Standardized Technical Specification

PRIIA Dual Mode (DC)
Passenger Locomotive

Requirements Document

Issue Revision 1.3

Adopted by the Executive Board December 6th, 2011

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1.0 Introduction [Informative]

The requirements in this document describe the desired features for a dual mode (nominal 700 VDC 3rd rail electric and diesel-electric) locomotive. Specific features or functions that are deemed appropriate by the Locomotive Team and its Technical Subgroups shall have priority over these requirements and shall be reflected by specific language in the vehicle specification. Such exceptions must be identified by the Technical SubGroups and are subject to review and approval by Executive Board.

1.1 PRIIA Mandated Requirements

The following requirements are derived from the PRIIA 305 mandate except where noted.

1.1.1 Technical:

- Up to 125 mph capability in diesel-electric mode and 80 mph in electric mode (700 VDC 3rd rail).
- For operation in corridor service (routes up to 600 miles in length).
- Standardization – consider areas such as:
  - Vehicle structure for common platform for all vehicle types within the locomotive fleet;
  - Component attachments (e.g. truck, HVAC);
  - Components at a fit/ form/ function/ input/ output level (e.g. truck, wheels, axles, couplers, cab controls / displays, cab seats, inter-vehicle jumpers, HVAC units, static inverters, batteries, lighting, door systems, etc.);
  - Seek commonality in components between PRIIA vehicle types where appropriate (bi-level, single level, locomotive, etc.).
- New Technology – consider areas such as:
  - Crash Energy Management (energy absorbing coupler, deformable anticlimber, collapsible structural members, trigger levels, interior fixtures, etc.);
  - Environmentally responsible (energy efficient, low weight, low noise and vibration, consideration of recycled materials / material recyclability, low impact HVAC refrigerant, energy efficient lighting, etc.);
  - Train data networks (Ethernet, IP address based components, etc.).
- Interoperable with existing single level vehicles in mixed consist to be specified by the purchaser and the following Amtrak vehicles: Amfleet, Viewliner, Long Distance Single-Level Car, Horizon etc., including existing motive power of purchaser.
- Compliance with all applicable regulations.
- Reliability and Maintainability Requirements - Cost effective to operate.

1.1.2 Process:

- Inclusive development to include key stakeholders:
  - Amtrak
  - States
  - FRA
  - Industry, such as:
    - Vehicle Suppliers;
    - Component/ System Manufacturers.

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- Live specification with change management.
- Configuration management for vehicle development and specification leading to conformed specification.
- Traceability of such processes to support PRIIA 305 Executive Committee approval.

1.2 Operational Considerations

1.2.1 The Specification to Be Developed

The primary consideration of the PRIIA 305 Dual Mode (DC) Locomotive Specification to be developed from this Requirements Document should be the adequacy of the Specification in addressing the operational considerations needed to procure, design and build a fleet of dual mode passenger locomotives that will be:

- Designed for use without restriction under a wide spectrum of environmental and physical conditions that are found throughout the United States, including access to New York City;
- Specified in configurations and containing features to allow potential users of these locomotives to create new fleets of equipment for establishment of new services, replacement of existing equipment, or addition of new locomotives to existing fleets without major impact;
- Designed and built to meet the needs of the traveling public, the operations and maintenance providers and the passenger rail agencies by creating attractive, safe equipment that is reliable, cost-effective, maintainable, easy to operate and durable; and
- Operationally and functionally compatible with existing trains and train sets currently in production

The PRIIA 305 dual mode (DC) locomotives must be designed and built so that they can be integrated into an existing fleet of locomotives with minimal impact on the existing fleet, as well as be able to create a stand-alone fleet of locomotives for the purposes of starting new services, replacement of existing fleets and placement of new locomotives into service.

1.2.2 Passenger Train Metropolitan Area Tunnel Access Requirements or Air Quality Operating Restrictions

New York: Under New York State Law, the use of locomotives powered by steam or by internal combustion engines within the Park Avenue Tunnel in New York City has been prohibited since 1903. Subsequent legislation extended the prohibition to the other tunnels.

The Appendix contains Table I listing the four existing tunnels used by passenger trains to access New York City and their operational characteristics; a fifth tunnel is under construction.

