

21.1.1 Reports

Written or Computer Generated reports of all tests performed on the locomotives and their components shall be submitted to the purchaser. Tests required by the Specification which are performed on all locomotives or all components shall be included in the History Books.

21.1.2 General Test Requirements

All tests shall be performed at plants of the Builder or of the Contractors unless otherwise specified. Use of track testing on the railroad other than that described specifically herein is to be held to a minimum. All tests and test facilities will be approved by the purchaser. Where the Builder already has standard tests/procedures that meet the intent of any of the following sections, these may be submitted as alternate test proposals for approval by the purchaser.

The Builder and the purchaser jointly shall select suitable track of proper length and alignment to permit implementation of the qualification track tests required. These tests shall be conducted by and at the expense of the Builder. All working and moving parts, and all operating devices; and controls of each locomotive and its apparatus, shall be tested and put in proper operating condition. Should the locomotive be disassembled in

any way for shipment, it shall be given an operational test upon reassembling at the delivery point on a track provided by the applicable Railroad, at the expense of the Builder.

After receipt of the locomotive at the designated delivery point and before -L passing into regular operation, each locomotive will be carefully inspected, and any part, device or apparatus requiring adjustment, repair or replacement will be called to the attention of the Builder, in writing, who shall make adjustment, repair or replacement at his own expense.

The purchaser reserves the right to make, at its own expense, additional operating tests of locomotives within the parameters set out in this Specification.

The Builder may assign a competent representative lo witness such operating tests. Any defects disclosed by such tests, in apparatus, material or workmanship shall be corrected at the Builder's expense. All expense and costs incurred in the removal of locomotives from the designated delivery point for correction of defects shall be borne by the Builder.

Official final acceptance of the locomotive by the purchaser shall be performed after all tests are successfully completed in accordance with the requirements stated herein. All costs and expenses incurred in performing these tests, including transportation to and from the test tracks, shall be borne solely by the Builder.

21.1.3 Brake Test

The following brake tests shall be performed by the Builder:

21.1.3.1 Road Brake Test

A road brake test shall be performed with a train set consisting of a locomotive and four cars. The Builder shall provide instrumentation (to include, as a minimum, wheel temperature, brake cylinder pressures, time, distance, speed and acceleration), and test personnel to adequately evaluate the brake equipment and demonstrate stop distances and times and verify braking characterization. Builder shall also conduct concurrently wheel slip/slide tests. Reports of all tests shall be submitted for approval prior to final locomotive acceptance. Road brake test to be performed in conjunction with the Locomotive Track Test. A single locomotive shall also be tested to determine stop distance and wheel temperatures up to maximum authorized speed at 10 mph increments.

21.1.3.2 Blended Brake Test

On each locomotive, the blended air/dynamic brakes shall be functionally tested according to Builder's Standards so that the current settings control calibration, etc., meet the performance requirements. Actual stopping distance tests shall be incorporated into the train set track testing.

21.1.4 Qualification Tests

The following qualifying tests shall be conducted by the Builder performing the Road Testing.

Sound Levels Test	Clearance Test
Road Brake Test	Blended Brake Test

Train line Test Performance Test

All charts of data recorded shall be treated for permanence, and shall become the property of the purchaser.

21.1.5 Carbody Water-tightness Test

Each locomotive shall be subjected by the Builder to a complete test for water-tightness, as described below:

All areas of the sides, ends, and roof, including doors and windows, of the locomotives shall be given a complete test for water-tightness. The test shall be made before installation of sound deadening material, thermal insulation, and interior finish. Water shall be sprayed from nozzles which are spaced no more than three feet from and aimed directly at the surface being tested. Not less than 0.625 gallons per minute shall be delivered to each square foot of surface being tested. The nozzle velocity of the water shall be not less than 150 ft. per second.

It is not required that the water-tightness test be deferred until the carbody is completely assembled. Individual tests may be used to demonstrate the water tightness of large components such as sides, roof, ends, with testing of the assembled carbody restricted to connections between tested components and areas not previously tested. All spray applications shall run for a period long enough to enable inspection to be made and to insure leak proof structure. It is the intent of this test to establish the total water tightness integrity of the cab. Locomotives shall have leaks corrected and retested until a satisfactory water test is obtained with no leakage detected on each completed locomotive.

