FTA RESEARCH

FEDERAL TRANSIT ADMINISTRATION

Rail Vehicle Qualification Test Compendium

FEBRUARY 2015

FTA Report No. 0083
Federal Transit Administration

PREPARED BY
MaryClara Jones and Nicholas Wilson
Transportation Technology Center, Inc.
a subsidiary of the Association of American Railroads

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DISCLAIMER

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SPONSORED BY

Federal Transit Administration
Office of Research, Demonstration and Innovation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liter	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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13. ABSTRACT

Qualification and acceptance testing and analysis for new passenger rail vehicles for transit systems has been specified by the transit/commuter agency for which the cars will be supplied to and/or by government agencies. Regulatory testing defined by the Federal Railroad Administration (FRA) is currently only for passenger vehicles operating at 90 mph or greater. Transportation Technology Center Inc. (TTCI) was contracted by the Federal Transit Administration (FTA) to identify and document all of the requirements for qualification or acceptance testing of passenger rail vehicles and signal and control systems that may be performed prior to their deployment in service in the U.S. Sources of the tests identified were found by reviewing American Public Transportation Association (APTA) recommended practices, FRA requirements, Request for Proposal (RFPs), and other international sources. In addition to identify qualification tests, an assessment of the adequacy of the facilities currently available at the Transportation Technology Center (TTC) in Pueblo, CO, for conducting these tests will be performed. For tests for which the required facilities do not exist at TTC, an assessment was performed to determine whether an alternative site capable of performing the tests exists.

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ABSTRACT

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Transportation Technology Center Inc. (TTCI) was contracted by the Federal Transit Administration (FTA) to identify and document all tests for qualification or acceptance testing of passenger rail vehicles and signal and control systems that may be performed prior to their deployment in service in the United States. Sources of the tests identified were found by reviewing practices recommended by the American Public Transportation Association (APTA), Federal Railroad Administration (FRA) requirements, Request for Proposals (RFPs), and other international sources.

EXECUTIVE SUMMARY

Transportation Technology Center Inc. (TTCI) was contracted by the Federal Transit Administration (FTA) to identify and document all tests for qualification or acceptance testing of passenger rail vehicles and signal and control systems that may be performed prior to their deployment in service in the United States. Sources of the tests identified were found by reviewing the following:

- American Public Transportation Association (APTA) standards
- Federal Railroad Administration (FRA) requirements
- Request for Proposals (RFPs)
- Other international sources

All tests and analyses identified were categorized into a public document that can be downloaded at www.fta.aar.com. This database is searchable and is categorized by the following:

- Mode of Operation
- Operating Speed Range
- Test Category

The database will be updated yearly as new information and details about current requirements, tests, and capabilities becomes available.

In addition to the searchable database, information is included on passenger rail testing facilities at which qualification tests may be performed, comparison of rail vehicle dynamic modeling software packages, summary of rail vehicle propulsion systems, and the Transportation Technology Center's (TTC's) current capabilities related to high speed rail testing.

SECTION

1

Introduction and Objectives

Transportation Technology Center Inc. (TTCI) was contracted by the Federal Transit Administration (FTA) to identify and document all tests for qualification or acceptance testing of passenger rail vehicles and signal and control systems for transit systems that may be performed prior to their deployment in service in the United States.

Background

Qualification and acceptance testing of passenger rail vehicles has been specified primarily by the transit/commuter agency for which the cars will be supplied to and/or by government agencies. During the 1970s, the Urban Mass Transportation Administration (UMTA) was involved in developing the General Vehicle Test Plan (GVTP). The GVTP listed the test and instrumentation requirements for performing passenger car qualification tests both at the Transportation Technology Center (TTC) and offsite. In 1991, UMTA was reorganized into the Federal Transit Administration (FTA), and the requirements as specified by UMTA for testing passenger car no longer were required. Many tests found in the GVTP are still being used, but with a slightly different name and/or with updated data collection techniques.

Since the renaming of UMTA to FTA, the Federal Railroad Administration (FRA) has defined specific qualification and acceptance testing based on the maximum speed of vehicle. For vehicles that have speeds below 90 mph (speed defined as being below FRA requirements), transit agencies define their own specifications. These agency-defined specifications usually are outlined in a Request for Proposals (RFPs) that is distributed when a new vehicle is to be procured.

Deliverables Available for Public Use

The final deliverable for this work is a database that documents all past and present qualification and acceptance tests. This database is available at http://fta.aar.com/ and is a searchable database based on the categories detailed in the Compilation of Tests section. The searchable database will be updated yearly as new information and details about current requirements, tests, and capabilities becomes available. More information on the searchable database is provided in the Searchable Database with Tests section.

Identification of Qualification and Acceptance Tests

Past and present analyses and qualification and acceptance tests were identified using multiple sources. The specifications identified also include past specifications that may no longer be used into other specifications but are still listed as stand-alone specifications. Sources of tests and analyses include American Public Transportation Association (APTA) specifications, FRA regulations, transit agency procurement specifications, discussion with transit agencies and car builders, TTCI experience in testing passenger vehicles, and other specifications from international sources. The specifications found through each source are described in the report.

APTA Specifications

APTA specifications were researched, and specifications related to testing and qualifying a new rail vehicle were documented. The specifications identified include those for crash energy management/crashworthiness, truck frame fatigue, and wheel load equalization. Many other documents reference APTA specifications, specifically many transit agency RFPs. APTA specifications found and referenced in the database include the following:

- APTA SS-M-011-99 – Standard for Compressed Air Quality for Passenger Locomotive and Car Equipment
- APTA SS-M-005-98, Rev. 2 – Code of Tests for Passenger Car Equipment Using Single Car Testing
- APTA Standard SS-C&S-034-99, Rev. 2 – Standard for the Design and Construction of Passenger Railroad Rolling Stock
- APTA RP-M-009-98 – Recommended Practice for New Truck Design
- APTA SS-M-014-06 – Standard for Wheel Load Equalization of Passenger Railroad Rolling Stock

FRA Requirements

FRA regulation documents (both existing and proposed) were researched and documented. During the time of the literature search, there were several proposed requirements that have since been implemented. These proposed requirements are documented, as are the implemented requirements with slight changes from the proposed requirements. FRA regulations found and referenced in the database include the following:

- Track Safety Standards Code of Federal Regulations, 49CFR213
- PRIIA Specifications, including locomotive, single level, bi-level, and trainset specification

- Technical Criteria and Procedures for Evaluation the Crashworthiness and Occupant Protection Performance of Alternatively Designed Passenger Rail Equipment for Use in Tier I Service (RSAC report)
- Safety Advisory 2012-02 – Low Speed Wheel-Climb Derailments of Passenger Equipment with "Stiff" Suspension Systems

Transit Agency Requirements

Available transit agency RFP documents also were reviewed for specific tests and analyses that transit agencies require for newly-procured vehicles. Some transit agencies have specific tests or analyses that are required due to their particular operating system and/or issues that have occurred in the past. Any tests listed in RFP documents that were not already identified through other regulatory or government documents were included in the testing database. The RFPs reviewed either were from testing programs with which TTCI has been involved or were provided by transit agencies contacted for the project. RFPs were supplied for all rail operating modes.

Other Sources

Other sources of testing specifications were reviewed, including international specifications, and are included in the database. The international testing specifications were cross-referenced to the U.S. tests identified, and the cross-reference is included in the database as a separate field. The following sources were used to identify international tests included in the database:

- British Railways Board Group Standards
- Japan Ministerial Standards
- International Union of Railways (UIC)
- International Organization for Standardization (ISO)

In addition to reviewing international standards, passenger testing programs with which TTCI has been involved were reviewed. Tests performed at TTC or in revenue service were identified and confirmed to be in the database. Any tests not listed in the database at time of cross-reference were then added to the database. No reference to customer name or test program is included.

SECTION 2

Compilation of Tests

All tests identified were categorized by vehicle type and type of test along with several other categories, including:

- Mode of Operation
- Operating Speed Range
- Test Category

Only tests specifically identified in regulatory, recommended practice, or procurement documents for the specified mode are discussed in this section. Many tests could be applied to other modes but are not specifically identified for those modes. Tests that could apply to modes other than those for which they are specifically written are discussed in the New Tests and Specifications section. The categories are discussed in more detail in the following sections. All tests are provided in Appendix A in tabular form.

Mode of Operation

During the identification of the passenger tests, the mode of operation was listed for each test. Many tests can apply to all modes, but some tests are specific to the mode of operation. The three modes of operation used to categorize the tests are the following:

- Intercity, Regional, Commuter Rail – rail transit equipment operating on the general freight railroads
- Heavy Rail, Subways, Metros – rail transit equipment operating on a private, protected right-of-way
- Light Rail/Streetcar – rail transit equipment operating on a street, median, or sidewalk, but also may operate on private right-of-way

Operating Speed Category

In addition to identifying the mode of operation, the operating speed that is associated with the test was listed. Some tests are required (regulatory) only if the passenger vehicle will be operating over a certain speed. In these cases, the speeds for the tests are provided. The following speed categories were used based on the specification speed requirement and are shown in the database for each test:

- Speeds 90 mph and below
- Speeds greater than 90 mph
- Speeds greater than 110 mph
- Speeds less than 125 mph
- Speeds greater than 125 mph

Test Category

Each test was categorized for specific safety and performance categories, as follows:

- Vehicle Dynamics
- Structural Integrity
- Signaling and Train Control
- Component Performance
- Electrical and Propulsion Performance and Capability
- Specification Compliance
- Endurance/Revenue Service
- Noise/Vibration
- Vehicle Dynamic Modeling

The test categories are described in detail in the following sections, as are tests that fall into each category. Note that some tests could be put into several testing categories but were put into only one category. Some tests are designed for specific rail modes but could be applicable to other modes. Additional information on these tests is included in the comment section. Detailed information on the step in build process, regulatory information, source for test, etc., are provided in the database.

Vehicle Dynamics

The Vehicle Dynamics testing category is used for tests for the safety and ride comfort of passengers. The tests that fall into this category are either static or dynamic tests that will require instrumentation to measure and compare to criteria listed in the test specification. The instrumentation that may be required includes accelerometers, instrumented wheelsets, strain gages, and string potentiometers. Examples of tests in this category include ride quality tests as per ISO 2631, roll angle (static lean) test, truck equalization test (wheel load equalization), and vehicle qualification. Table 2-1 shows the tests and modes that fall into this category.

Table 2-1

Vehicle Dynamics Tests

Test	Mode(s)	Operating Speed	Facility Type
Ride Quality Tests	All	All	Test Track
Ride Roughness–Acceleration	All	All	Test Track
Ride Roughness–Component-Induced Vibration	All	All	Test Track
Ride Roughness–Deceleration	All	All	Test Track
Ride Roughness–Worst Speeds	All	All	Test Track
Dynamic Shake Test	All	All	Test Track
Dynamic Shake Test–Lateral	All	All	Test Track
Dynamic Shake Test–Longitudinal	All	All	Test Track
High Speed Testing/Vehicle Qualification	Intercity, Regional, Commuter	All	Test Track
Locomotive Track Test	Intercity, Regional, Commuter	All	Test Track
Minimally Compliant Analytical Track (MCAT)	Intercity, Regional, Commuter	Class 6 Track or 6 inches cant deficiency	Test Track
On Board Acceleration	All	All	Test Track
Roll Angle Tests (Static Lean Test)	Intercity, Regional, Commuter	All	Rail Building
Truck Equalization (Wheel Load Equalization)	Intercity, Regional, Commuter	All	Rail Building
Truck, Coupler, and Cable Curving Test	Intercity, Regional, Commuter	All	Test Track
Vehicle Qualification	All	All	Test Track

Structural Integrity

Structural Integrity tests include tests for crashworthiness. The tests performed for structural integrity of passenger rail cars depend highly on mode of rail and speed. Light rail, for example, does not have as many structural integrity/crashworthiness tests required due to the typically lower speeds light rail travels compared to other modes of rail and the generally lighter-weight equipment with which the trains could interact. Table 2-2 shows the structural integrity tests listed in the database. Note that at the time of publishing this report, some of the tests and criteria were under review and could be changed—in particular, "Collision with Conventional Equipment," "Colliding Equipment Override," and "Connected Equipment Override."

Table 2-2 *Structural Integrity Tests*

Test	Mode(s)	Operating Speed	Facility Type
Colliding Equipment Override	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	<125 mph	Test Track and Load Fixtures
Collision Post Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Collision with Conventional Equipment	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	<125 mph	Test Track
Compression Load Test at the Draft Stop	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Connected Equipment Override	Intercity, Regional, Commuter	<125 mph	Test Track
Corner Post Elastic-Plastic Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Corner Post Longitudinal Load Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Coupler Energy Absorbed Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Coupler Initiation Load	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Coupling Impact Test	Heavy Rail, Subways	All	Test Track
Collision Post (Collision Wall) and Corner Post Loads Test: Elastic Design Loads	Heavy Rail, Subways, Metros	All	Load Fixtures
Roof Integrity	Intercity, Regional, Commuter	<125 mph	Load Fixtures and Building
Crash Energy Management Tests	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	<125 mph	Load Fixtures
Diagonal Jacking Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
End Sill Compression Load Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
End Structure Integrity of Cab End	Intercity, Regional, Commuter	<125 mph	Load Fixtures
End Structure Integrity of Non-cab End	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Interior Fixture Attachment	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	<125 mph	Load Fixtures
Locomotive Car body Compression Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Occupant Protection Features	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	<125 mph	Load Fixtures
Occupied Volume Integrity	Intercity, Regional, Commuter/	<125 mph	Load Fixtures
Proof Load Tests	Heavy Rail, Subways, Metros	All	Load Fixtures
Side Structure Integrity	Intercity, Regional, Commuter/Heavy Rail, Subways, Metros	<125 mph	Load Fixtures
Structural Absorber Energy Absorption	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Structures-Acceleration	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	All	Test Track
Structures–Constant Velocity	All	All	Test Track
Structures–Deceleration	All	All	Test Track
Trigger, Frangible Element, Fuse	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Vertical Load Test	Intercity, Regional, Commuter/ Heavy Rail, Subways, Metros	<125 mph	Load Fixtures

Signaling and Train Control

Tests in the Signaling and Train Control category are currently all for intercity, regional, and commuter lines. Heavy rail, subways, metros, and light rail/street car systems also perform such tests, but they usually are specific to the individual transit system and, therefore, are not included. These tests are completed for safety, interoperability, and time schedule performance. Table 2-3 shows a summary of signaling and train control tests.

Table 2-3 *Signaling and Train Control Tests*

Test	Mode(s)	Operating Speed	Facility Type
Brake Control Operation	Intercity, Regional, Commuter	<125 mph	Test Track
Locomotive and air brake control	Intercity, Regional, Commuter	<125 mph	Test Track
Cab Indicator Operation	Intercity, Regional, Commuter	<125 mph	Test Track
Event Recorder Performance	Intercity, Regional, Commuter	<125 mph	Test Track
Event Recorder-Video Performance	Intercity, Regional, Commuter	<125 mph	Test Track
Headlight and Crossing Light Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Horn and Bell Operation	Intercity, Regional, Commuter	<125 mph	Test Track
MU and COMM Trainline Function Operation	Intercity, Regional, Commuter	<125 mph	Test Track
Positive Train Control (PTC) and/or Automatic Train Control (ATC)	Intercity, Regional, Commuter	<125 mph	Test Track
Positive Train Control System	Intercity, Regional, Commuter	<125 mph	Test Track
Speedometer/Over-speed Performance	Intercity, Regional, Commuter	<125 mph	Test Track
Train Speed Control Test	Intercity, Regional, Commuter	<125 mph	Test Track
480 Head End Power (HEP) Trainline	Intercity, Regional, Commuter	<125 mph	Test Track

Component Performance

Component performance tests are performed on components of the vehicle to make sure the components are reliable and safe and will endure in revenue service. Table 2-4 displays a summary of component performance tests.

Table 2-4 *Component Performance Tests*

Test	Mode(s)	Operating Speed	Facility Type
Truck Frame Fatigue Test	All	<125 mph	Load Fixtures
Truck Frame Load Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Allowable Stresses	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Truck Frame Overload Test	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Radiography Inspection of First Truck	All	All	Radiograph Equipment
Truck Primary Suspension Tests	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Friction Brake Performance Test	Intercity, Regional, Commuter	<125 mph	Test Track
Brake Component Fatigue Tests	Intercity, Regional, Commuter	<125 mph	Load Fixtures
Brake Pad and Shoe Force Tests	Intercity, Regional, Commuter	<125 mph	Test Track or Rail Building
Catenary–Measurement of Total Mean Uplift Force	Intercity, Regional, Commuter /Light Rail/Street Car	All	Test Track
Catenary–Measurement of Contact Force	Intercity, Regional, Commuter /Light Rail/Street Car	All	Test Track
Catenary–Measurement of Displacement	Intercity, Regional, Commuter /Light Rail/Street Car	All	Test Track

Electrical and Propulsion

Electrical and Propulsion tests are performed for performance and compatibility and to monitor energy consumption. Table 2-5 shows a summary of electrical and propulsion tests.

Table 2-5 *Electrical and Propulsion Tests*

Test	Mode(s)	Operating Speed	Facility Type
Radio Frequency Interference	All	All	Test Track
Trainline Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Locomotive Sequence Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Locomotive Electrical Tests	Intercity, Regional, Commuter	<125 mph	Rail Building
Electrical Load/Phase Balance/Power Factor	Intercity, Regional, Commuter	<125 mph	Rail Building
EMI/EMC Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Locomotive Auxiliary Tests	Intercity, Regional, Commuter	<125 mph	Rail Building
Locomotive Propulsion Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Propulsion Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Head End Power (HEP) Test	Intercity, Regional, Commuter	<125 mph	Rail Building
Power Consumption	All	All	Test Track
Battery and Battery Charger Operation Tests	Intercity, Regional, Commuter	<125 mph	Rail Building
Electrical Apparatus Tests	Intercity, Regional, Commuter	<125 mph	N/A
Battery Capacity	Intercity, Regional, Commuter	<125 mph	Rail Building
Battery/Battery Charger Performance	Intercity, Regional, Commuter	<125 mph	Rail Building

Specification Compliance

Specification Compliance tests are tests for vehicle performance as required by the specific transit agency or specification. Some of the tests are compared to different criteria as required by the specific revenue line on which the vehicle will be operating. For example, clearance requirements usually are completed but the criteria may be different based on the revenue line. Table 2-6 shows a summary of specification compliance tests.