Area Left Blank for Other State or City Operational Requirements or Restrictions

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2.0 Requirements [Normative unless otherwise indicated]

2.1 Key Requirements

- Locomotive designs shall be modular to the extent practical in order to minimize the amount of additional design required to adapt to the needs of different state agencies and classes of service.
- The locomotive shall be fully compliant with FRA's requirements for structural strength, crashworthiness and testing per 49CFR Part 238, as follows:
  - The locomotive shall meet or exceed 49CFR Part 238 Tier 1 structural requirements.
  - The locomotive shall meet or exceed APTA Standard SS-C&S–034-99 for the Design and Construction of Passenger Rolling Stock.
- The design of the locomotive shall incorporate collision energy management (CEM) features.
- Locomotives shall be designed for a service life of 25 years.
- Standardization
  - Dual mode (700 VDC 3rd rail electric and diesel-electric) locomotive shall provide for standardization of components with those used in the PRIIA Diesel-Electric Passenger Locomotive (Specification 305-005) to the maximum extent practicable;
  - Consider providing a common platform for potential future locomotives using straight diesel-electric propulsion and electric power provided by an overhead catenary system. Any future dual mode diesel-electric/ AC catenary locomotive shall provide for standardization of components with those used in the PRIIA Diesel-Electric Passenger Locomotive (Specification 305-005) and any PRIIA Dual Mode (DC) Passenger Locomotive Specification developed from this Requirements Document, to the maximum extent practicable."
- Self loading to maximum horsepower in diesel mode.
- Minimum starting tractive effort of 65,000 lbs.
- Capability to be controlled from a Cab-Car in push-pull operation.
- Comply with EPA Tier IV diesel engine emission requirements.
- Comply with locomotive-borne signal system equipment installations, including Positive Train Control (PTC), Electronic Train Management System (ETMS), Cab Signal and/ or Automatic Train Control (ATC) systems consistent with 49 CFR Part 236, Subpart I – *Positive Train Control Systems*.

2.2 Capacity and Locomotive Performance

- Maximum speed: Up to 125 mph in diesel mode and 80 mph in electric mode, under existing FRA Tier 1 equipment requirements, bi-directional running.
- Ability to meet or exceed trip times on routes presently using dual mode locomotives (diesel-electric/ 700 VDC 3rd rail).
- Duty cycle
  - Normal duty:
    - Continuous operation for up to 20 hours and 1200 miles per day.
    - Representative operating profile shall be defined by the purchaser.
    - Maximum duty cycle in electric mode; i.e., ability to operate in electric mode wherever 3rd rail electric power is present.

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- Operating range with 10% reserve of all fluids (supply, waste, fuel, etc.) and supplies, with the understanding that the operating range could be less to meet the needs of Amtrak, different state agencies, and different classes of service:
  - Distance: 900 miles
  - Duration: 30 hours
- Fuel capacity to allow a range performance for an assumed stopping pattern and route profile shall be 1,800 U.S. Gallons.
- Ability to start a train of 1,900,000 lbs on a 2% grade (multiple locomotives permitted) or 1,300,000 lbs. on a 3% grade (single locomotive).

Except where specifically listed in this document, the performance requirements do not necessarily have to be achieved by a single locomotive. Compliance can be achieved by the use of multiple locomotives if doing so will provide a reduced life cycle cost.

In addition, consideration should be given to identifying whether there are changes that can be easily embodied within the dual mode locomotive design to increase its operational flexibility. These might include changes to reflect the operational usage such as gearing changes for top speed versus acceleration and traction.

2.3 Dimensions, Clearances and Track Geometry

2.3.1 Overall Carbody Dimensions

- Locomotives shall fully conform to Amtrak's standard single level clearance diagram (drawing D 05-1355, latest revision)

2.3.2 Track Geometry

- The locomotives shall be designed and tested for revenue operation at all appropriate speeds up to a maximum of 125 mph, on all classes of track from FRA Class 1 to Class 7 in diesel mode and up to 80 mph, on all classes of track from FRA Class 1 to Class 4 in electric mode.
- Track quality shall be assumed to be minimally compliant for each class of track, per FRA regulations and AREMA standards.
- Ride quality standards and testing methods shall be as specified in ISO 2631 (most recent version).
- Maximum cant deficiency of 6 inches.

2.4 Environmental Conditions

The locomotives shall be designed to operate within the environmental extremes defined in Amtrak Specification 963 (most recent version). All systems must function normally at elevations up to 9200 ft. above sea level, except for those systems associated with the 700 VDC 3rd rail electric propulsion, which must function normally up to an elevation of only 100 ft. above sea level.