21.1.6 Air Conditioning Functional Test

In all locomotives, the air conditioning system shall be functionally tested. The operation of the thermostatic control system shall be demonstrated by test and shall be in accordance with specified settings. Controls shall be checked and adjusted for temperature distribution and proper volume of air conditioning.

21.1.7 Heating Functional Test

In all locomotives, the heating system shall be functionally tested. 'The operation of the thermostatic control system shall be demonstrated by test and shall be in accordance with specified settings. Controls shall be checked and adjusted for temperature distribution and proper volume of heat.

21.1.8 Body Compression or Squeeze Test

No body compression test will be required if the following conditions are met:

- An existing design is used without significant structural change

AND

- The existing design has been embodied in a locomotive which passed a satisfactory compression lest for which adequate records exist

AND

- It can be agreed between the purchaser and the Builder that the total weight of this locomotive does not exceed that of the tested locomotive by more than 5%. If the body compression test is found necessary, it shall made on the first locomotive as a bare structure, by the Builder, to prove compliance of the structure with this Specification. The test shall be made at the Builder's plant or other acceptable facility approved by the purchaser.
- The body, as delivered to the test facilities by the Builder, shall be structurally complete. The body shall consist of a structure shell only, excluding such items as exterior and interior trim, windows, doors, seats, lights, insulation, interior lining, etc. Under floor apparatus, however, may be substantially complete. Sub-floor panels and floor insulation may also be installed. Other apparatus may be installed with prior approval by the purchaser.
- During the test, the body shall be supported on trucks to allow longitudinal movement. The body shell shall be loaded with sufficient dead weight to bring the total body weight up to the normal ready-to-run weight. This loading shall be distributed according to the distribution of weight in the finished locomotive.
- The pressure of the testing machine shall be applied by hydraulic power and the force measured by a means independent of those producing the force, to eliminate errors due to friction. Sufficiently recent calibration of the weighing device shall be available to assure accuracy within +1%.
- The test load of 800,000 lbs. shall be applied to the rear draft stops, by means of ram and in the centerline of draft. No allowance shall be made for the camber of the body. The ram shall be supported but shall remain free to move longitudinally with respect to the locomotive end. Cushioning means, such as lead sheets, shall be provided to assure uniform bearing at the draft stops. Regular draft gear carrier shall be installed and shall support the inner end of this ram.
- Strain gauges shall be applied at points agreed upon in advance with the purchaser. These strain gauges shall have a means of calibrating them to suit the material used and to adjust for other factors which might affect the accuracy of the reading. Strain lacquer shall be incorporated as requested by the purchaser for investigation of stress concentrations. SR-4 electric strain gauges, or other gauges specifically suited for the application, shall be used as required. A minimum of 60 strain gauges shall be used.
- Vertical deflection shall be measured in the region of the side sill by means of a wire stretched between corner posts. This wire shall be fastened at one end and kept tight at the other end by means of a weight with the wire passing over a pulley. Deflections shall be measured using scales with mirrors located at the body corner posts, at bolster posts, and at the center of the locomotive. Deflections shall be measured to the nearest 0.01 inch, and the deflections shall be considered as the average of the readings taken on both sides. The deflection measured at any preliminary load application may be disregarded to eliminate the influence of whatever friction may be present. Deflection between bolsters and center of locomotive shall be determined by plotting the data determined above.

- For the purpose of this Specification, a member shall be considered as having developed permanent deformation if the yield point or yield strength in the appropriate direction - tension or compression - as published or otherwise issued by the material Contractor is reached or exceeded. For materials for which the Contractor publishes a yield point, strain gauge readings taken as directly proportional to the claimed yield point stress shall be used to determine whether or not the point has been reached. For materials for which the Contractor publishes yield strength, strain gauge readings corresponding to a directly proportional reading for the yield strength plus 0.002 inches per inch shall be used to determine whether yield has occurred. For calculation of strain at the published yield point or yield strength values, the modulus of elasticity shall be taken as the Contractor's published value.
- If a reading indicating attainment of the yield point or yield strength is found on any strain gauge, the Builder may request a retest prior to the redesign; and the Contracting Officer may grant this request with the provision that up to four additional strain gauges in the same general area will be required to determine the effects of surrounding material of the plastic deformation that has presumably occurred, and to determine whether stress values as great as the published yield point or yield strength are reached in the retest. If the high reading has been accompanied by visible evidence of distress in the member, a design correction will be required regardless of strain gauge values indicated in any retest.
- The zero point for strain gauge readings may be the readings found after relaxation of total buff loads up to 175,000 pounds provided that no reading encountered at intermediate load levels shall have indicated attainment of the yield point or yield strength. If such a reading has occurred at a lower level, the additional strain gauges required in the paragraph immediately preceding may be required prior to imposition of the 800,000 pound load.