Table 2-6 *Specification Compliance Tests*

Test	Mode(s)	Operating Speed	Facility Type
Acceleration	All	All	Test Track
Acceleration Acceptance	Intercity, Regional, Commuter	<125 mph	Test Track
Adhesion-Deceleration	All	All	Test Track
Air brake tests	Intercity, Regional, Commuter	<125 mph	Test Track
Blended Brake Test	Intercity, Regional, Commuter	<125 mph	Test Track
Brake Capacity Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Brake Test	Intercity, Regional, Commuter	<125 mph	Test Track
Deceleration–Blended Braking	All	All	Test Track
Deceleration–Dynamic Braking	All	All	Test Track
Deceleration–Emergency Braking	All	All	Test Track
Deceleration–Service Friction	All	All	Test Track
Drift Test (traction resistance)	All	All	Test Track
Duty Cycle-Friction Brakes	All	All	Test Track
Friction Brake System Endurance Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Hand Brake Operation	Intercity, Regional, Commuter	<125 mph	Building / Test Track
Handbrake Tests	Intercity, Regional, Commuter	<125 mph	Building / Test Track
Singe Car Air Brake and Pneumatic System Operation	Intercity, Regional, Commuter	<125 mph	Building / Test Track
Spin/Slide-Acceleration	All	All	Test Track
Spin/Slide-Deceleration	All	All	Test Track
Clearance Diagram Compliance Tests	All	<125 mph	Building/Test Track
Clearance Test	All	<125 mph	Building/Test Track
Headlights, Misc. Light Adjustment	Intercity, Regional, Commuter	<125 mph	Building/Test Track
Horn Test	Intercity, Regional, Commuter	<125 mph	Test Track
Cab Car Compatibility with Locomotive	Intercity, Regional, Commuter	<125 mph	Building or Test Track
Functionality Tests of All Equipment	Intercity, Regional, Commuter	<125 mph	N/A
Parking Brake Tests	Intercity, Regional, Commuter	<125 mph	Building
Locomotive Sequence Tests	Intercity, Regional, Commuter	<125 mph	Building
Pilot Train Compatibility with Existing Amtrak Bi-Level Cars	Intercity, Regional, Commuter	<125 mph	N/A
Door Safety Systems	Intercity, Regional, Commuter	<125 mph	N/A

Table 2-6 (cont'd.) *Specification Compliance Tests*

Test	Mode(s)	Operating Speed	Facility Type
Emission	Intercity, Regional, Commuter	<125 mph	Test Track
Material Certification	Intercity, Regional, Commuter	<125 mph	Laboratory
Smoke and Flame Components	Intercity, Regional, Commuter	<125 mph	Fire laboratory
Wheel Slip/Slide System Test	Intercity, Regional, Commuter	<125 mph	Test Track
Wheelslide Control System Operation	Intercity, Regional, Commuter	<125 mph	Test Track
Car Weight	Intercity, Regional, Commuter	<125 mph	Building/Test Track

Endurance/Revenue Service

Testing of the final vehicle can be done both at a test site to simulate revenue service and put the vehicle through endurance testing and also at the revenue service site. These tests are done to work out any issues that may happen before fully commissioning the vehicle. Table 2-7 shows a summary of endurance and revenue service tests.

Table 2-7 *Endurance/Revenue Service Tests*

Test	Mode(s)	Operating Speed	Facility Type
Post Delivery Testing of Pilot Train with Other Equipment	Intercity, Regional, Commuter	<125 mph	Test Track
Pilot Train Testing	Intercity, Regional, Commuter	<125 mph	Test Track
Reliability and Post-Delivery Tests	Intercity, Regional, Commuter	<125 mph	Test Track
Simulated Revenue Service	All	All	Test Track

Noise and Vibration

Tests for noise and vibration are completed onboard the vehicle and also in relation to wayside. Table 2-8 shows a summary of noise and vibration tests.

Table 2-8

Noise and Vibration Tests

Test	Mode(s)	Operating Speed	Facility Type
Acceleration Effect of Speed–On Car	All	All	Test Track
Deceleration Effect of Speed–On Car	All	All	Test Track
Effect of Speed–On Car	All	All	Test Track
Effect of Car Speed–Wayside	All	All	Test Track
Effect of Track Section–On Car	All	All	Test Track
Equipment Noise Survey–Wayside	All	All	Test Track
Interior Noise Survey	All	All	Test Track
Screech Loop Survey–On Car	All	All	Test Track
Screech Loop Survey–Wayside	All	All	Test Track
Sound Level Test	Intercity, Regional, Commuter	<125 mph	Test Track
Noise and Vibration Tests	Intercity, Regional, Commuter	<125 mph	Test Track

Vehicle Dynamics Modeling

The Vehicle Dynamics Modeling category includes analyses performed primarily to predict safety and performance before actual tests are performed but also to extend the range of analysis to conditions that may not be tested. The analyses are performed using simulation software, and results are usually compared to the performance criteria used during actual testing. Table 2-9 shows the analyses for vehicle dynamics modeling. Note that many analyses for vehicle dynamic modeling are completed before testing occurs in the Vehicle Dynamics category. Since the tests in this category are analyses, no information on facilities is included. However, TTCI staff are fully capable and experienced to perform the required work.

Table 2-9

Vehicle Dynamic Modeling Tests/ Analyses

Test/Analyses	Mode(s)	Operating Speed
Ride Quality Tests	All	All
Minimally Compliant Analytical Track (MCAT)	Intercity, Regional, Commuter	All
FRA Low-Speed Safety Advisory	All	All
Roll Angle/Static Lean Tests	All	All
Truck Equalization/Wheel Load Equalization Tests	All	All
AAR Standard M-1001 Chapter 11 Service-Worthiness Tests and Analyses for New Freight Cars	All	All
Vehicle Modeling on Track Vehicle will be Qualified	All	All

SECTION

3

Searchable Database of Tests

All tests identified in the Compilation of Tests section are available in Appendix A or online at http://www.fta.aar.com. Online PDFs of tests are available as downloads, or the searchable database can be used to find applicable tests. Figure 3-1 displays the homepage for the FTA database online.

If a user wants to filter the data directly online, the filter function can be used. Figure 3-2 displays the filter function on the website page. The user can filter by the following categories:

- Mode of Operation
- Vehicle Type
  - All Types Listed
  - All Vehicles
  - Passenger Cars
  - Locomotives, electric multiple units (EMUs), diesel multiple units (DMUs)
- Compliance Document Type
  - All
  - APTA
  - APTA and FRA
  - FRA
  - Other
  - RFP
- Category of Test
- Testing Categorization
  - Structural Safety
  - Operational Safety
  - Reliability
  - Passenger Satisfaction
- Facility Requirements

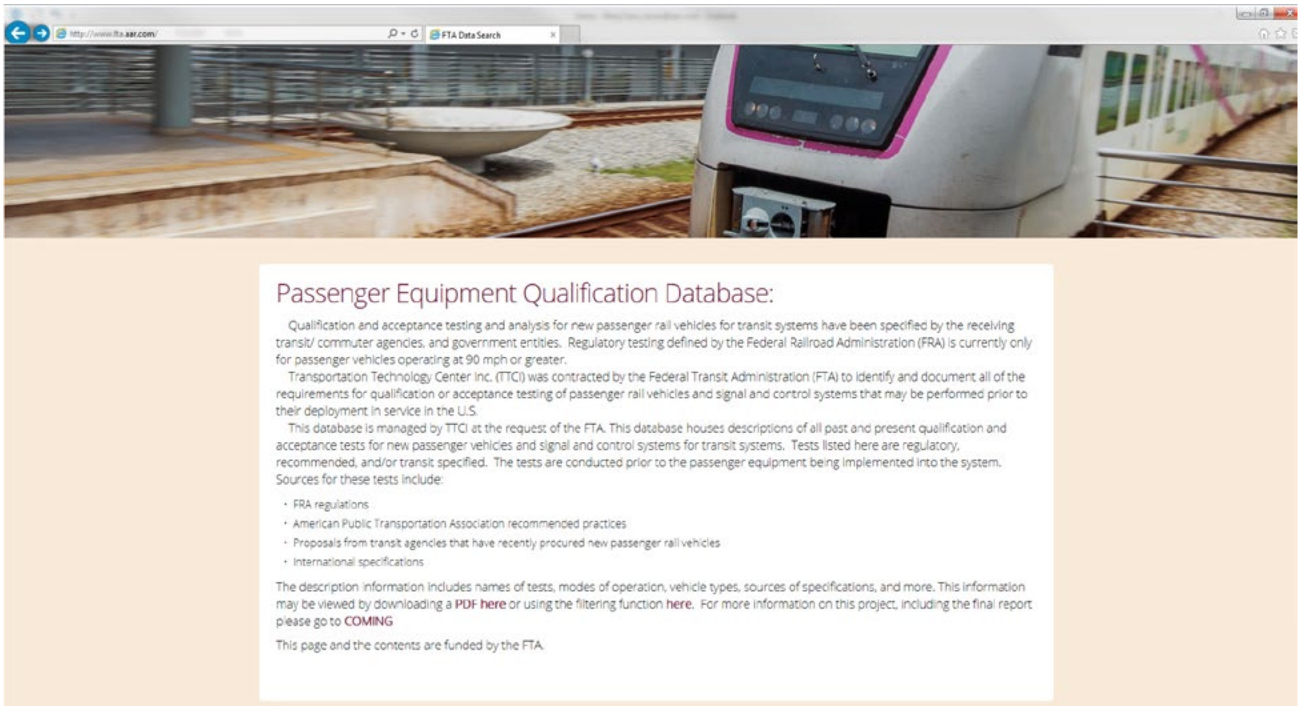

Figure 3-1 *Homepage for FTA database with tests identified*

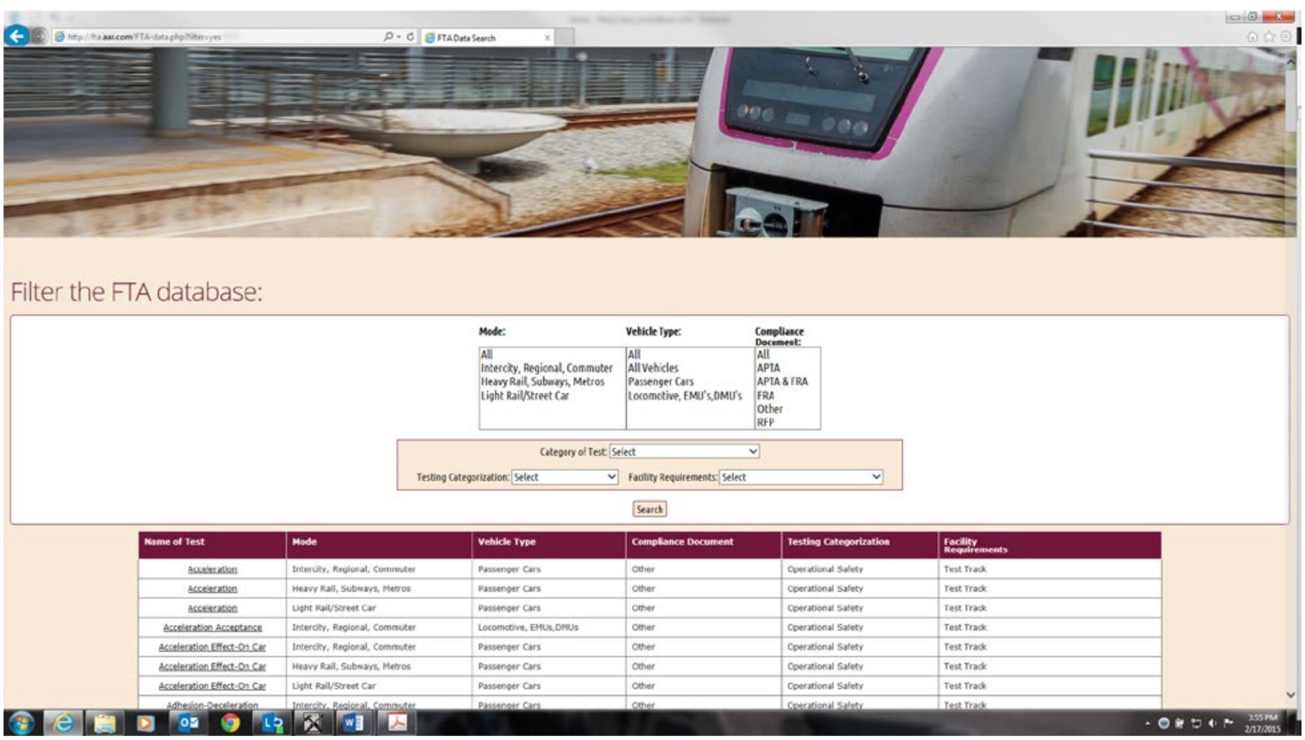

Figure 3-2 *Filter section of FTA database online*

SECTION 4

New Tests and Specifications

New tests, modeling, and specifications were identified. New tests and modeling were identified because of a similar European specification that exists but would need to be modified for U.S. rail. The new tests/calculations include:

- Resistance of Railway Vehicles to Roll-Over Gales – calculation for resistance to roll-over gales (high winds)
- Vehicle Dynamics Measured Over a Vertical Rail Dip – simulation of a vehicle's ability to traverse a dip in the rail
- Door Failure Test – door cycle failure tests for manufacturers/suppliers to test for component failure due to doors being held by patrons

In addition to new tests, new formal specifications on how to perform a test also were identified. This is because several RFPs included a request for a specific test but no formal specification was available. The tests found with no formal U.S. specification on how to perform include:

- Truck Rotation Test Specification – specification that describes test to measure the amount of torque to turn a truck
- Emergency Exit for Passenger Vehicles – defines the minimum requirements to enable passenger to safely and expediently exit rolling stock under emergency conditions
- Vehicle Characterization and Suspension Characterization Test – identifies resonant frequency modes of vehicle and suspension characteristics

Table 4-1 displays the new tests and specifications identified and includes rail mode, type of testing (on-track or laboratory), components required for testing, similar European specifications, and other comments.

Table 4-1

New Tests and Specifications

Mode	New Test/ Specification	Type of Testing	Components Required for Testing	Similar European Specification
All	Truck Rotation Test Specification	On-Track Testing	Truck	GM/RT2000, GM/RC2641, EN14363:2005 (E)
All	Resistance of Railway Vehicles to Roll-Over Gales	Calculation	Calculation	GM/RT2142
All	Vehicle Dynamics Measured Over a Vertical Rail Dip	Simulation and On-Track Testing	Vehicle	GM/TT0088
All	Emergency Exit for Passenger Vehicles	Calculation	Calculation	GO/OTS220
All	Door Failure Test Specification	Lab Testing	Door	
All	Vehicle Characterization and Suspension Characterization Tests	Rail Facility Testing	Vehicle	
All	Standard for Modeling and Testing Loaded and Empty Condition and Air Suspension Inflated and Deflated Condition	Simulation and On-Track Testing	Vehicle	

SECTION

5

Tests That Could Be Applied to Modes Other Than Originally Intended

During the review of the testing specifications, tests were identified and grouped by rail mode for which the test was written. Some tests were written primarily for Intercity, Regional, and Commuter rail but could be applicable to other modes of rail with modifications to the specification. Table 5-1 shows the tests that could be applied to other modes of passenger rail transportation.

Table 5-1

Tests that Could Be Applied to Other Modes of Rail with Modification to Test Specification

Test	Rail Mode for which Test was Originally Written	Rail Mode to Which Test Could Apply
Acceleration Acceptance	Intercity, Regional, Commuter	All
Air Brake Tests	Intercity, Regional, Commuter	All
Blended Brake Tests	Intercity, Regional, Commuter	All
Brake Capacity Tests	Intercity, Regional, Commuter	All
Brake Component Fatigue Tests	Intercity, Regional, Commuter	All
Brake Pad and Shoe Force Test	Intercity, Regional, Commuter	All
Friction Brake Performance Test	Intercity, Regional, Commuter	All
Friction Brake System Endurance Tests	Intercity, Regional, Commuter	All
Hand Brake Tests	Intercity, Regional, Commuter	All
PTC and/or ATC Tests	Intercity, Regional, Commuter	All
Collision Post and Corner Post Load Tests	Intercity, Regional, Commuter	All
Collision with Conventional Equipment	Intercity, Regional, Commuter	All
Compression Loads	Intercity, Regional, Commuter	All
Minimally Compliant Analytical Track (MCAT)	Intercity, Regional, Commuter	All

SECTION 6

TTC Passenger Rail Testing Facilities

TTC's testing capabilities were assessed compared to the tests discussed in the previous sections. A detailed description of TTC's passenger facilities is provided in Appendix B. Tables 6-1 and 6-2 summarize the test tracks and testing facilities at TTC and the rail mode of operation for which the facility can be used, the type of facility, and the maximum speed of vehicle for which the facility can be used.