2.5 Carbody

- All exterior doors be designed to prevent ingress and buildup of snow and ice.
- Cab compartment shall have positive air circulation and fresh air ventilation to prevent the entrance of dust, sand, fumes, liquids or precipitation into the locomotive cab with doors and windows closed.
- Electrical compartments shall be vented positively to exclude dust and sand.

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- Engine compartment ventilation air shall be filtered with inertial filters and have a positive pressure to preclude dirt, rain and snow ingestion.
- Fuel tank shall be compartmentalized with not less than four compartments.

2.6 Electrical

- Equip locomotives with MU (push – pull) control trainline jumper cable.
- Provide blended dynamic braking in all modes.
- Provide Head End Power (HEP) capacity of 800kW @ at 100% duty cycle.

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3.0 Summary

This requirements document specifies the requirements for a dual mode locomotive powered either by a diesel engine or 3rd rail electrical power. Specific requirements for a particular order are to be documented in Chapter 23 Customer Variables of the specification. As future markets for a general dual mode locomotive expands and technology evolves, a potential future dual mode diesel-electric and AC catenary locomotive may be developed on a common platform with the dual mode diesel-electric and 3rd rail locomotive. Examples of specific requirements for potential future common platform locomotives could be catenary versus 3rd rail, DC versus AC electrical supply, and voltage and frequency requirements. It is further recognized that the choice of electrical supply, e.g. high voltage AC or medium voltage DC, may require tradeoffs in top speed to maintain satisfactory track impact forces.

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Appendix A: Table I: Passenger Train Access to New York City

	Park Avenue Tunnel	North River Tunnels	East River Tunnels	Empire Tunnel	East Side Access Tunnel
Year In Service	1876/ 1907[1]	1910	1911	1991	2016[11]
Number of Tracks	4	2	4	1	2
Maximum Equipment Height	14'-10"	14'-8"[5]	14'-8"[5]	14'-8"[5]	13'-6"[12]
Maximum Grade	3.0%	2.0%	1.5%	2.0%	3.25%
700VDC 3rd Rail	Under-running	Over-running[6]	Over-running	Over-running	Over-running
12k VAC /25 Hz Catenary	No	Yes	Yes	Yes	No
Station Served	GCT	NYP	NYP	NYP	GCT
Serving Railroad	MNR / AMTK[2]	AMTK / NJT	AMTK / LIRR	AMTK	LIRR
Dispatching Railroad	MNR	AMTK	AMTK	AMTK	LIRR
Service Territory	North to MNR Hudson, Harlem and New Haven Lines[3]	AMTK south to Philadelphia and points south and west; NJT west to New Jersey[7]	AMTK north to Boston and LIRR East to Long Island[9]	North to Albany and points north and west[10]	East onto Long Island
Dual Mode Locomotives	P32AC-DM [DC]	ALP-45DP[8] [AC]	DM30AC [DC]	P32AC-DM [DC]	None[13]
Dual Voltage (DC/ AC) Equipment	M-8 (EMU)[4]	None	None	None	None