21.1.9 Collision Post Test

The Builder shall submit a plan for making this test to the purchaser for approval.

If an existing design is used without significant structural changes and that design has previously passed a satisfactory Collision Post Test for which adequate records exist, a further test may not be required at the purchaser sole discretion.

21.1.10 Miscellaneous Body Tests and Adjustments

The following tests and adjustments shall also be made by the Builder.

21.1.10.1 Truck Coupler and Cable Clearance

Truck clearances, lengths and location of brake air hoses and electrical jumpers, and coupler and drawbar clearances and operation shall be checked by moving a locomotive over a curve and crossover duplicating or exceeding the most restricting track work specified as 315 ft. radius (18 degree curve) and a no. 7 crossover at 12 ft centers.

21.1.10.2 Locomotive Headlight

The headlight on each locomotive shall be aimed and adjusted to meet the required FRA beam characteristics.

21.1.11 Clearance Test

The Builder shall make tests of a locomotive to determine the tilt angle of the carbody when standing on track with a super-elevation of 6 inches. Worst case conditions shall be shown for fully worn wheels and broken springs.

Drawings and written reports of these tests shall be .submitted for approval. Preliminary clearance drawings shall be furnished to the purchaser within 90 days following contract award.

21.1.12 Weighing

The Builder shall weigh all locomotives at shipment and furnish a weight ticket to the Purchaser. Each truck of each locomotive shall be weighed individually lo check for weight distribution. Locomotives shall be weighed with full supplies, as well as weighed light with no supplies. Supplies shall include fuel, water and sand.

21.1.13 Wheel Slip/Slide System Test

In order to provide a test of the operation of the wheel slide protection system under actual operating conditions, facilities shall be provided for a test of this system during the road brake tests. Instrumentation shall be maintained on this train at all times ready to record the following quantities simultaneously:

- Individual axle speeds
- Brake Cylinder Pressure
- Time Intervals
- Traction Motor Current

Recording shall be by means of multiple-channel recording oscillographs. Personnel assigned to observe the test shall be prepared to run this instrumentation at any time that adverse adhesion conditions may occur. This test shall be continued until recordings have been obtained showing three stops and starts during which slides and slips were successfully corrected. In the event that sufficiently adverse rail conditions to obtain such recordings do not occur during the test, the Builder shall induce slips and slides with artificial rail wetting equipment to demonstrate the performance of this system. The slip/slide test can be run in conjunction with the Locomotive Track Test.

21.1.14 Locomotive Electrical Tests

The following electrical tests shall be performed by the Builder on each locomotive:

- Test all wiring circuits to insure continuity and polarity after assembly and installation of all equipment.
- Make a direct current ground insulation test on each locomotive as follows: (a) disconnect all ground wires; (b) disconnect tine storage battery at its terminals; (c) each nominal voltage circuit shall be megger tested using a 500-volt megger and the insulation resistance shall not be less than two Megohm. During this test, ground all other circuits. If this test shows freedom from ground connection, the high potential test specified below shall be applied.

- A high potential ground insulation lest shall be made on all circuits and apparatus on each locomotive in accordance with current standard Contractor's procedure. All wires, cables and/or equipment that fail to meet this test shall be removed and replaced. After replacement of any such defective parts, materials or equipment, the locomotive shall be subject to re-testing.
- Reconnect ground connection and storage battery and then test all circuits on each locomotive for proper functioning.
- Components furnished by the Contractor that are assembled, housed, and wired into package units at the point of manufacture shall be tested at the point of manufacture, and a certified test report concerning actual tests made on components being furnished for this Contract shall be attached. Requirements for these certified tests shall be mutually agreed upon between the Builder and the Purchaser.

21.1.15 Locomotive Brake Tests

The following brake tests shall be performed by the Builder.

21.1.15.1 Air Brake Tests

Air brakes shall be tested and adjusted for performance complying with FRA regulations. Also, tests recommended by AAR and the brake Contractor shall be performed when not in conflict with FRA regulations.