Table 6-1 *TTC Test Tracks*

Track	Facility Type	Type of Rail Mode	Maximum Speed for Passenger Trains	Comments
Railroad Test Track (RTT)	Test Tracks	All*	162 mph in sections, 132 mph in reverse curve for tilting trains**	Overhead catenary (AC)
Transit Test Track (TTT)	Test Tracks	All*** (short section of overhead catenary on one tangent section)	89 mph	Third rail and short section of overhead catenary (DC)
Train Dynamics Track (TDT)/ Impact Track	Test Tracks	All***	80 mph	Primarily used for impact and derailment testing
Balloon Loop	Test Tracks	All*	40 mph	Overhead catenary (AC)
Precision Test Track (PTT)	Test Tracks	All*	Depends on which section of the track	Used for vehicle dynamic response under perturbed track conditions
Wheel/Rail Mechanisms (WRM) Loop	Test Tracks	All*	Depends on each curve in the loop	Primarily used for testing curving performance
Tight Turn Loop (Screech Loop)	Test Tracks	All**	15-18 mph	Used for investigating wheel noised, truck curving behavior, and rail vehicle stability under extreme curvature conditions
High Speed Track Geometry Test Bed	Test Tracks	All	125 mph (dependent on class of track or perturbation amplitude)	On-track test bed that can be adjusted to provide known track geometry perturbations to evaluate track geometry measurement vehicles for measurement accuracy and test new passenger vehicles; adjustable perturbations designed per MCAT for tangent
PTC Test Bed	Test Tracks	All*	40 mph due to turnout	Certain types of PTC tests

* DC electrically-powered vehicles need to be towed by locomotive.
**Maximum speed for non-tilting trains is 145 mph in sections and 118 mph in reverse curve.
*** AC electrically-powered vehicles need to be towed by locomotive.
****All electrically powered vehicles will need to be towed by locomotive.

Table 6-2 *TTC Testing Facilities*

TTC Testing Facility	Facility Type	Rail Mode	Comments
Rail Dynamics Laboratory (RDL)	Rail Vehicle Building	All, with limitations (no overhead catenary or third rail)	Primarily used for static testing
Center Service Building (CSB)	Rail Vehicle Building	All, with limitations (no overhead catenary or third rail)	Primarily used for maintenance of vehicles
Transit Maintenance Building (TMB)	Rail Vehicle Building	All, with limitations for third rail (has AC overhead catenary)	Primarily used for transit project testing
Urban Rail Building (URB)	Rail Vehicle Building	Heavy Rail, Subway	Primarily used for vehicles requiring third rail power
Passenger Rail Services Building (PSB)	Rail Vehicle Building	All, with limitations for third rail (has AC overhead catenary)	
Vibration Test Unit (VTU)	Test Fixture	All	Located in RDL; evaluate suspension characteristics, components, and vehicle natural frequencies
Simuloader (SMU)	Test Fixture	All	Located in RDL; carbody structural fatigue tests
Mini-Shaker Unit (MSU)	Test Fixture	All	Located in RDL; measures truck suspension system characteristics
Vehicle Impact Wall	Collision Wall	All, depending on speed and test specification	Inclined railway track leads to impact wall for CEM testing
One Million Pound Squeeze Test Fixture	Test Fixture	All, with modifications	Used for carbody structural and CEM testing
Brake Dynamometer	Test Fixture	All, with some modifications	Can be used for brake and wheel tests; wheel tests limited to 28 –42” wheels
Turn Table in TMB	Test Fixture	All	Able to float a two-axle truck under rail vehicle

Alternative Passenger Rail Testing Facilities

Alternative passenger rail testing facilities in the United States also were identified and surveyed. The results summarized in this section are based on feedback from each facility if the survey was returned or through a phone interview. If no feedback was provided, information was derived from other public sources such as websites. Alternative testing facilities for component and/or passenger rail vehicle testing identified include:

- Center for Advanced Technology for Large Structural Systems (ATLSS)
- CTL Group
- MGA Research
- BAE Systems
- WMATA Testing and Commissioning Facility
- Most car builder manufacturing facilities

Appendix C shows the survey sent to the alternative facilities identified. Some surveys either were not returned or information was gathered via phone or face-to-face interviews. Surveys completed during a phone interview or from information from other sources are indicated as such.

ATLSS

ATLSS is located at Lehigh University in Bethlehem, Pennsylvania. A survey was sent to ATLSS, but no response was received. Information about ATLSS is from data gathered from its website at http://www.atlss.lehigh.edu/, which indicates that ATLSS is primarily a structures testing facility, but it does have passenger equipment testing capabilities that provide metallurgical testing and can generate multi-directional static and time-varying loads. Its test equipment features an 800,000-lb and a 5,000,000-lb universal load frame testing machine and a dynamic test bed with broad fatigue-testing capabilities with a wide range of instrumentation.[1]

CTL Group

CTL Group in Skokie, Illinois, has component testing capabilities including partial and full-scale mock-ups. CTL Group can perform static and dynamic load testing in excess of 1 million pounds. Its load fixtures allow for testing of a broad array of coupler and truck components including entire truck frames. It has completed testing for passenger equipment including APTA standards and Amtrak.[2]

MGA Research

MGA Research is located in Burlington, Wisconsin, on 400 acres and is designed around automobiles and medium-duty trucks. It has an accelerator dynamic sled and laboratories for quasi-static, environmental, and durability tests. The facilities for dynamic, quasi-static, and durability of seating systems are used regularly for rail vehicle component testing, specifically APTA SS-C&S-016-99. It currently has not performed any complete rail vehicle testing, only components.[3]

BAE Systems

BAE Systems is located in Phoenix, Arizona. A survey sent was not returned; information provided is based on information provided on its website at www.baesystems.com, which indicates that it has electrical and radio frequency testing capabilities with microwave test capability from DC to 18 GHz in a controlled environment and high-voltage test capability up to 100 Kv in a fully-enclosed Faraday cage. It has been involved in power management for rail vehicles and has equipment to monitor power to help with better fuel savings and decreased emissions.[4]

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[1] http://www.atlss.lehigh.edu/
[2] http://www.ctlgroup.com/home/
[3] http://mgaresearch.com/
[4] www.baesystems.com

WMATA Testing and Commissioning Facility

The Washington Area Metropolitan Transit Authority (WMATA) Testing and Commissioning Facility is being built in College Park, Maryland, to test and commission the new 7000 series cars purchased by WMATA. The commissioning facility was expected to open in October 2014 to provide static testing; at the time of writing the report, the facility had not yet opened and no expected date of opening was available. This facility will have enough area to house four married pairs with three positions for lifting and one for a pit. It also will house offices for WMATA civil and mechanical engineering staff and a power laboratory. A test track is also being built adjacent to the mainline tracks from the Greenbelt Station to College Park Station, which will be about 9,000 feet of tangent track and will be mostly level. This track will be used for dynamic track testing including automatic train control.

Car Builder Manufacturer Facilities

Testing facilities and laboratories perform testing for passenger vehicles, and car builders perform some testing as well. Many car builders have facilities available for static testing and short on-track dynamic testing runs. These facilities include water tightness testing facilities, short dynamic test tracks, buildings with lifts, pits, turn tables, and environmental chambers.

Other Facilities

Other testing facilities were identified that are outside of the United States:

- Railway Technical Research Institute (RTRI) in Japan has large-scale laboratory equipment including:
  - Rolling stock test plant that simulates the conditions of tracks and running trains
  - Brake test stand to develop high performance brake systems
  - Large-scale shaking table to simulate earthquake motion under actual track and truck conditions
  - Large-scale rainfall simulator
  - Ride comfort simulator
  - Current collection testing equipment
  - Large-scale Noise Wind Tunnel
- Centre d'Essais Ferroviaire (CEF) Railway Testing Centre in France has dedicated test tracks for testing of urban rail vehicles and signaling systems.
- China Academy of Railway Sciences (CARS) at the National Railway Test Center[5] has large-scale laboratory testing equipment and a test track to test urban transit vehicles.

[5] http://home.rails.com.cn/en/index.php?id=1.

SECTION 7

Complementary Tasks

Several additional tasks were completed as part of this project. These tasks were complimentary to FTA and funded by TTCI:

- Comparison of Rail Vehicle Dynamic Modeling Software
- Summary of Rail Vehicle Propulsion Systems
- Current Capabilities at TTC related to High Speed Rail Testing

Comparison of Rail Vehicle Dynamic Modeling Software

Qualification and acceptance testing of new rail vehicles also involves computer modeling before and after the building of the rail vehicle using rail vehicle dynamics modeling software. A comparison of rail vehicle dynamic modeling software was completed. The computer software programs that were identified and surveyed include:

- Gensys
- Adams/Adams-Rail
  - Medyna (Solver for Adams/Adams-Rail)
- Voco
- Samsrail
- Universal Mechanism
- Simpack
- VI-Rail
- NUCARS®[6]
- Vampire®[7]

Four other software packages were identified, but no contact information was found. These packages include AGEM, and three other packages of unknown name from Portugal, Spain, and Italy. As a result, no information is provided in the comparison for these packages.

[6] NUCARS® is a registered trademark of Transportation Technology Center, Inc., Pueblo, Colorado.

[7] Vampire® is a registered trademark in the United Kingdom of Delta Rail, Inc.

Appendix C includes the survey that was sent to the software developers to identify specific capabilities related to inputs to the software, simulation output options, integration with other software programs, pricing and customer support, and ease of use. Results from the survey are provided as received from the software company at the time of completion of the survey, and TTCI did not validate the accuracy of the results. If the software company did not return the survey and had a website, an attempt was made to complete the survey based on the information provided on the website. The information gathered from the survey is summarized in Table 7-1. For software packages with question marks in the table, no information was provided on the website.

Summary of Rail Vehicle Propulsion Systems

Rail vehicle propulsion systems used in the passenger industry were reviewed. The following three types of propulsion systems are used in the United States:

- Vehicles hauled by diesel electric locomotives
- Vehicles powered by electricity from either third rail and/or overhead catenary, including:
  - Electric locomotives
  - Self-propelled vehicles such as Light Rail Vehicles and Electric Multi Unit (EMU) vehicles
- Self-propelled vehicle powered by onboard diesel engines – Diesel Multi Unit (DMU); the three methods of transmitting power to wheels of DMUs are:
  - Diesel-mechanical – engine energy is transmitted via gearbox and driveshaft
  - Diesel-hydraulic – hydraulic torque converter acts as the transmission
  - Diesel-electric – diesel engine drives the electric generator or alternator

Each mode of rail operation was analyzed based on the type of propulsion system. Commuter rail can use diesel locomotives, electric locomotives, EMUs, and DMUs. Several transit agencies with commuter rail operations use both diesel locomotives and electrification to power their vehicles. The choice for type of propulsion for these transit agencies is an economic decision dependent on infrastructure requirements (number of vehicles and train sets to meet commuter needs, route, length, speed requirements, etc.) leading to total infrastructure cost for the system. The overhead catenaries systems are most commonly AC-powered with voltages from 1.5 kV to 25 kV. Table 7-2 shows the breakdown of manufacturers for propulsion systems for commuter vehicles currently in use or being manufactured for use in the United States. Some of these manufacturers are no longer in business or have been absorbed by other companies.

Table 7-1 *Rail Vehicle Dynamics Modeling Software*

Software Name	Gensys[8]	ADAMS & ADAMS RAIL[9]	MEDYNA	VOCO (French)[10]	SAMSRail	Universal Mechanism[11]	SIMPACK[12]	VI Rail	NUCARS®[13]	Vampire®[14]
Provided Survey Response? (Y/N)	Y	N	N	Y	N	Y	N	Y	Y	Y
Organization (Country) Origin	AB DEsolver (Sweden)	MSC Software Corporation (USA/Europe)	Walter Kik Germany)	IFSTTAR (France)	Shabbana, U of Illinois–Chicago	Laboratory of Computational Mechanics (Russia)	SIMPACK AG (Germany)	VI-GRADE (Germany)	Transportation Technology Center Inc. (USA)	DeltaRail (UK)
Software Capabilities (Y/N):										
Input real wheel and rail measurements?	Y	?	N/A	Y	?	Y (creation is supported, limited support of import)	?	Y	Y	Y
Special trackwork inputs?	Y	?		Y		N (in development)	Y	Y	Y	Y
Parametric variations?	Y	?		Y		Y	Y	Y	Y	Y
Animated output?	Y	?		Y		Y	Y	Y	Y	Y
Input from latest W/R measurement devices?	?	?		N		N	?	Y	Y	Y
North American RR “templates”	?	?		N		Y	?	Y	Y	Y
Supplemental packages for analysis of input and output?	Y	?		Y		Y	Y	Y	Y	Y
Batch analysis capability?	Y	?		Y		Y	Y	Y	Y	Y
CAD interface?	n	?		Y		Y	Y	Y	N	Y
FEM interface?	Y	?		Y		Y	Y	Y	N	Y
Software Limitations										
# connections allowed (List #)	N/A (depends on computer memory)	?	N/A	no limit	?	limited only by RAM size	?	no limit	5000 currently but can be adjusted	Multiple
# of bodies allowed (List #)	N/A (depends on computer memory)	?		no limit		limited only by RAM size	?	no limit	300 currently but can be adjusted	180

[8] http://www.gensYs.se/
[9] http://web.mscsoftware.com/support/librarY/conf/adams/rail/haarlem00.cfm
[10] http://www.tandfonline.com/doi/abs/10.1080/00423114.2013.768771#preview
[11] http://www.universalmechanism.com/en/pages/index.php?id=1
[12] http://www.simpack.com/
[13] http://www.aar.com/nucars/index.html
[14] http://vampire-dynamics.com/
[15] http://www.vi-grade.com/

Table 7-1 (cont'd.) *Rail Vehicle Dynamics Modeling Software*

Software Name	Gensys[8]	ADAMS & ADAMS RAIL[9]	MEDYNA	VOCO (French)[10]	SAMSRail	Universal Mechanism[11]	SIMPACK[12]	VI Rail	NUCARS®[13]	Vampire®[14]
User Information: (Y/N)										
GUI not cumbersome	Y	?	N/A	Y	?	?	?	Rating of 3 (scale 1-easy, 9-hard)	Y	Y
Mouse-driven Windows=type user interface w/pull down menus, etc.	Y	?		Y		Y	Y	Y	Y	Y
Pictorial animation	Y	?		Y		Y	Y	Y	Y	Y
Model building with pictorial interaction	Y (just for checking input data model)	?		Y		Y	Y	Y	N	Y
Other Information										
Help desk? (Y/N)	Y	?	N/A	N	?	Y	Y	Y	Y	Y
Price (list if available)	About $4,800 (31282 SEK) for standard version	50K USD one time + 20% yearly maintenance		33,000 Euro (perpetual)		$17,000 f	Upon request only	Depends on local, regional/ global network license	Varies, depends on use	Varies, depends on use
On-line support? (Y/N)	N (email only)	?		N		Y	?	Y	Y	Y
Predictable and regular software releases? (Y/N)	N (not after 2009)	?		N (every 1/2 yrs)		Y	Y	Y	Y	Y
Website link	http://www.gensYs.se/									
http://web.mscsoftware.com/support/librarY/conf/adams/rail/haarlem00.cfm		http://www.tandfonline.com/doi/abs/10.1080/00423114.2013.768771#preview								
	http://www.universalmechanism.com/en/pages/index.php?id=1									
http://www.simpack.com/										
http://www.vi-grade.com/	http://www.aar.com/nucars/index.html	http://vampire-dynamics.com/								
Additional comments			Solver used with ADAMS/ Rail				Data obtained from web	Info obtained from website, datasheet, survey results		

Table 7-2

Commuter Rail Propulsion Systems

Name of Manufacturer	Propulsion System Type
Brookville	Diesel Electric Locomotive
Caterpillar	Diesel Electric Locomotive
Cummins	Diesel Electric Locomotive
Detroit Diesel	Diesel Electric Locomotive
General Electric	Diesel Electric Locomotive
Electro-Motive Diesel (EMD), including predecessors General Motors Electro Motive Division and Electro-Motive Corporation (EMC)	Diesel Electric Locomotive
Motive Power Inc.	Diesel Electric Locomotive
Siemens	Diesel Electric Locomotive
Asea Brown Broveri	Electric Locomotive
Bombardier and Alstom Consortium	Electric Locomotive
Siemens	Electric Locomotive
Ansaldo Breda	Diesel Multi Unit
Budd Company	Diesel Multi Unit
Bombardier Corporation	Diesel Multi Unit
CAF	Diesel Multi Unit
Colorado Rail Car	Diesel Multi Unit
EIKON International	Diesel Multi Unit
Hyundai Rotem	Diesel Multi Unit
Niigata Transys	Diesel Multi Unit
Nippon Sharyo	Diesel Multi Unit
Siemens	Diesel Multi Unit
Stadler Rail	Diesel Multi Unit
ABB Daimler-Benz Transportation	Electricity (Overhead Catenary)
ABB Traction (Asea Brown Boveri)	Electricity (Overhead Catenary)
American Passenger Rail Company (formerly Morrison-Knudsen)	Electricity (Overhead Catenary)
Bombardier Corporation	Electricity (Overhead Catenary)
Budd Company	Electricity (Overhead Catenary)
General Electric Company	Electricity (Overhead Catenary)
Kawasaki Rail Car (formerly Kawasaki Heavy Industries)	Electricity (Overhead Catenary)
Nippon Sharyo	Electricity (Overhead Catenary)
Pullman Car and Manufacturing Corporation	Electricity (Overhead Catenary)
Hyundai Rotem Company	Electricity (Overhead Catenary)
Saint Louis Car Company	Electricity (Overhead Catenary)
Sumitomo Corporation	Electricity (Overhead Catenary)
Tokyu Car Company	Electricity (Overhead Catenary)

Light rail systems are powered by overhead catenary with various voltage/current capabilities. Table 7-3 lists the manufacturers of light rail propulsion systems that are still currently in use in the United States. Some of these manufacturers are no longer in business or have been absorbed by other companies.

Table 7-3

Light Rail Propulsion System Manufacturers

Name of Manufacturer
ABB Traction (ASEA Brown Boveri)
Acciaio
Adtranz-Stadler Fahrzeug
Alstom
Ansaldo Breda
Boeing Vertol Company
Bombardier Corporation
Breda Transportation
Brookville Mining Equipment Corporation
Colomna Machine Works
Construcciones y Auxiliar de Ferrocarrilles
English Electric Company
Fujinagata Zosen Company
Gomaco Trolley Company
J.G. Brill Company
James Moore
Jewett Car Company
John Hammond and Company
Kawasaki Rail Car (formerly Kawasaki Heavy Industries)
Kinki Sharyo Company
Linke-Hoffmann-Busch Waggon-Fahrzeug-Maschinen
Nippon Sharyo
Oregon Iron Works
Perley Thomas Car Company
Porto Company Shops
Preston Workshops (Melbourne & Metropolitan Tramways Board)
Pullman-Standard
Regional Transit Authority of Orleans and Jefferson
Saint Louis Car Company
Siemens
Skoda Dopravni Technikaltd
UTDC
W.L. Holman Company

Heavy rail systems are powered by a third rail with various voltage/current configurations. Table 7-4 lists the manufacturers of heavy rail propulsion systems that are still currently in use in the United States. Some of these manufacturers are no longer in business or have been absorbed by other companies.