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A.1 Notes to Table I

1. The Park Avenue Tunnel was electrified in 1907 with 700 VDC under-running 3rd rail.
2. As a standing procedure, Amtrak utilizes Metro North Railroad's Park Avenue Tunnel to Grand Central Terminal as a detour route into New York City when there is a problem with the Spuyten Duyvil drawbridge onto Manhattan Island or the Empire Tunnel into Penn Station.
3. Metro North Railroad operates dual mode P32AC-DM locomotives between Grand Central Terminal and: Poughkeepsie & Wassaic, NY; and Waterbury & Danbury, Connecticut.
4. The M-8 Electric Multiple Unit (EMU) is DC/AC "dual voltage" equipment as it can operate on 700VDC 3rd rail from GCT to just east of New Rochelle on the MNR New Haven Line, where it changes over to operate on 12.5k VAC/60 Hz catenary power to New Haven. It has the capability to operate on Amtrak's 25kVAC/60Hz catenary power east of New Haven.
5. Amtrak's North River, East River and Empire Tunnels all have a maximum equipment height of 14'-8", which is consistent with AMTK's Clearance Diagram D 05-1355 for single level equipment capable of unrestricted operation on the Northeast Corridor.
6. The over-running 700VDC 3rd rail in the North River Tunnels extends to just south of the tunnel portal in New Jersey. It is for emergency use only; it will not support daily operation without extensive rehabilitation and the construction of a new power substation in New Jersey.
7. Amtrak operates its Northeast Corridor service and long-distance service south towards Washington, DC and beyond. New Jersey Transit operates commuter rail service using EMU's and electric locomotive hauled trains to various lines in Northern New Jersey.
8. New Jersey Transit has taken delivery of the first of 36 total ALP-45DP dual mode (AC) locomotives, with diesel and both 12kVAC/25Hz & 25kVAC/60Hz electric power capability. NJT intends to serve non-electrified lines in northern New Jersey in diesel mode and transfer to electric operation under catenary on the Northeast Corridor through the North River Tunnels into Penn Station. Montreal's Agence metropolitaine de transport (AMT) has ordered 20 units.
9. Amtrak operates its Northeast Corridor service north to New Haven, Connecticut, and Boston Massachusetts, as well as a long distance train to St. Albans, Vermont. LIRR operates both dual mode DM30AC locomotives and M-7 EMU's from Penn Station through the East River tunnels into both non-electrified and electrified territory on Long Island.
10. Amtrak operates its Empire Service north and west to Albany and Niagara Falls as well long distance trains: the Lake Shore Limited to Chicago, Illinois; the Maple Leaf to Toronto, Ontario; the Adirondack to Montreal, Quebec [supported by New York State]; and the Ethan Allen to Rutland, Vermont [supported by Vermont].
11. Long Island Rail Road anticipates the completion of the East Side Access Tunnel in 2016. It will connect to new lower level tracks at Grand Central Terminal.
12. The East Side Access Tunnel utilizes the lower level of the previously constructed 63rd Street Tunnel under the East River. The upper level is for subway use only, and the lower commuter rail level was designed with a vertical clearance of 13'-6" for use only by LIRR EMUs. LIRR intends to use their current fleet of M-7 EMUs and the future M-9 EMU (in design).
13. LIRR plans to serve Grand Central Terminal through the East Side Access Tunnel using EMU's only. LIRR's existing fleet of DM30AC dual mode (700VDC over-running 3rd rail) locomotives will not clear the tunnel; accordingly, LIRR has no plans to use them in the

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future. Passengers destined to non-electrified territory will change at intermediate stations to trains pulled by straight diesel locomotives to reach destination.

A.2 Glossary of Terms used in Table I

AMTK	Amtrak (National Railroad Passenger Corporation)
LIRR	Long Island Railroad, a subsidiary of the Metropolitan Transportation Authority, a State Authority which is independent of the New York State Department of Transportation.
MNR	Metro North Railroad, a subsidiary of the Metropolitan Transportation Authority.
NJT	New Jersey Transit Rail Operations, a subsidiary of NJ Department of Transportation.
GCT	Grand Central Terminal is a stub-end station at located at 42nd Street between Park Avenue and Lexington Avenue in New York City. The Park Avenue Tunnel terminates at GCT. The existing lower level tracks at GCT have a maximum grade of 3%. The new East Side Access Tunnel will terminate at a yet lower level of tracks under GCT; the maximum grade of this tunnel is believed to be 3.25%.
NYP	Pennsylvania Station ("Penn Station") is a through station located between 33rd and 34th Streets and between 7th and 8 Avenues in New York City. Penn Station is located between the North River Tunnels on the west and the East River Tunnels on the east. The Empire Tunnel from the north was constructed over the North River Tunnels and enters the west side of Penn Station south of the North River Tunnel portals.
ALP-45DP	This is a Bombardier 3600 Hp diesel-electric locomotive which operates from either 12kVAC/ 25Hz or 25kVAC/ 60Hz AC catenary with the diesel prime mover shut down. NJT has one on hand, one at the AAR TTCI facility in Pueblo for testing, and a total order of 36. AMT, the commuter rail agency in the Montreal metropolitan area has 10 on order.
DM30AC	This is an EMD 3000 HP diesel-electric locomotive which operates on 700VDC over-running 3rd rail with the diesel prime mover shut down. LIRR has a fleet of 23.
M-8	Electric Multiple Unit (EMU) equipment powered by both 700VDC under-running 3rd rail and 12.5k VAC/ 60 Hz catenary power.
P32AC-DM	This is a General Electric 3200 HP diesel-electric locomotive which operates on 700VDC 3rd rail with the diesel prime mover shut down. MNR has a fleet of 31 which operate on the under-running 3rd rail; AMTK has a fleet of 18 which operate on the over-running 3rd rail.

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