21.1.15.2 Parking Brake Test

The parking brake on each locomotive shall be tested. On the first locomotive, a test shall be performed to prove compliance with the Specification shall be performed using first new and then fully worn brake shoes. On the other locomotives, a functional test shall be performed using new shoes.

21.1.16 Locomotive Sequence Tests

A complete sequence test shall be made on each locomotive, including front-rear sequence changes, relays and switches, sanding, auxiliary motor starting circuits, wheel slip control, main propulsion and braking, main circuit breaker, calibration of safety relays, meter calibration, excitation, and any other testing required to insure that all circuits are performing properly.

21.1.17 Sound Level Test

Sound level measurements shall be made during the qualification tests on one locomotive, as well as statically with all auxiliary equipment operating using a standard sound level meter.

21.1.18 HEP Test

The Head End Power source shall be tested by the Builder. Data taken during the test shall include, but not be limited to:

Voltage Current

Frequency Kw

The load shall be varied over the full range up to 110 % of full load.

21.1.19 Locomotive Track Test

The Builder shall provide the purchaser with a proposal to lest a locomotive at 125 MPH within the guidelines outlined.

The first completed locomotive with 4 California cars or approved equal cars shall be track tested. This test shall demonstrate the satisfactory operation of all control systems, auxiliary systems, propulsion systems, braking system alarm circuits, and shall be conducted at AAR Transportation Test Center in Pueblo, Colorado a site suitable to the purchaser. The test shall also demonstrate the performance and ride quality characteristics of the locomotive.

The locomotive shall be subjected to an operational track test in which approximately §00 2500 miles of non revenue operation shall be accumulated. This test shall be conducted by and at the expense of the Builder. The test shall demonstrate the operational performance of the locomotive regarding acceleration, maximum running speed and braking. This shall be considered successful when the last 300 The test may be terminated, at the purchaser discretion, when at least 500 miles have been completed without experiencing any malfunction in a component or system.

The data recorded during the tests shall include, but is not limited to the following:

- Acceleration Deceleration
- Traction motor current
- Traction motor voltage
- Brake pipe pressure
- Locomotive brake cylinder pressure
- Dynamic brake current
- Speed
- Distance intervals
- Time intervals
- Ride quality indices
- Wheel slip and slide performance

The Builder shall provide, at his expense, the test personnel and instrumentation (locomotive mounted and wayside) necessary to demonstrate the safety margin of the locomotive and trucks against derailment and track deformation. The data shall include, but is not limited to the following:

- Critical speeds for maximum roll, pitch and yaw motion
- Maximum g-forces transmitted to carbody in lateral, vertical and longitudinal planes
- Lateral and vertical forces exerted on the track structure.
- A known perturbation suitable to the purchaser shall be incorporated in the track structure to obtain generated L/V ratios, track forces, and body-accelerations to demonstrate compliance to specification requirements.

21.1.20 Train Speed Control Test

The Builder shall test the train speed control system of each locomotive using the necessary test equipment as recommended by the original Contractor.

21.1.21 Test Plans and Data

All test data shall be subject to the purchaser review and approval, and shall become the property of the purchaser upon satisfactory completion of tests. If the locomotive or any related equipment or subsystems fail to satisfy the test requirements, or demonstrate noncompliance with proposal performance, necessary corrective adjustment shall be made, and this locomotive shall be retested as directed by **the purchaser**.

The Builder shall, within 120 days following award of the contract, submit to the purchaser for review and approval a detailed test plan which shall satisfy the requirements of this section.

21.1.22 Stress Analysis of Locomotive

The Builder shall submit to the purchaser for approval, a complete summary of stress analyses of the locomotive structure, trucks and major equipment securement, at least 90 days prior to the construction of the locomotives. Emphasis shall be placed on analyses of front collision posts, coupler pockets, cab body structure and sill and anti-climber arrangement.

21.2 Documents and Certifications

21.2.1 Locomotive - FRA Tests and Documents

- Three copies of FRA. Form 4-A, "Specification for Locomotive

  Unit No.____, with all data entered and accompanied by the required diagram, for submission to the FRA and for the files of the applicable Railroad and the Purchaser.

- The Builder shall furnish lo the Purchaser for each locomotive four copies of FRA. Form F-6180-49, "Monthly Locomotive Unit Inspection and Repair

Report," completely filled out for submission to the FRA, for display in the locomotive and for the files of the applicable Railroad and the Purchaser.