Table 7-4

Heavy Rail Propulsion System Manufacturers

Name of Manufacturer
AAI Corporation-CAF
ABB Daimler-Benz Transportation
ABB Traction (Asea Brown Boveri)
Alstom Transportation
Alstom/Kawasaki Rail Car
American Passenger Rail Company (formerly Morrison-Knudsen)
Boeing Vertol Company
Bombardier Corporation
Breda Transportation
Budd Company
Canadian Vickers
General Electric Company
Hawker Siddeley Canada
Hitachi
Kawasaki Rail Car (formerly Kawasaki Heavy Industries)
Pullman-Standard
Rohr Corporation
Saint Louis Car Company
Siemens Transportation Systems
Societe Franco-Belge de Material
Tokyu Car Company
UTDC
Westinghouse-Amrail

TTC's Current Capabilities Related to High Speed Rail Testing

Facilities at TTC are currently configured for testing up to a maximum speed of 162 mph. This allows testing of Tier II level rolling stock and equipment with a maximum speed of 150 mph. The following sections detail TTC's high speed rail test capabilities and the upgrades necessary to meet high speed rail test requirements [1]. Major facility upgrades would be required to test at higher speeds.

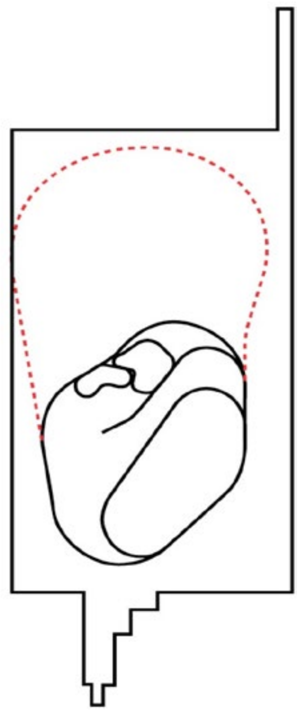
Raising Maximum Test Speed

Cant deficiency limits the maximum continuous speed on the RTT to 160 mph. To raise the maximum testing speed, the track must be modified by increasing the loop size. Investment numbers rise dramatically with such improvements. The acreage at TTC is sufficient to contain a closed oval with curvature suitable for 220 mph, but the investment for such a track would approach $150 million. Such a track would have tangent sections capable of a peak speed of 270 mph.

Figure 7-1 shows the proposed extension for curvatures suitable for 220 mph in a red dotted line. By extending the track beyond the current northern boundary, an additional $50 million investment would yield a tangent section capable of over 300 mph. Construction time is roughly three years.

Figure 7-1

RTT proposed increase in loop size (shown as red dotted line) for 220 mph curve capabilities



High Speed Siding

A new siding with high speed rail (HSR) test sections on concrete slab track is proposed for the Railroad Test Track (RTT). The siding will be used to support HSR and Positive Train Control (PTC) performance testing.

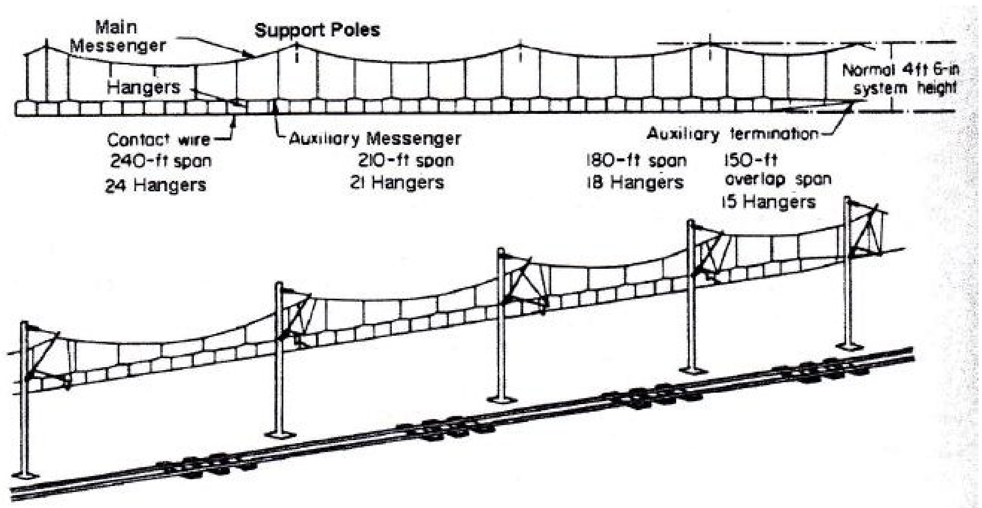
Per the FRA sponsored project "Needs Assessment—Railroad Test Track Siding Options for High Speed Testing," completed in 2011, adding an HSR siding to the RTT for $21 million will provide a location for curved MCAT perturbations and will facilitate many of the required tests. This three-mile siding is proposed to include both tangent and curved track. Six MCAT segments are possible within the body of the curve. Multiple track forms can be tested. The curve in this siding, together with MCAT segments, can be used for cant deficiency studies. Timing for this project would be 18 to 24 months.

RTT Catenary System

The RTT catenary system is a "compound catenary" design, which typically performs well at speeds up to 125 mph. Figure 7-2 shows a schematic of the existing compound catenary at the TTC.

Figure 7-2

Existing compound catenary at TTC

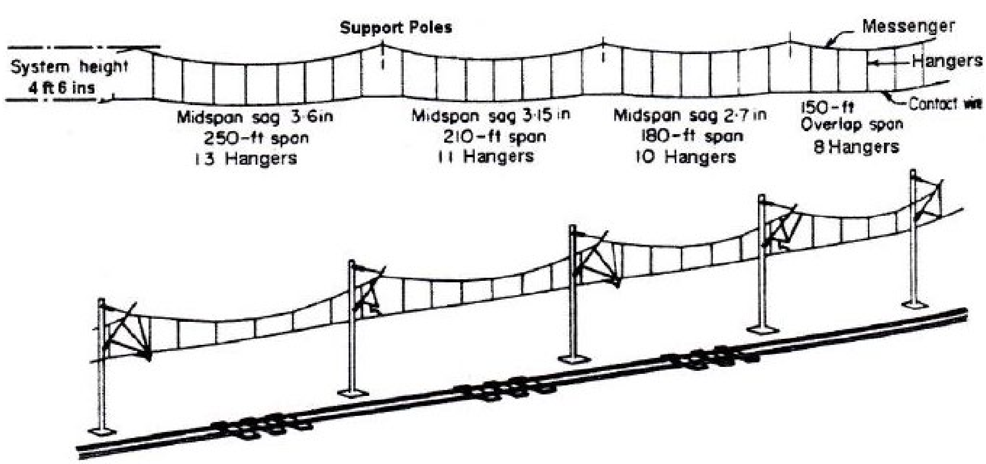


The RTT catenary was installed at TTC in the late 1970s and has extensive wear in the existing hanger supports and contact wires due to age, operations, and environmental factors. The Colorado climate has contributed heavily to the deterioration of the system components. High winds and other factors have accelerated mechanical wear and corrosive damage. The estimate for refurbishment of the existing compound catenary system is based on a 1994 overall assessment of the RTT. Although some investments have been made to correct deficiencies found at that time and as recently as 2009, it can be assumed that mechanical wear and failures with this design have continued. A more thorough analysis is needed to quantify the required work.

The preferred option is to convert the current RTT "compound catenary system" to a "sagged simple catenary system." Figure 7-3 shows the sagged simple catenary. The sagged simple catenary design has become the system of choice for high speed applications in Europe and has been installed on the New Haven to Boston section of AMTRAK's Northeast Corridor.

Figure 7-3

Sagged simple catenary



The primary advantages of the sagged simple catenary are:

- Allows speeds in excess of 200 mph; has been tested in France at speeds up to
- 350 mph.
- Reduces number of system components, which reduces component wear, maintenance and longer term capital restoration costs.
- Can be installed in a staged approach (if required) with current compound system.

The estimated cost to replace convert the existing catenary system to a sagged simple design is $2.0 million and would take about 12 months.

Passenger Car Structural Test Facility

Currently, quasi-static structural strength validation testing of vehicles can be completed at TTC, including:

- Vertical load test with approximately 200,000 lbf distributed over the floor
- End load tests with loads up to 800,000 lbf applied at different heights
- Side load test
- Corner Post Energy Absorption Test (120,000 ft-lb at 30" above floor)
- Principal Energy Absorption Mechanism (PEAM) test (900,000 lbf to 1.4 million lbf 38" stroke)

Figure 7-4 displays the current structural test facility at TTC.

Figure 7-4

Passenger car structural test facility at TTC

Summary of Upgrades Recommended for High Speed Rail Testing

Table 7-5 summarizes the upgrades recommended at TTC for high speed rail testing [2].

Table 7-5

Testing and Investment Cost and Schedule for High Speed Testing

Description	Cost*	Timing (months)	Comment
HS Turnouts on RTT	$8 million	8	Preliminary for high speed siding
RTT High Speed Siding	$25 million	18–24	Depends on options and length
Passenger car structural test facility	Various	12	Quasi-static vehicle structural testing
Catenary Upgrade on RTT	$2–3 million	2	Increases speeds on RTT and reduces maintenance
Raise Maximum Test Speed	$22–210 million	36	CFR Tier III speeds up to 220 mph

*Based on 2011 costs inflated to 2014 costs using Railroad Cost Recovery Index.

SECTION

8

Conclusions and Recommendations

This report presents the results of identifying all passenger rail vehicle qualification tests that are required or recommended to be completed. These tests are either regulatory requirements defined by the FRA or specification requirements defined by the transit agency RFP. In addition, European specifications were identified and cross referenced to the US specifications.

Qualification tests for rail passenger vehicles are ever changing. The tests presented in this report are the tests currently being used. Recommendations from this project are to update the tests listed in the database on a yearly basis since tests and requirements will change.

REFERENCES

[1] Witte, M., N. Wilson, R. Fries, and H. Wu. 2013. Comparison of FRA Regulations to International High-Speed Rail Standards. DOT/FRA/ORD-13/30 Federal Railroad Administration, Washington DC, May. http://ntl.bts.gov/lib/48000/48100/48170/TR_Comparison_FRA_Regulations_Intl_High-Speed_20120516_final_1_.pdf

[2] Li, D., N. Wilson, and A. Tajiddini. 2011. Needs Assessment—Railroad Test Track Siding Options for High Speed Testing. Unpublished. Task Order 259 report submitted to Federal Railroad Administration, Washington DC, May.

APPENDIX

A

Tests in Tabular Form

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
	Acceleration and Braking																
Intercity, Regional, Commuter	Acceleration	Passenger Cars	Specification	Specification Compliance	P-2001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Acceleration	Passenger Cars	Specification	Specification Compliance	P-2001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Acceleration	Passenger Cars	Specification	Specification Compliance	P-2001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Acceleration Acceptance	Locomotive, EMUs, DMUs	Qualification	Specification Compliance	Table 19-1: Test Matrix	<125 mph	Other	Operational Safety	Test Track	Test Center or Revenue Track	Yes		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Acceleration Effect-on Car	Passenger Cars	Specification	Noise/Vibration	PN-2001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Acceleration Effect-on Car	Passenger Cars	Specification	Noise/Vibration	PN-2001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Acceleration Effect-on Car	Passenger Cars	Specification	Noise/Vibration	PN-2001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Adhesion-Deceleration	Passenger Cars	Specification	Specification Compliance	A-3021-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Adhesion-Deceleration	Passenger Cars	Specification	Specification Compliance	A-3021-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Adhesion-Deceleration	Passenger Cars	Specification	Specification Compliance	A-3021-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Air brake tests	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.3.15.1	<125 mph	Other	Operational Safety	Test Track	Test Center or Revenue Track	Yes		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				Japan Ministerial Standards2012
Intercity, Regional, Commuter	Blended brake test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.3.15.2	<125 mph	Other	Operational Safety	Test Track	Test Center or Revenue Track	Yes	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf	RP-E-014-99 Diesel Electric Locomotive Blended Brake Control			GM/TT0169, 0170, 0171,2044
Intercity, Regional, Commuter	Brake Capacity Tests	Passenger Cars	Specification	Specification Compliance	19.5.4.4	<125 mph	Other	Operational Safety	Test Track	Builder	Yes	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Brake Component Fatigue Tests	Passenger Cars	Specification	Specification Compliance	19.5.4.2	<125 mph	Other	Operational Safety	Test Track	Builder	Yes	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Brake control operation	Passenger Cars	Specification	Signaling and Train Control	APTA SS-M-011-99	<125 mph	Other	Operational Safety	Test Track	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	
Intercity, Regional, Commuter	Brake Pad and Shoe Force Tests	Passenger Cars	Specification	Specification Compliance	19.5.4.1	<125 mph	Other	Operational Safety	Test Track	Builder	Yes	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Brake Test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.3.9	<125 mph	Other	Operational Safety	Test Track	Test Center	Yes	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Deceleration Effect-on Car	Passenger Cars	Specification	Noise/Vibration	PN-3001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Heavy Rail, Subways, Metros	Deceleration Effect-on Car	Passenger Cars	Specification	Noise/Vibration	PN-3001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Light Rail/Street Car	Deceleration Effect-on Car	Passenger Cars	Specification	Noise/Vibration	PN-3001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012

Mode	**Name** of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Deceleration-Blended Braking	Passenger Cars	Specification	Specification Compliance	P-3001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Heavy Rail, Subways, Metros	Deceleration-Blended Braking	Passenger Cars	Specification	Specification Compliance	P-3001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Light Rail/Street Car	Deceleration-Blended Braking	Passenger Cars	Specification	Specification Compliance	P-3001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Intercity, Regional, Commuter	Deceleration-Dynamic Braking	Passenger Cars	Specification	Specification Compliance	P-3003-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Heavy Rail, Subways, Metros	Deceleration-Dynamic Braking	Passenger Cars	Specification	Specification Compliance	P-3003-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Light Rail/Street Car	Deceleration-Dynamic Braking	Passenger Cars	Specification	Specification Compliance	P-3003-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Intercity, Regional, Commuter	Deceleration-Emergency Braking	Passenger Cars	Specification	Specification Compliance	P-3004-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Heavy Rail, Subways, Metros	Deceleration-Emergency Braking	Passenger Cars	Specification	Specification Compliance	P-3004-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Light Rail/Street Car	Deceleration-Emergency Braking	Passenger Cars	Specification	Specification Compliance	P-3004-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Intercity, Regional, Commuter	Deceleration-Service Friction	Passenger Cars	Specification	Specification Compliance	P-3002-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Heavy Rail, Subways, Metros	Deceleration-Service Friction	Passenger Cars	Specification	Specification Compliance	P-3002-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Light Rail/Street Car	Deceleration-Service Friction	Passenger Cars	Specification	Specification Compliance	P-3002-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				Japan Ministerial Standards2012
Intercity, Regional, Commuter	t Test (traction resistance)	Passenger Cars	Specification	Specification Compliance	P-4001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	t Test (traction resistance)	Passenger Cars	Specification	Specification Compliance	P-4001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	t Test (traction resistance)	Passenger Cars	Specification	Specification Compliance	P-4001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Duty Cycle-Friction Brakes	Passenger Cars	Specification	Specification Compliance	P-5001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Duty Cycle-Friction Brakes	Passenger Cars	Specification	Specification Compliance	P-5001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Duty Cycle-Friction Brakes	Passenger Cars	Specification	Specification Compliance	P-5001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Friction Brake Performance Test	Passenger Cars	Specification	Component Performance	19.5.14.2.8	<125 mph	Other	Operational Safety	Test Track	Test Center	Yes		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Friction Brake System Endurance Tests	Passenger Cars	Specification	Specification Compliance	19.5.4.3	<125 mph	Other	Operational Safety	Test Track	Test Center	Yes		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Hand Brake Operation	Passenger Cars	Specification	Specification Compliance	19.6.4.2	<125 mph	Other	Operational Safety	Test Track	Builder	Yes		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Handbrake Tests	Passenger Cars	Specification	Specification Compliance	19.5.4.5 per APTA SS-M-006-98	<125 mph	Other	Operational Safety	Test Track	Builder	Yes		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		GM/RT2000, Japan Ministerial Standards 2012
Intercity, Regional, Commuter	Locomotive and air brake control	Passenger Cars	Specification	Signaling and Train Control	16.6.13.6	<125 mph	Other	Operational Safety	Test Track	Builder	Yes		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Single Car Air Brake and Pneumatic System Operation	Passenger Cars	Specification	Specification Compliance	PTA SS-M-005-98 and AAR S471	<125 mph	Other	Operational Safety	Test Track	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-005-98	
Intercity, Regional, Commuter	Spin/Slide-Acceleration	Passenger Cars	Specification	Specification Compliance	P-2011-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Spin/Slide-Acceleration	Passenger Cars	Specification	Specification Compliance	P-2011-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Spin/Slide-Acceleration	Passenger Cars	Specification	Specification Compliance	P-2011-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Spin/Slide-Deceleration	Passenger Cars	Specification	Specification Compliance	P-3011-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Spin/Slide-Deceleration	Passenger Cars	Specification	Specification Compliance	P-3011-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Spin/Slide-Deceleration	Passenger Cars	Specification	Specification Compliance	P-3011-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
	Clearances																
Intercity, Regional, Commuter	Clearance Diagram Compliance Tests	Passenger Cars	Specification	Specification Compliance	19.6.14.1.2	<125 mph	Other	Operational Safety	None(diagram)	Builder	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		GM/RT2149
Heavy Rail, Subways, Metros	Clearance Diagram Compliance Tests	Passenger Cars	Specification	Specification Compliance	Agency Specified	<125 mph	Other	Operational Safety	None(diagram)	Builder	No	Individual cars require fixture modification - fabrication	Specified by RFP Specified by RFP				GM/RT2149
Light Rail/Street Car	Clearance Diagram Compliance Tests	Passenger Cars	Specification	Specification Compliance	Agency Specified	<125 mph	Other	Operational Safety	None(diagram)	Builder	No	Individual cars require fixture modification - fabrication					GM/RT2149
Intercity, Regional, Commuter	Clearance Test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.3.6	<125 mph	Other	Operational Safety	Test Track orRail Facility	Test Center, Builder Facility, or Revenue Track	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				GM/RT2149
Heavy Rail, Subways, Metros	Clearance Test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Agency Specified	<125 mph	Other	Operational Safety	Test Track orRail Facility	Test Center, Builder Facility, or Revenue Track	No	Individual cars require fixture modification - fabrication	Specified by RFP Specified by RFP				GM/RT2149
Light Rail/Street Car	Clearance Test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Agency Specified	<125 mph	Other	Operational Safety	Test Track orRail Facility	Test Center, Builder Facility, or Revenue Track	No	Individual cars require fixture modification - fabrication					GM/RT2149
	Communications																

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Cab indicator operation	Passenger Cars	Specification	Signaling and Train Control	19.6.13.8	<125 mph	Other	Operational Safety	N/A	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Event recorder performance	Passenger Cars	Specification	Signaling and Train Control	19.6.13.3	<125 mph	Other	Operational Safety	N/A	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Event recorder-video performance	Passenger Cars	Specification	Signaling and Train Control	19.3.13.4	<125 mph	Other	Operational Safety	N/A	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Headlight and crossing light tests	Passenger Cars	Specification	Signaling and Train Control	19.6.13.14 per49CFR Section229.125	<125 mph	Other	Operational Safety	N/A	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Headlights, Misc. Light Adjustment	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Table 19-1: Test Matrix	<125 mph	Other	Operational Safety	N/A	Test Center, Builder Facility, or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Horn and bell operation	Passenger Cars	Specification	Signaling and Train Control	19.6.13.12	<125 mph	Other	Operational Safety	Rail Facility	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Horn Test per 49CFR229.129	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Table 19-1: Test Matrix	<125 mph	Other	Operational Safety	Rail Facility	Test Center, Builder Facility, or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	MU and COMM trainline function operation	Passenger Cars	Specification	Signaling and Train Control	19.6.13.9	<125 mph	Other	Operational Safety	Test Track	Test Center or Revenue Track	Yes		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Positive Train Control (PTC) and/or Automatic Train Control (ATC) if equipped	Locomotive, EMUs, DMUs	Specification	Signaling and Train Control	Table 19-1: Test Matrix	<125 mph	Other	Operational Safety	Test Track	Revenue Track	Yes		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Positive train control system	Passenger Cars	Specification	Signaling and Train Control	19.6.13.5	<125 mph	Other	Operational Safety	Test Track	Revenue Track	No	Tests are still being developed. Testing procedures are being developed under specific RFPs (e.g. CalTrans)	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Radio Frequency Interference	Passenger Cars	Specification	Electrical & Propulsion Performance	PSI-6001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Radio Frequency Interference	Passenger Cars	Specification	Electrical & Propulsion Performance	PSI-6001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Radio Frequency Interference	Passenger Cars	Specification	Electrical & Propulsion Performance	PSI-6001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	peedometer/overspeed performance	Passenger Cars	Specification	Signaling and Train Control	19.6.13.2	<125 mph	Other	Operational Safety	Test Track	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Train Speed Control Test	Locomotive, EMUs, DMUs	Specification	Signaling and Train	19.3.20	<125 mph	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Test Location Specified by owner / agency	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Trainline Tests	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.5.10.2	<125 mph	Other	Operational Safety	Test Track	Builder	No	Test Location Specified by owner / agency	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
	Compatibility																
Intercity, Regional, Commuter	Cab Car Compatibility with the Locomotive	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Table 19-1: Test	<125 mph	Other	Reliability	Test Track	Test Center or Revenue Track	No	Test Specific onlocation to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	nctionality Tests of all equipment	Passenger Cars	Specification	Specification Compliance	19.7.2	<125 mph	Other	Reliability	Test Track	Revenue Track	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Parking brake tests	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.3.15.3	<125 mph	Other	Operational Safety	Test Track	Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Locomotive Sequence Test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Table 19-1: Test	<125 mph	Other	Operational Safety	Test Track	Builder Facility or Test Center	No	Test Specific onlocation to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Locomotive Sequence Tests	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	19.3.14	<125 mph	Other	Operational Safety	Test Track	Builder Facility or Test Center	No	Test Specific onlocation to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Pilot Train Compatibility with Existing Amtrak Bilevel Cars	Passenger Cars	Qualification	Specification	19.5.14.2.2	<125 mph	Other	Operational Safety	(California Car, Superliner, Surfliner)	Revenue Track	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Post Delivery Testing of Pilot Train with Other Equipment	Passenger Cars	Specification and Qualification	Enduran ce/ Revenue Service	19.8.	<125 mph	Other	Reliability	Test Track	Revenue Track	No	Post test infers testing to be on agency property	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	480V HEP trainline	Passenger Cars	Specification	Signaling and Train Control	19.6.10.5.1	<125 mph	Other	Reliability	Test Track	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Locomotive Electrical Test	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	Table 19-1: Test	<125 mph	Other	Reliability	Test Track	Builder Facility or Test Center	No	Test Specific onlocation to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Locomotive ElectricalTests	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	19.3.11	<125 mph	Other	Reliability	Test Track	Builder Facility or Test Center	No	Test Specific onlocation to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Electrical Load/PhaseBalance/Power Factor	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.5.10.1	<125 mph	Other	Reliability	Test Track	Builder	No	Usually performed by builder at assembly location	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	EMI/EMC	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	Table 19-1: Test	<125 mph	Other	Reliability	Test Track	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	EMI/EMC	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.5.9.3 per APTA SS-E-010-98	<125 mph	Other	Reliability	Test Track	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Locomotive Auxiliary Tests	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	19.3.13	<125 mph	Other	Reliability	Test Track	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Locomotive Propulsion Tests	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	19.3.12	<125 mph	Other	Reliability	Test Track	Builder Facility or Test Center	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Propulsion Test	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	Table 19-1: Test	<125 mph	Other	Reliability	Test Track	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Head End Power (HEP) Test	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	19.3.16	<125 mph	Other	Reliability	Test Track	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	HEP Test per APTA RP-E-011-98	Locomotive, EMUs, DMUs	Specification	Electrical & Propulsion Performance	Table 19-1: Test	<125 mph	Other	Reliability	Test Track	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Power Consumption	Passenger Cars	Specification	Electrical & Propulsion Performance	PC-5011-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Power Consumption	Passenger Cars	Specification	Electrical & Propulsion Performance	PC-5011-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Power Consumption	Passenger Cars	Specification	Electrical & Propulsion Performance	PC-5011-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
	Crashworthiness																
Intercity, Regional, Commuter	Allowable stresses	Passenger Cars	Specification	Structural Integrity	19.5.2.1	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Loading Fixture required	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Colliding Equipment Override	All	Specification	Structural Integrity	RSAC Paragraph 3.3	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Individual cars require fixture modification - fabrication	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Colliding Equipment Override	All	Specification	Structural Integrity	RSAC Paragraph 3.3	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Individual cars require fixture modification - fabrication	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Light Rail/Street Car	Collision Post (Collision Wall) and Corner Post Loads Test	All	Specification	Structural Integrity	RT-1-2009 10.3.4	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	Yes	Specification may be purchased by user	ASME RT-2-2014 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Collision Post Test	Locomotive, EMUs, DMUs	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	Other	Structural Safety	Rail Facility	Test Center	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf	APTA SS-C&S-034-99			EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Collision with Conventional Equipment	All	Specification	Structural Integrity	RSA C Para grap	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Individual cars require fixture modification - fabrication	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Collision with Conventional Equipment	All	Specification	Structural Integrity	RSAC Paragraph 3.1	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	Yes	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Compression load test at the draft stop	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	Other	Structural Safety	Rail Facility	Builder	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Compression Loads	All	Specification	Structural Integrity	RT-2-2008 10.3.3	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	Yes	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Light Rail/Street Car	Compression Loads	All	Specification	Structural Integrity	RT-1-2008 10.3.3	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	Yes	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Connected Equipment Override	All	Specification	Structural Integrity	RSAC Paragraph 3.4	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Individual cars require fixture modification - fabrication	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Heavy Rail, Subways, Metros	Connected Equipment Override	All	Specification	Structural Integrity	RSAC Paragraph 3.4	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	post elastic-plastic test	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	APTA	Structural Safety	Rail Facility	Builder	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdfhttp://www.highspeed- rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdfAPTA SS-C&S-034-99 http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdfhttp://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99APTA SS-M-011-99	EN 15227:2008+A1:2010
Intercity, Regional, Commuter	post longitudinal load test	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	APTA	Structural Safety	Rail Facility	Builder	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf		http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Corner Post Test	Locomotive, EMUs, DMUs	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	APTA	Structural Safety	Rail Facility	Test Center	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Corner Post Transverse Load Test	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	APTA	Structural Safety	Rail Facility	Builder	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf		http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Complete coupler, draft gear, radial connector, yoke, coupler carrier and uncoupling mechanism	Passenger Cars	Specification	Structural Integrity	19.5.3 per FRA & APTA regs	<125 mph	APTA & FRA	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf		http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Coupler Energy Absorbed Test	Locomotive, EMUs, DMUs	Specification	Structural Integrity	19.5.1	<125 mph	Other	Structural Safety	Rail Facility	Test Center	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Coupler Energy Absorbed Test	Passenger Cars	Specification	Structural Integrity	Table 19-1 CEM System Test Matrix (6.9)	<125 mph	Other	Structural Safety	Rail Facility	Test Center	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf				N 15227:2008+A1:2010, GM/RT2102
Intercity, Regional, Commuter	Coupler Initiation Load*	Locomotive, EMUs, DMUs	Specification	Structural Integrity	19.5.1	<125 mph	Other	Structural Safety	Rail Facility	Test Center	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Coupler Initiation Load*	Passenger Cars	Specification	Structural Integrity	Table 19-1 CEM System Test Matrix (6.9)	<125 mph	Other	Structural Safety	Rail Facility	Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf				N 15227:2008+A1:2010, GM/RT2102
Heavy Rail, Subways, Metros	Coupling Impact Test	All	Specification	Structural Integrity	RT-2-2008 10.5	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Light Rail/Street Car	Coupling Impact Test	All	Specification	Structural Integrity	RT-1-2009 10.5	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Collision Post (Collision Wall) and Corner Post Loads Test: Elastic Design Loads	All	Specification	Structural Integrity	RT-2-2008 10.3.4	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Collision post elastic-plastic test	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	APTA	Structural Safety	Rail Facility	Builder	No	Individual cars require fixture modification - fabrication	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Collision Post Loads: Elastic–Plastic Design Loads Test	All	Specification	Structural Integrity	RT-2-2008 10.3.5	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				
Intercity, Regional, Commuter	Roof Integrity	All	Specification	Structural Integrity	RSAC Paragraph 3.8	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No		http://www.fra.dot.gov/eLib/Details/L01292	http://www.fra.dot.gov/eLib/Details/L01292http://www.fra.dot.gov/eLib/Details/L01292			EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Roof Integrity	All	Specification	Structural Integrity	RSAC Paragraph 3.8	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Crash energy management	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	N 15227:2008+A1:2010, GM/RT2100
Heavy Rail, Subways, Metros	Crash Energy Management Tests	All	Specification	Structural Integrity	RT-2-2008 10.4	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Light Rail/Street Car	Crash Energy Management Tests	All	Specification	Structural Integrity	RT-1-2009 10.4	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-1-2009 Safety Standard for Structural Requirements for Light Rail Vehicles				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Diagonal jacking test	Passenger Cars	Specification	Structural Integrity	19.5.1.9	<125 mph	Other	Structural Safety	Rail Facility	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdfhttp://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		EN 15227:2008+A1:2010
Intercity, Regional, Commuter	l compression load test	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	Other	Structural Safety	Rail Facility	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf		http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	EN 15227:2008+A1:2010
Intercity, Regional, Commuter	End Structure Integrity of Cab End	All	Specification	Structural Integrity	RSAC Paragraph 3.6	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No		http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	End Structure Integrity of Cab End	All	Specification	Structural Integrity	RSAC Paragraph 3.6	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	End Structure Integrity of Non-cab End	All	Specification	Structural Integrity	RSAC Paragraph 3.7	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No		http://www.fra.dot.gov/eLib/Details/L01292	http://www.fra.dot.gov/eLib/Details/L01292http://www.fra.dot.gov/eLib/Details/L01292http://www.fra.dot.gov/eLib/Details/L01292http://www.fra.dot.gov/eLib/Details/L01292APTA SS-C&S-034-99			EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	End Structure Integrity of Non-cab End	All	Specification	Structural Integrity	RSAC Paragraph 3.7	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Interior Fixture Attachment	All	Specification	Structural Integrity	RSAC Parag raph3	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Usually performed by builder at assembly location	http://www.fra.dot.gov/eLib/Details/L01292		APTA SS-C&S-006-98, Rev. 1	APTA SS-C&S-034-99, Rev. 2	EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Interior Fixture Attachment	All	Specification	Structural Integrity	RSAC Parag raph3	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292		APTA SS-C&S-006-98, Rev. 1	APTA SS-C&S-034-99, Rev. 2	EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Locomotive Carbody Compression Test	Locomotive, EMUs, DMUs	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Loading Fixture required	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Occupant Protection Features	All	Specification	Structural Integrity	RSAC Parag raph3	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Specific Instrumentation per vehicle type	http://www.fra.dot.gov/eLib/Details/L01292	APTA SS-C&S-016-99, Rev. 2	APTA SS-C&S-011-99		EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Occupant Protection Features	All	Specification	Structural Integrity	RSAC Parag raph3	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292	APTA SS-C&S-016-99, Rev. 2	APTA SS-C&S-011-99		EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Occupied Volume Integrity	All	Specification	Structural Integrity	RSAC Paragraph 3.2	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Specific Instrumentation per vehicle type	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Occupied Volume Integrity	All	Specification	Structural Integrity	RSAC Paragraph 3.2	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Proof Load Tests	All	Specification	Structural Integrity	RT-2-2008 10.3	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard for Structural Requirements for Heavy Rail Vehicles				EN 15227:2008+A1:2010
Light Rail/Street Car	Proof Load Tests	All	Specification	Structural Integrity	RT-1-2009 10.3	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-1-2009 Safety Standard for Structural Requirements for Light Rail Vehicles				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Side Structure Integrity	All	Specification	Structural Integrity	RSAC Paragraph 3.9	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Loading Fixture required	http://www.fra.dot.gov/eLib/Details/L01292	http://www.fra.dot.gov/eLib/Details/L01292			EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Side Structure Integrity	All	Specification	Structural Integrity	RSAC Paragraph 3.9	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292	http://www.fra.dot.gov/eLib/Details/L01292			EN 15227:2008+A1:2010

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Structural Absorber Energy Absorption	Passenger Cars	Specification	Structural Integrity	Table 19-1 CEM System Test Matrix (4.21.4 & 4.21.5)	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Structures-Acceleration	Passenger Cars	Specification	Structural Integrity	S-2001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Test Location Specified by owner / agency	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Structures-Acceleration	Passenger Cars	Specification	Structural Integrity	S-2001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Structures-Acceleration	Passenger Cars	Specification	Structural Integrity	S-2001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Structures-Constant Velocity	Passenger Cars	Specification	Structural Integrity	S-1001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Test Location Specified by owner / agency	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Structures-Constant Velocity	Passenger Cars	Specification	Structural Integrity	S-1001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Structures-Constant Velocity	Passenger Cars	Specification	Structural Integrity	S-1001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Structures-Deceleration	Passenger Cars	Specification	Structural Integrity	S-3001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Test Location Specified by owner / agency	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Structures-Deceleration	Passenger Cars	Specification	Structural Integrity	S-3001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Structures-Deceleration	Passenger Cars	Specification	Structural Integrity	S-3001-TT	All	Other	Structural Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Trigger, Frangible Element, Fuse 4.21.4 &4.21.5	Passenger Cars	Specification	Structural Integrity	Table 19-1 CEM System Test Matrix (4.21.4 & 4.21.5)	<125 mph	Other	Structural Safety	Rail Facility	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Vertical load test	Passenger Cars	Specification	Structural Integrity	APTA Standard SS-C&S-034-99	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Testing requires specific fixturing with load actuation	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-011-99	EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Vertical Load Test	All	Specification	Structural Integrity	RT-2-2008 10.3.2	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard forStructural Requirements for Heavy RailVehicles				EN 15227:2008+A1:2010
Light Rail/Street Car	Vertical Load Test	All	Specification	Structural Integrity	RT-1-2009 10.3.2	All	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	ASME RT-2-2008 Safety Standard forStructural Requirements for Heavy RailVehicles				EN 15227:2008+A1:2010
	Doors																
Intercity, Regional, Commuter	Door safety systems	Passenger Cars	Specification	Specification Compliance	19.6.5.1	<125 mph	Other	Operational Safety	800 cycles	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
	Electrical Safety																
Intercity, Regional, Commuter	Battery and battery charger operation	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.6.10.2.1	<125 mph	Other	Reliability	Test Track orRail Facility	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Battery and battery charger operation	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.6.10.2.4	<125 mph	Other	Reliability	Test Track orRail Facility	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Battery and Battery Charger Tests	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.5.10.3	<125 mph	Other	Reliability	Test Track or Rail Facility	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Electrical apparatus tests	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.6.10.1	<125 mph	Other	Reliability	Test Track o rRail Facility	Builder	No	Usually performed by builder at assembly location	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Battery capacity	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.6.10.2.2	<125 mph	Other	Reliability	Test Track or Rail Facility	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Battery/Battery Charger Performance	Passenger Cars	Specification	Electrical & Propulsion Performance and Compatibility	19.6.10.2.3	<125 mph	Other	Reliability	Test Track or Rail Facility	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
	Emissions																
Intercity, Regional, Commuter	Emissions	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Table 19-1: Test Matrix	<125 mph	Other	Operational Safety	Rail Facility	Builder	No	TTC currently not capable of emissions testing - facilities required	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
	In-Service Requirements																
Intercity, Regional, Commuter	Pilot Train Testing	Passenger Cars	Specification	Endurance/Revenue Service	19.5.14.2.1	<125 mph	Other	Operational Safety	Test Track	Revenue Track	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		14363:2005 (E), GM/RT2000
Intercity, Regional, Commuter	Reliability and Post-Delivery Tests	Passenger Cars	Specification	Endurance/Revenue Service	19.9	<125 mph	Other	Operational Safety	Test Track	Revenue Track	No	Post test infers testing to be on agency property	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Current Collection Systems - Measurement of Total Mean Uplift Force	All	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Intercity, Regional, Commuter	Current Collection Systems - Measurement of Total Contact Force	All	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Intercity, Regional, Commuter	Current Collection Systems - Measurement of Displacement	All	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Intercity, Regional, Commuter	Current Collection Systems - Measurement of Arching	All	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Light Rail/Street Car	Current Collection Systems - Measurement of Total Mean Uplift Force	Passenger Cars	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Light Rail/Street Car	Current Collection Systems - Measurement of Total Contact Force	Passenger Cars	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Light Rail/Street Car	Current Collection Systems - Measurement of Displacement	Passenger Cars	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Light Rail/Street Car	Current Collection Systems - Measurement of Arching	Passenger Cars	Specification	Component Performance	EN 50317	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	EN 50317				
Intercity, Regional, Commuter	Simulated Revenu eService	Passenger Cars	Qualification	Endurance/Revenue Service	RS-5001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Simulated Revenue Service	Passenger Cars	Qualification	Endurance/Revenue Service	RS-5001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Simulated Revenue Service	Passenger Cars	Qualification	Endurance/Revenue Service	RS-5001-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
	Lifecycle/Maintenance Intervals																
Intercity, Regional, Commuter	Truck Frame Fatigue Test	Passenger Cars	Specification	Structural Integrity	APTA RP-M-009-98	<125 mph	APTA	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Fatigue Testing requires specific fixturing with load actuation	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA RP-M-009-98	
Intercity, Regional, Commuter	Truck Frame Load Test	Passenger Cars	Specification	Structural Integrity	19.5.2.3	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Testing requires specific fixturing with load actuation	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Truck Frame OverloadTest	Passenger Cars	Specification	Structural Integrity	19.5.2.4	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Testing requires specific fixturing with load actuation	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
	Materials																
Intercity, Regional, Commuter	Radiography inspection of critical welds on first production truck and other primary structural members	All	Specification	Structural Integrity	Agency Specified	All	RFP	Structural Safety	Rail Facility	Builder	No	TTC has capabilities for radiography but there are limitations due to size and thickness of material be scanned	Specified by RFP	ASTM E 94			
Heavy Rail, Subways, Metros	Radiography inspection of critical welds on first production truck and other primary structural members	All	Specification	Structural Integrity	Agency Specified	All	RFP	Structural Safety	Rail Facility	Builder	No	TTC has capabilities for radiography but there are limitations due to size and thickness of material be scanned	Specified by RFP	ASTM E 94			
Light Rail/Street Car	Radiography inspection of critical welds on first production truck and other primary structural members	All	Specification	Structural Integrity	Agency Specified	All	RFP	Structural Safety	Rail Facility	Builder	No	TTC has capabilities for radiography but there are limitations due to size and thickness of material be scanned	Specified by RFP	ASTM E 94			
Intercity, Regional, Commuter	Fluid Entry Inhibition	All	Specification	Structural Integrity	RSAC Paragraph 3.5	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	TTC does not have facility to perform fluid integrity testing	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Fluid Entry Inhibition	All	Specification	Structural Integrity	RSAC Paragraph 3.5	<125 mph	FRA	Structural Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292				EN 15227:2008+A1:2010
Intercity, Regional, Commuter	Material Certification	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.6	<125 mph	Other	Operational Safety	N/A	Test Center or Revenue Track	No	If certain degree curves required - installation required	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Smoke and Flame Components per 49CFR238.103	Locomotive, EMUs, DMUs	Specification	Specification Compliance	Table 19-1: Test	<125 mph	Other	Operational Safety	Facility that tests flammability	Builder	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
	Noise and Vibration																
Intercity, Regional, Commuter	Effect of Speed-On Car	Passenger Cars	Specification	Noise/Vibration	PN-1001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Effect of Speed-On Car	Passenger Cars	Specification	Noise/Vibration	PN-1001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Light Rail/Street Car	Effect of Speed-On Car	Passenger Cars	Specification	Noise/Vibration	PN-1001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Effect of Car Speed-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-1001-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Effect of Car Speed-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-1001-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Effect of Car Speed-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-1001-TT	All	Other	Reliability	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Effect of Track Section-on Car	Passenger Cars	Specification	Noise/Vibration	PN-1101-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Effect of Track Section-on Car	Passenger Cars	Specification	Noise/Vibration	PN-1101-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Effect of Track Section-on Car	Passenger Cars	Specification	Noise/Vibration	PN-1101-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Equipment Noise Survey-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-0001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Equipment Noise Survey-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-0001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Equipment Noise Survey-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-0001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Interior Noise Survey	Passenger Cars	Specification	Noise/Vibration	PN-1301-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Interior Noise Survey	Passenger Cars	Specification	Noise/Vibration	PN-1301-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Interior Noise Survey	Passenger Cars	Specification	Noise/Vibration	PN-1301-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Ride Quality	All	Specification and Qualification	Vehicle Dynamics	ISO 2631-1 Second Edition 1997-05-01	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	International Standards Organization				EN14363:2005 (E), GM/RT2000; BS 6841; ENV12299)
Light Rail/Street Car	Ride Quality	All	Specification and Qualification	Vehicle Dynamics	ISO 2631-1 Second Edition 1997-05-01	All	Other	Passenger Satisfaction	Test Track	Revenue Track	No	Specification may be purchased by user	International Standards Organization				EN14363:2005 (E), GM/RT2000; BS 6841; ENV12299)
Intercity, Regional, Commuter	Ride Quality Tests	All	Specification and Qualification	Vehicle Dynamics	ISO 2631	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		EN14363:2005 (E), GM/RT2000; BS 6841; ENV12299)
Intercity, Regional, Commuter	Ride Roughness-Acceleration	Passenger Cars	Specification	Vehicle Dynamics	R-2001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Ride Roughness-Acceleration	Passenger Cars	Specification	Vehicle Dynamics	R-2001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Ride Roughness-Acceleration	Passenger Cars	Specification	Vehicle Dynamics	R-2001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Ride Roughness-Component Induced Vibration	Passenger Cars	Specification	Vehicle Dynamics	R-0010-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				GM/RT2160
Heavy Rail, Subways, Metros	Ride Roughness-Component Induced Vibration	Passenger Cars	Specification	Vehicle Dynamics	R-0010-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				GM/RT2160
Light Rail/Street Car	Ride Roughness-Component Induced Vibration	Passenger Cars	Specification	Vehicle Dynamics	R-0010-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				GM/RT2160
Intercity, Regional, Commuter	Ride Roughness-Deceleration	Passenger Cars	Specification	Vehicle Dynamics	R-3001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Ride Roughness-Deceleration	Passenger Cars	Specification	Vehicle Dynamics	R-3001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Ride Roughness-Deceleration	Passenger Cars	Specification	Vehicle Dynamics	R-3001-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Ride Roughness-Worst Speeds	Passenger Cars	Specification	Vehicle Dynamics	R-1101-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Ride Roughness-Worst Speeds	Passenger Cars	Specification	Vehicle Dynamics	R-1101-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Ride Roughness-Worst Speeds	Passenger Cars	Specification	Vehicle Dynamics	R-1101-TT	All	Other	Passenger Satisfaction	Test Track	Test Center or Revenue Track	No	ISO Standard has replaced this	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Screech Loop Survey-on Car	Passenger Cars	Specification	Noise/Vibration	PN-1201-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may bepurchased by user - Screech loop is 150' radius - vehicle must accommodate	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Screech Loop Survey-on Car	Passenger Cars	Specification	Noise/Vibration	PN-1201-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Screech Loop Survey-on Car	Passenger Cars	Specification	Noise/Vibration	PN-1201-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Screech Loop Survey-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-1201-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may bepurchased by user - Screech loop is 150' radius - vehicle must accommodate	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Screech Loop Survey-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-1201-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Screech Loop Survey-Wayside	Passenger Cars	Specification	Noise/Vibration	CN-1201-TT	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Sound Level Test	Locomotive, EMUs, DMUs	Specification	Noise/Vibration	19.3.7 as per 49CFR Section 229.121	<125 mph	Other	Passenger Satisfaction	Test Track or Rail Facility	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Noise and Vibration Tests	Passenger Cars	Specification	Noise/Vibration	19.5.14.2.7 per ANSI Standard S1.4Type2	>90 mph	Other	Passenger Satisfaction	Test Track or Rail Facility	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		UIC - Railway Noise in Europe, http://www.env.go.jp/en/air/noise/railway.html
	Track Geometry/ Vehicle Response																
Intercity, Regional, Commuter	Dynamic Shake Test	Passenger Cars	Specification	Vehicle Dynamics	R-0001-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Dynamic Shake Test	Passenger Cars	Specification	Vehicle Dynamics	R-0001-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Dynamic Shake Test	Passenger Cars	Specification	Vehicle Dynamics	R-0001-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Dynamic Shake Test-Lateral	Passenger Cars	Specification	Vehicle Dynamics	R-0002-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Dynamic Shake Test-Lateral	Passenger Cars	Specification	Vehicle Dynamics	R-0002-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Dynamic Shake Test-Lateral	Passenger Cars	Specification	Vehicle Dynamics	R-0002-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	Dynamic Shake Test-Longitudinal	Passenger Cars	Specification	Vehicle Dynamics	R-0003-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Heavy Rail, Subways, Metros	Dynamic Shake Test-Longitudinal	Passenger Cars	Specification	Vehicle Dynamics	R-0003-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Light Rail/Street Car	Dynamic Shake Test-Longitudinal	Passenger Cars	Specification	Vehicle Dynamics	R-0003-XX	All	Other	Operational Safety	Test Track	Test Center or Revenue Track	No	Specification may be purchased by user	UMTA-MA-06-0025-75-14				
Intercity, Regional, Commuter	High-speed Testing/Vehicle Qualification	All	Qualification	Vehicle Dynamics	49CFR 213.345	<125 mph	Other	Operational Safety	125 mph, instrumented car, IWS	Test Center or Revenue Track	No	TTC test track capable to 160 mph - IWS fabrication for specific cars	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl	

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need to be modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar International Standard
Intercity, Regional, Commuter	Locomotive Track Test	Locomotive, EMUs, DMUs	Specification	Vehicle Dynamics	19.3.8	<125 mph	Other	Operational Safety	Test Track	Test Center	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Locomotive Track Test Acceptance	Locomotive, EMUs, DMUs	Qualification	Vehicle Dynamics	Table 19-1: Test	<125 mph	Other	Operational Safety	Test Track	Test Center	No	Usually performed by builder at assembly location	http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Minimally Compliant Analytical Track (MCAT)	All	Qualification	Vehicle Dynamics	49CFR213.345 (proposed)	Class 6 Track or 6 inches of cant deficiency	FRA	Operational Safety	None(simulations)	N/A	No	MCAT requires simulation of vehicle. TTCI capable of performing simulations	http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				
Heavy Rail, Subways, Metros	Minimally Compliant Analytical Track (MCAT)	All	Qualification	Vehicle Dynamics	49CFR213.345 (proposed)	Class 6 Track of 6inches of cant	FRA	Operational Safety	None(simulations)	N/A	Yes		http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				
Light Rail/Street Car	Minimally Compliant Analytical Track (MCAT)	All	Qualification	Vehicle Dynamics	49CFR213.345 (proposed)	Class 6 Track of 6 inches of cant deficiency	FRA	Operational Safety	None(simulations)	N/A	Yes	MCAT requires simulation of vehicle. TTCI capable of performing simulations	http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				
Intercity, Regional, Commuter	On Board Acceleration	All	Qualification	Vehicle Dynamics	49CFR213.333 j	>125mph	FRA	Operational Safety	Revenue Track	Test Center or Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Intercity, Regional, Commuter	On Board Acceleration	All	Qualification	Vehicle Dynamics	49CFR213.333 k	>110mph	FRA	Operational Safety	Revenue Track	Test Center or Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Intercity, Regional, Commuter	On Board Acceleration	All	Qualification	Vehicle Dynamics	49CFR213.333 l	>125mph	FRA	Operational Safety	Revenue Track	Test Center or Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Heavy Rail, Subways, Metros	On Board Acceleration	All	Qualification	Vehicle Dynamics	49CFR213.333 j	>125 mph	FRA	Operational Safety	Revenue Track	Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Heavy Rail, Subways, Metros	On Board Acceleration	All	Ongoing Monitoring	Vehicle Dynamics	49CFR213.333 k	>125 mph	FRA	Operational Safety	Revenue Track	Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Heavy Rail, Subways, Metros	On Board Acceleration	All	Ongoing Monitoring	Vehicle Dynamics	49CFR213.333 l	>125 mph	FRA	Operational Safety	Revenue Track	Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Light Rail/Street Car	On Board Acceleration	All	Ongoing Monitoring	Vehicle Dynamics	49CFR213.333 j	>125mph	FRA	Operational Safety	Revenue Track	Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Light Rail/Street Car	On Board Acceleration	All	Ongoing Monitoring	Vehicle Dynamics	49CFR213.333 k	>110mph	FRA	Operational Safety	Revenue Track	Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Light Rail/Street Car	On Board Acceleration	All	Ongoing Monitoring	Vehicle Dynamics	49CFR213.333 l	>125mph	FRA	Operational Safety	Revenue Track	Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				l14363:2005 (E), GM/RT2000
Intercity, Regional, Commuter	Roll Angle Tests	Passenger Cars	Specification	Vehicle Dynamics	19.5.14.1 per49CFR 213.57	<125 mph	Other	Operational Safety	Test Track orRail Facility	Builder	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Heavy Rail, Subways, Metros	Static Lean	All	Specification and Qualification	Vehicle Dynamics & Vehicle Dynamics Modeling	49CFR213.57	All	FRA	Operational Safety	Rail Facility	Builder Facility or Test Center	No		http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				GM/RT2000, GM/RC2641, EN14363:2005 (E)
Light Rail/Street Car	Static Lean	All	Specification and Qualification	Vehicle Dynamics & Vehicle Dynamics Modeling	49CFR213.57	All	FRA	Operational Safety	Rail Facility	Builder Facility or Test Center	No		http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				l14363:2005 (E), GM/RT2000
Intercity, Regional, Commuter	Static Lean-Proposed(Clearance)	All	Specification and Qualification	Vehicle Dynamics & Vehicle Dynamics Modeling	49CFR213.57	All	FRA	Operational Safety	Rail Facility	Builder Facility or Test Center	No		http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				GM/RT2000, GM/RC2641, EN14363:2005 (E)
Intercity, Regional, Commuter	Static Roll Stability 49CFR213.329	Locomotive, EMUs, DMUs	Specification	Vehicle Dynamics	Table 19-1: Test	<125 mph	Other	Operational Safety	Rail Facility	Builder Facility or Test Center	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				

Mode	Name of Test	Vehicle Type	Step in Build Process	Test Type	Specification	Required for What Speed?	Regulatory or Voluntary Standard (APTA, FRA, RFP, Other)	Testing Categorization (Safety, Reliability, or Passenger Satisfaction)	Facility Requirements	Proposed Location	Would Test need tobe modified to apply to specified mode? (Test was originally written for other mode)	Comments	Source/Reference 1	Source Reference 2	Source Reference 3	Source Reference 4	Similar InternationalStandard
Intercity, Regional, Commuter	Twisted Track Twist	Passenger Cars	Specification	Vehicle Dynamics	EN 14363	All	Other	Operational Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	EN 14363				
Heavy Rail, Subways, Metros	Twisted Track Twist	Passenger Cars	Specification	Vehicle Dynamics	EN 14363	All	Other	Operational Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	EN 14363				
Light Rail/Street Car	Twisted Track Twist	Passenger Cars	Specification	Vehicle Dynamics	EN 14363	All	Other	Operational Safety	Rail Facility	Builder Facility or Test Center	No	Specification may be purchased by user	EN 14363				
Intercity, Regional, Commuter	Truck Attachment	All	Specification	Structural Integrity	RSAC Paragraph3.10	<125 mph	FRA	Operational Safety	Test Track	Builder Facility or Test Center	No		http://www.fra.dot.gov/eLib/Details/L01292	http://www.fra.dot.gov/eLib/Details/L01292			EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Truck Attachment	All	Specification	Structural Integrity	RSAC Paragraph3.10	<125 mph	FRA	Operational Safety	Test Track	Builder Facility or Test Center	No	Still in draft form	http://www.fra.dot.gov/eLib/Details/L01292	http://www.fra.dot.gov/eLib/Details/L01292			EN 15227:2008+A1:2010
Heavy Rail, Subways, Metros	Truck Equalization	All	Specification and Qualification	Vehicle Dynamics & Vehicle Dynamics Modeling	APTA SS-M-014-06Wheel Load Equalization	All	APTA	Operational Safety	Test Track orRail Facility	Test Center, Builder Facility, or Revenue Track	No		APTA SS-M-014-06APTA SS-M-014-06				EN14363:2005 (E), GM/RT2000, GM/RC2641, GM/RT2000
Light Rail/Street Car	Truck Equalization	All	Specification and Qualification	Vehicle Dynamics & Vehicle Dynamics Modeling	APTA SS-M-014-06Wheel LoadEqualization	All	APTA	Operational Safety	Test Track orRail Facility	Test Center, Builder Facility, or Revenue Track	No						EN14363:2005 (E), GM/RT2000, GM/RC2641, GM/RT2000
Intercity, Regional, Commuter	Truck Equalization Test	All	Specification	Vehicle Dynamics	APTA SS-M-0140-06	<125 mph	APTA	Operational Safety	Rail Facility	Builder Facility or Test Center	No	Wheel loading / unloading fixturing required	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf	APTA SS-M-014-06	EN14363:2005 (E), GM/RT2000, GM/RC2641, GM/RT2000
Intercity, Regional, Commuter	Truck Primary Suspension Tests	Passenger Cars	Specification	Structural Integrity	19.5.2.6	<125 mph	Other	Structural Safety	Rail Facility	Builder Facility or Test Center	No	Testing requires specific fixturing with load actuation	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
Intercity, Regional, Commuter	Truck, Coupler and CableCurving Test	Locomotive, EMUs, DMUs	Specification	Vehicle Dynamics	Table 19-1: Test Matrix	<125 mph	Other	Operational Safety	Rail Facility	Test Center or Revenue Track	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Heavy Rail, Subways, Metros	Vehicle Qualification	All	Qualification	Vehicle Dynamics	49CFR213.345	<125 mph	FRA	Operational Safety	Test Track	Revenue Track	No	Dependent upon required specifications	http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				
Light Rail/Street Car	Vehicle Qualification	All	Qualification	Vehicle Dynamics	49CFR213.345	<125 mph	FRA	Operational Safety	Test Track	Test Center or Revenue Track	No		http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfr213_main_02.tpl				
Intercity, Regional, Commuter	Vehicle/track system qualification	All	Qualification	Vehicle Dynamics	49CFR213.345	Class 6 Track or 5inches of cant	FRA	Operational Safety	Revenue Track	Test Center or Revenue Track	No	IWS specific to thevehicle for 213.345 testing	http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				
Heavy Rail, Subways, Metros	Vehicle/track system qualification	All	Qualification	Vehicle Dynamics	49CFR213.345	Class 6 Track of 5inches of cant	FRA	Operational Safety	Revenue Track	Revenue Track	No	Dependent upon required specifications	http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				
Light Rail/Street Car	Vehicle/track system qualification	All	Qualification	Vehicle Dynamics	49CFR213.345	Class 6 Track of 5inches of cant	FRA	Operational Safety	Revenue Track	Test Center or Revenue Track	No		http://www.gpo.gov/fdsys/pkg/FR-2013-03-13/pdf/2013-04679.pdf				
Intercity, Regional, Commuter	Wheel Slip/Slide System Test	Locomotive, EMUs, DMUs	Specification	Specification Compliance	19.3.10	<125 mph	Other	Operational Safety	Test Track	Test Center	No		http://www.highspeed-rail.org/Documents/loco-spec-reva-2012jul10.pdf				
Intercity, Regional, Commuter	Wheelslide Control System Operation	Passenger Cars	Specification	Specification Compliance	19.6.4.3	<125 mph	Other	Operational Safety	Test Track	Test Center	No		http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		
	Weight																
Intercity, Regional, Commuter	Car Weight	Passenger Cars	Specification	Specification Compliance	19.6.14.1.1	<125 mph	Other	Reliability	Weigh Station in Track	Builder	No	Test Specific on location to be performed	http://www.highspeed-rail.org/Documents/PRIIA_Bi-Level_Spec_305-001_Approved_rev%20C.1.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Single%20Level%20Spec%20305%20003%20Approved%20Initial%20Release.pdf	http://www.highspeed-rail.org/Documents/PRIIA%20305%20DocSpec%20and%20other%20NGEC%20Documents/PRIIA%20Trainset%20Spec%20305-007%20Approved%20Initial%20Release.pdf		

APPENDIX

B

TTC Passenger Rail Testing Facilities

The TTC was established to provide a centralized railroad research and testing facility. TTC has laboratory facilities for static testing of railcars and dynamic testing of railcar and infrastructure components. These facilities are detailed in the following sections. The site has 48 miles of test tracks, and the Railroad Test Track (RTT) loop and Transit Test Track (TTT) loop are dedicated primarily to passenger equipment testing.

Test Tracks

Railroad Test Track (RTT)

The RTT loop (13.5-mile, 21.7 km) with its overhead catenary system is located in the central portion of the TTC. Figure B-1 displays the RTT loop specifications. Rail used for the RTT is standard 136 pounds per yard, A.R.E.M.A. specification rail. Concrete ties are installed on approximately 11 miles of track, with hardwood ties used in the remainder of track under various test section conditions.

The RTT alignment is designed to test passenger vehicles with tilt technology at a maximum running speed of 160 mph, to certify the vehicle for use at a maximum operating speed of 150 mph. Maximum speed for non-tilting vehicles is typically 124 mph. Freight vehicle testing is limited to 80 mph operating speed, unless qualified for higher speeds. This is based on FRA subpart G, Sections 213.301, 213.307, and 213.329. The track is maintained to FRA Class 8 safety standards to coincide with the 150 mph maximum operating speed. All curves around the RTT are 0° 50' curves, except for the reverse curve, which is a 1° 15' curve. This curve is speed limited based on the passenger vehicle's ability for overbalance. All curves have a 6-inch superelevation. FRA regulations limit the maximum allowable speeds on the RTT to the following:

- 145 mph for non-tilting trains at 6 inches cant deficiency in the 0° 50' curves
- 160 mph for tilting trains at 9 inches cant deficiency in the 0° 50' curves
- 118 mph for non-tilting trains at 6 inches cant deficiency in the 1° 15' reverse curve
- 132 mph for tilting trains at 9 inches cant deficiency in the 1° 15' reverse curve

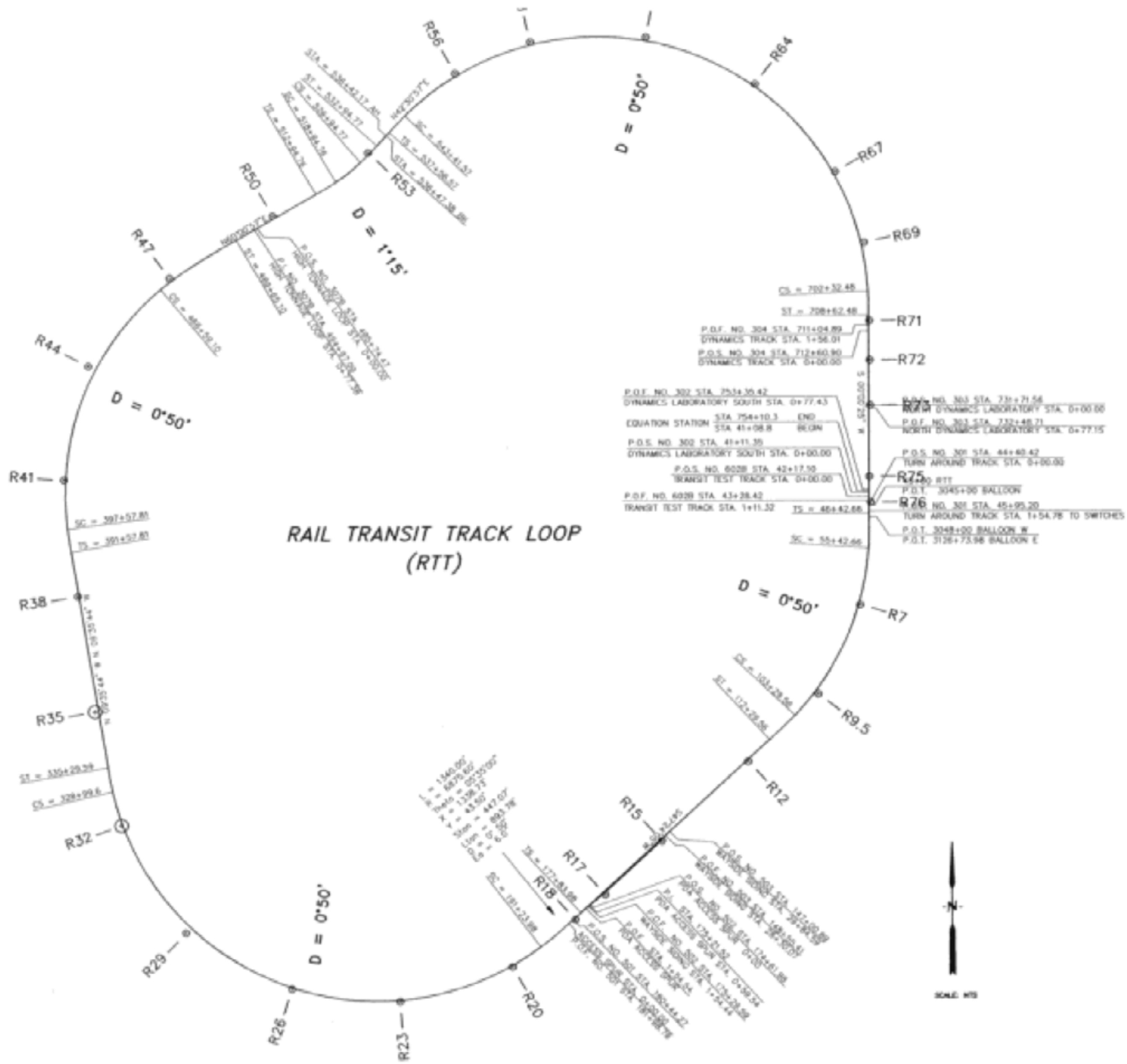


Figure B-1 *RTT loop*

The east tangent section is 5,100 feet long, with transition grades to 1.31%. The southeast tangent section is 6,500 feet, with a 1.47% grade at the upper and transitioning to 0.26% grade on the low end. The west tangent section is 5,900 feet transitioning from a 0.62% grade at the low end, to 0.15% grade on the upper end. Elevation is at a low point at the south end of the loop at elevation 4,861 feet above mean sea level and at a high of 5,035 feet in the northeast area of the loop, a difference of 174 feet. A 60-foot-long section of track at station R38 has been installed with experimental ladder type concrete longitudinal ties. Vehicle dynamic performance often changes noticeably when the train passes over this section.

The RTT overhead catenary system consists of a four-wire compound catenary system that receives power from the RTT substation located north of Post-100 and provides a continuous loop pattern around the track, as well as extensions around the Balloon Loop and extensions to two maintenance buildings (TMB and PSB). The system may be configured for single continuous voltage, dual voltage, or broken single voltage depending on test requirements. In single continuous voltage mode, endurance testing and certification testing may be achieved at one of the adjustable voltage settings. In dual-voltage mode, customers may test at 12.5 KVAC on half of the RTT loop and 25 KVAC on the other half of the loop simultaneously. In broken single voltage mode, testing of catenary power loss or phase break applications can be simulated. The RTT overhead catenary system is designed to provide up to 700 Amps to pantograph-equipped power cars at 12.5 KVAC or 25 KVAC and, with some effort, can be configured for 50,000 Volts AC operation. A compound-catenary system design allows for electric-powered train sets to operate at velocities up to top speeds of 165 mph with optimal pantograph pressures of 17–24 psig uplift.

The current RTT compound catenary design is depicted in Figures B-2 and B-3. The normal system height (the distance between the main messenger support point and the contact wire at the support pole) is 4 feet 6 inches. For the normal wire height of 22 feet 6 inches, the support height is 27 feet above rail. The catenary support style varies around the track to represent different styles used on the Northeast Corridor at the time of design, since it represented the only example of a modern high speed catenary system currently installed in North America at that time. The complexity of the compound catenary is highlighted by the number of hangers used to support the contact wire. Each 30-foot length of contact wire requires three hangers for support. The conductor details, together with their main mechanical properties and electrical current ratings (amp capacity), are presented in Table B-1. In recent years, the sagged simple catenary has generally become the system of choice for high speed applications in Europe and is the system installed on the New Haven to Boston extension of the Northeast Corridor. The system is considerably less expensive to install because of the reduced amount of components in the contact wire support system.

Figure B-2

Typical cross-section of RTT

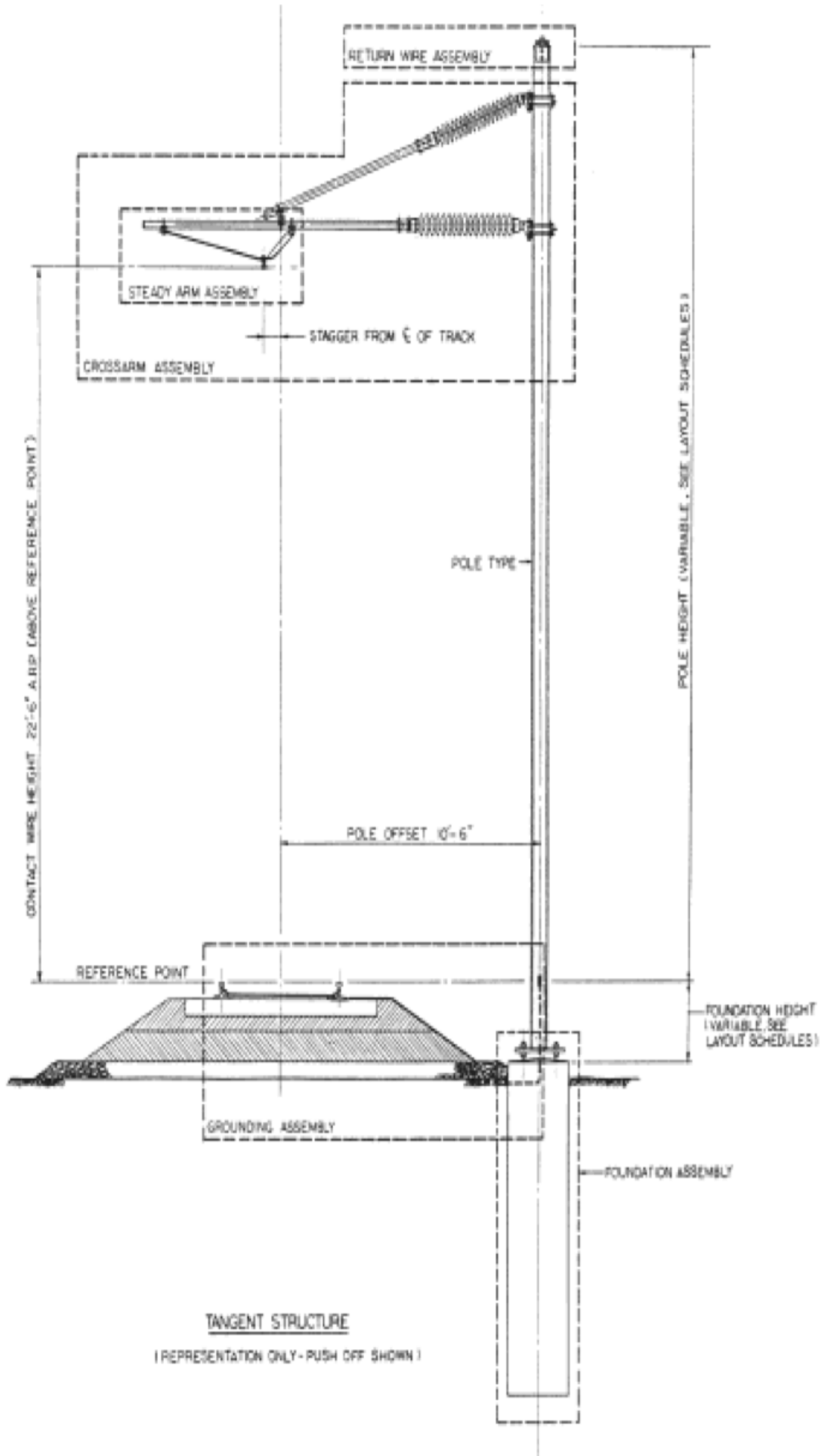


Figure B-3

RTT compound catenary

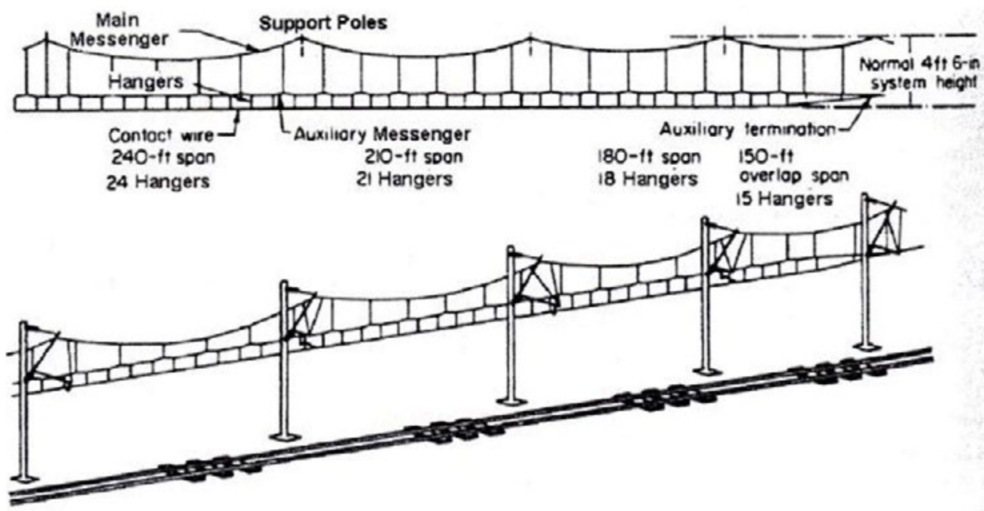


Table B-1 *Catenary Conductors – Mechanical and Electrical Properties*

Conductor Name	Type and Size	Material	Weight (lb/ft)	Minimum Breaking Strength (lb)	Nominal Tension (lb)	No. of Hangers (210 ft span)
Compound						
Messenger	19/0.0833	Alloy 80	0.4071	7,885	3,000	7
Auxiliary Messenger	7/0.0833	Alloy 80	0.150	2,905	1,200	15
Contact Wire	4/0 Grooved	Alloy 80	0.6417	10,820	3,500	
Simple						
Messenger	19/0/0833	Alloy 80	0.4071	7,885	3,200	7 or 12
Contact wire	350 MCM Grooved	H.D. Copper	1.063	11,810	4,200	

Current compound design: Midpoint sag = 0.75 inch (tangent)
= -0.25 inch (curves)

The RTT was retrofitted with a switch point indication/broken rail detection system in 1997 as part of the RTT restoration program. The system is an Electrified Electro Code System, as manufactured by Harmon Industries, similar to what is currently used on the Northeast Corridor. The RTT was divided into 12 blocks, each approximately 6,000 feet long, with an AC track circuit using a 156 Hz carrier frequency. A 4-ohm impedance bond is located at the end of each block to provide a low impedance path for the traction current return around the insulated joints at the ends of the blocks. An impedance bond is located on the RTT adjacent to the AC substation for traction current return. Switch points and derails are wired into the system to indicate correct alignment of the turnouts for running on the RTT. Dwarf indication lights have been installed at the turnouts to give a visual indication of correct turnout alignment. Radio signals from each block (zone) are transmitted to a main receiving station in the Operations Control Center (OCC) where the information is displayed on a computer screen. Vehicle travel can be tracked on the OCC display screen, as well as other track conditions. A portable tracking unit is used in the cab of the test locomotive to display the same information available at the main receiving unit in OCC. The detection system has been upgraded to support standard cab signaling. The system will work on systems operating on 100 Hz cab signal, which is a typical North American freight railroad cab system, and on 250 Hz cab signal, which is unique to the Northeast Corridor.

High-Speed Track Geometry Adjustable Precision Track Test Bed on RTT

Safety of new, high speed equipment can be assured by testing it on the RTT that has adjustable geometry defects matching those in FRA safety standards (Minimally Compliant Analytical Track, MCAT). This section of tangent slab track (R-14 through R-16) is built with adjustable plate assembly to allow lateral adjustments of ±½ inch and varying vertical adjustments with test speeds up to 125 mph. The test track can also be used to validate high speed track geometry recording equipment. Figure B-4 displays the test section on the RTT.

Figure B-4

High-speed track geometry adjustable precision track test bed

Transit Test Track (TTT)

The TTT is located in the south central portion of the TTC. It is a 9.1-mile (14.6 km) closed track loop maintained as a FRA Class 5 track. The north and south curves have a superelevation of 4½ inches on the 1° 30' degree curves. This allows the track to be used at the maximum operating speed of 80 mph freight vehicles in portions of the track, with passenger vehicles at a maximum operating speed of 89 mph, based on a 3-inch overbalance. Passenger vehicles may be allowed to obtain higher operating speeds if the class of track is upgraded, and the passenger vehicles are qualified for higher overbalance conditions. Its primary design purpose was to serve as a reference track for testing and evaluating urban rail vehicles (Metro and Light Rail). Secondary purposes are the development, test, and evaluation of vehicle subsystems, alternative types of track structures, and appropriate instrumentation.

Figure B-5 shows the test track consists of three straight (tangent) and three curved sections. The tangent section of the TTT is on the west side of the loop and is 11,000 feet (3,353 m) long with approximately 4,200 feet (1,277 m) of level track (zero grade) and 7,700 feet (2,341 m) at 0.69% grade. The east side of the TTT contains approximately 5,200 feet (1,581 m) at 1.47% grade, part straight and part on a wide curve. The curves at the north and south end of the loop are 1° -30' curves, with a 3,820-foot (1,164 m) radius, and 4.5 inches (11.4 cm) of superelevation. The curve near the middle of the eastern side is a 0°-50' curve with 6.876-foot (2,096 m) radius and 3 inches (7.7 cm) of superelevation. The track was constructed with six different test zones, where type of tie and tie spacing were changed as variables. Figures B-6 and B-7 illustrate the two tie type configurations. Each of the six test sections has a type of construction currently being used by transit systems. Sections I, II, and III employ hardwood tie sections at 24 inches (0.61 m) on center on straight track and 23 inches (0.6 m) on center on curved track for jointed rail.

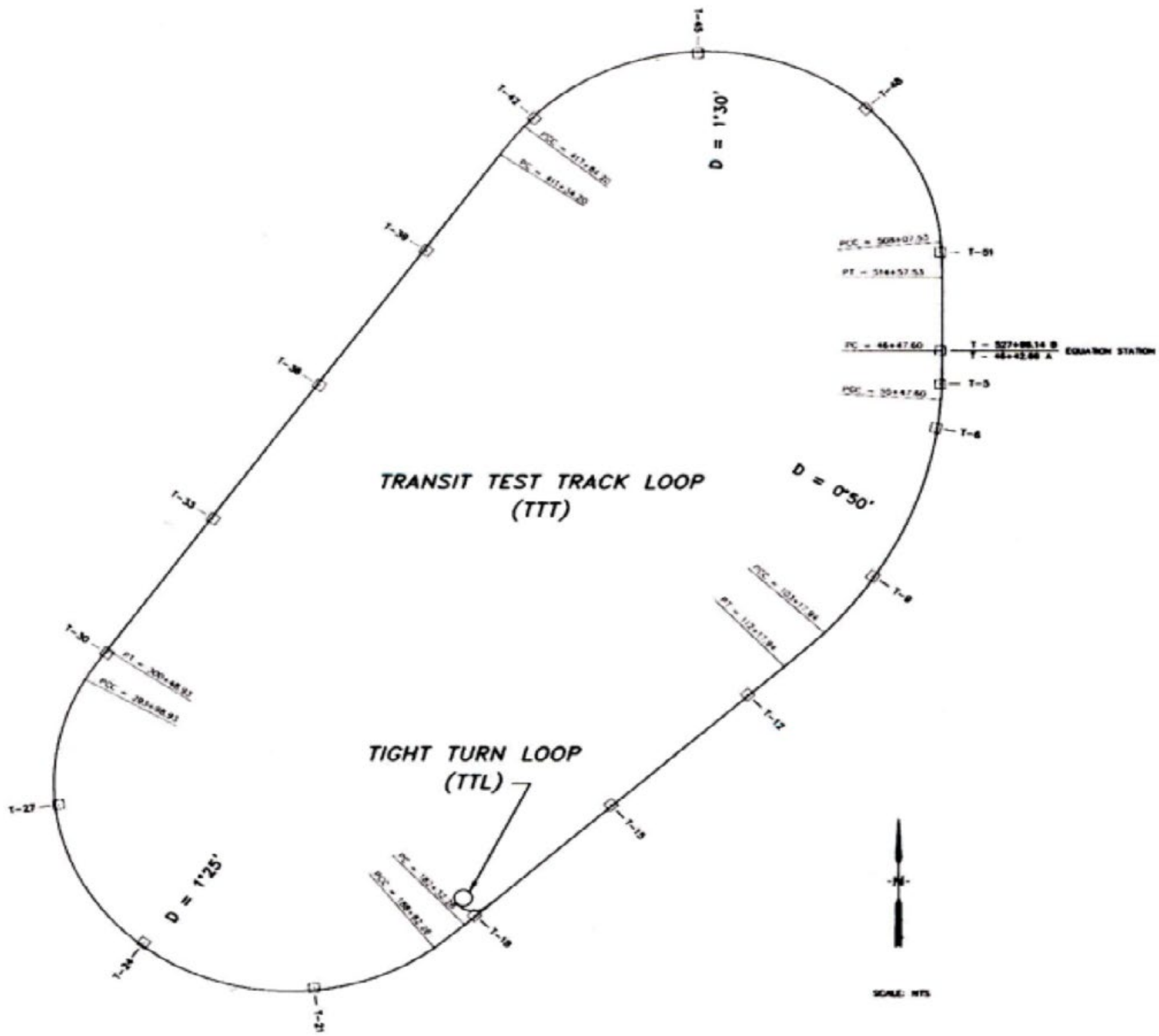


Figure B-5 *TTT loop*

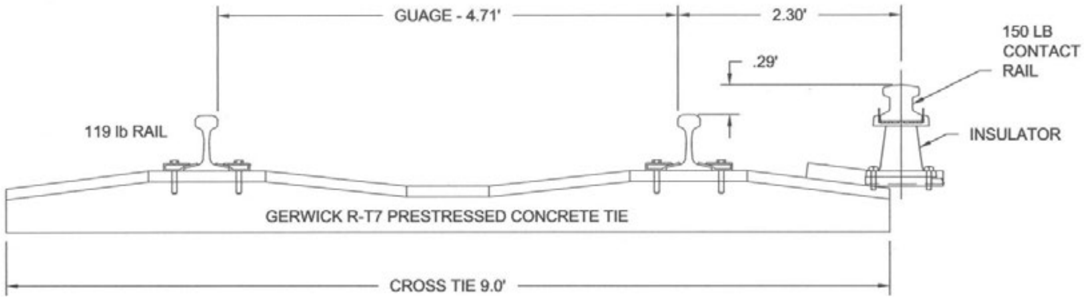


Figure B-6 *Typical TTT cross-section, track assemblies I, II, and III*

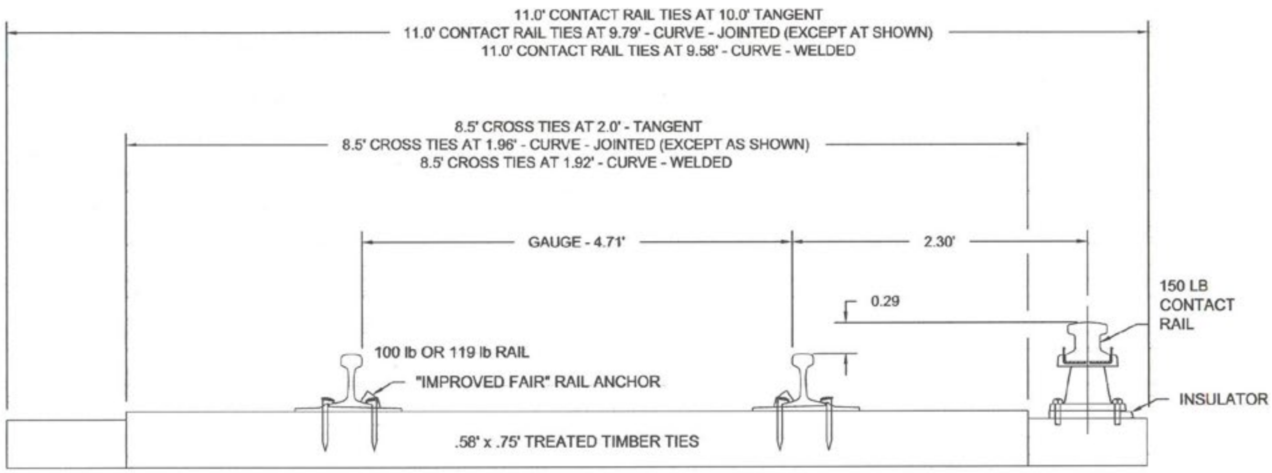


Figure B-7 *Typical TTT cross-section, track assemblies IV, V and VI*

The remaining track sections are laid on concrete ties. Section IV ties are 30 inches (0.76 m) on center on straight track and 27 inches (0.68 m) on curved. Section V, which is all curved, uses 23-inch (0.58 m) center-to-center spacing and Section VI, also all curved, uses a center-to-center spacing of 33 inches (0.84 m).

Two different weights of running rail are used on the TTT. Sections I, IV, V, and VI employ rail weighing 119 pounds per yard (59 kg/m), laid as continuous welded rail. Sections II and III use rail weighing 100 pounds per yard (50 kg/m). The rail in Section II is continuously welded, while that in Section III is jointed. The track sections thus permit evaluating vehicle performance on the following types of track construction:

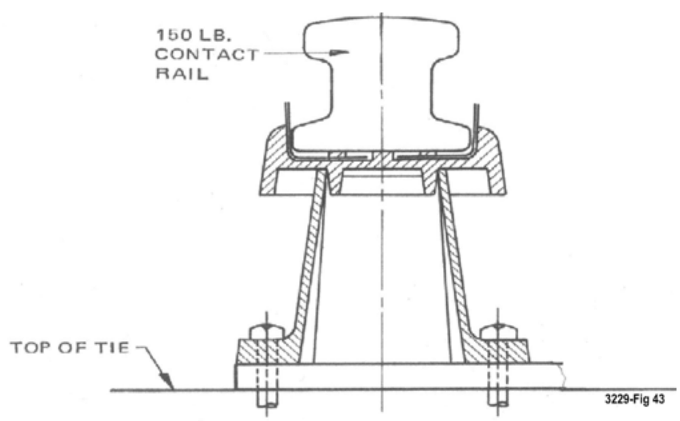
- 119-lb continuous welded rail on wood ties
- 119-lb continuous welded rail on concrete ties, at three different tie spacings
- 100-lb continuous welded rail on wood ties
- 100-lb jointed rail on wood ties

The lengths of each of the above combinations are sufficient to give meaningful data on such factors as noise, vibration, and ride comfort.

The third rail system on the TTT consists of two grounded running rails and a parallel third rail powered by two DC substations. Figure B-8 shows their capabilities. Each substation is capable of providing 5.5 MW of DC power to the third rail. The substations are configured in parallel, and each substation contains two rectifier banks in parallel. This configuration allows the two 6-pulse rectifier substations to operate out of phase with each other in order to provide the appearance of 12-pulse rectification of AC power to DC power. The substation/third-rail system currently allows for variable voltage operation up to 2000 Volts DC for paddle-equipped power cars on the entire 9-mile transit loop. Two rectifiers in the Urban Maintenance Building (URB) allow for third-rail power to be provided into the maintenance area of the building to allow for adjustments or repairs to test vehicles. All rectifiers are voltage adjustable and current limited to provide necessary power requirements and over-current protection to the system.

Figure B-8

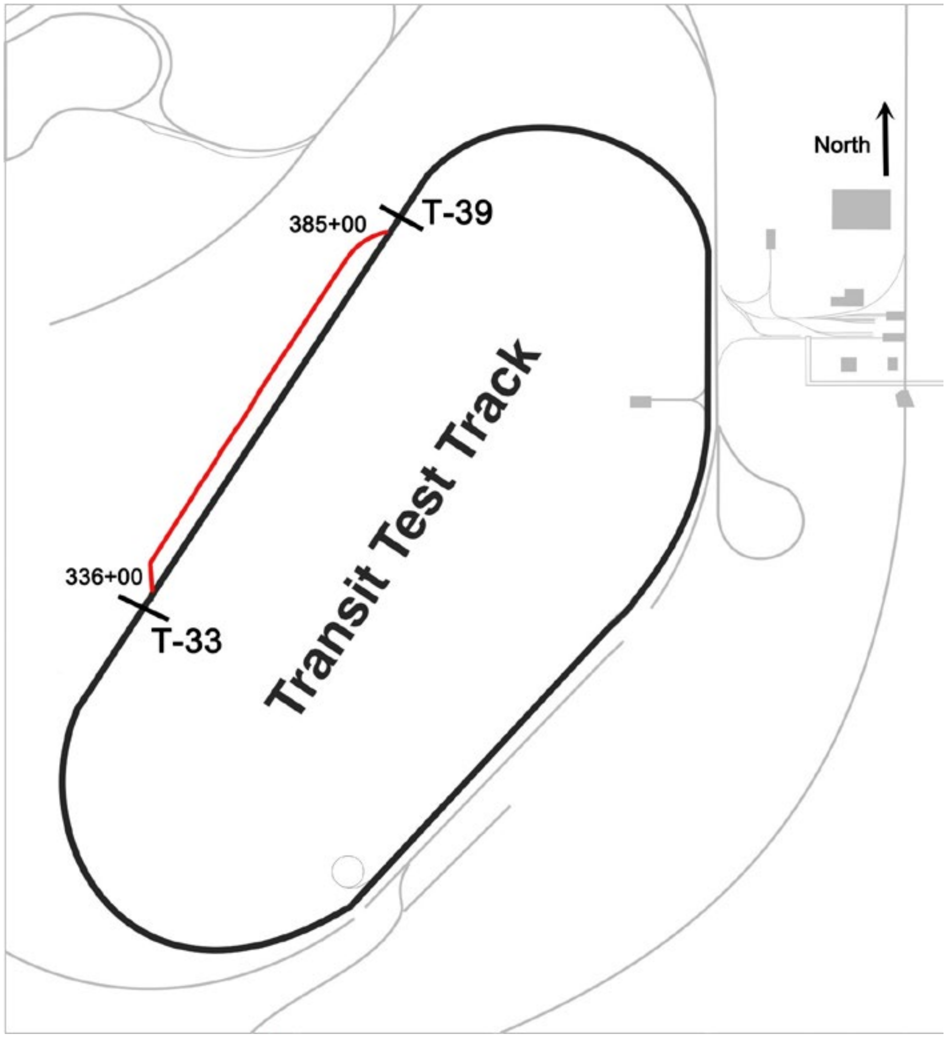
Detail of contact rail, contact (third) rail support



A two-mile section of overhead trolley style catenary was installed on the west tangent section of the TTT in the 1970s. The catenary is connected to the third rail along the line with jumpers extending up the wood catenary poles to the contact wire. Poles are spaced approximately 100 feet apart, with jumpers to be replaced at every other pole location.

A new 5,000-foot-long double-ended siding off of the TTT was constructed in 2013. It has overhead power with voltage variable from zero to 2,200 Volts DC. It runs in a northeasterly direction, beginning with a No. 10 turnout from the TTT between track markers T-33 and T-34. It runs generally uphill to another No. 10 turnout connecting to the TTT between T-38 and T-39. Figure B-9 shows that new siding in red.

Figure B-9
500-foot TTT siding

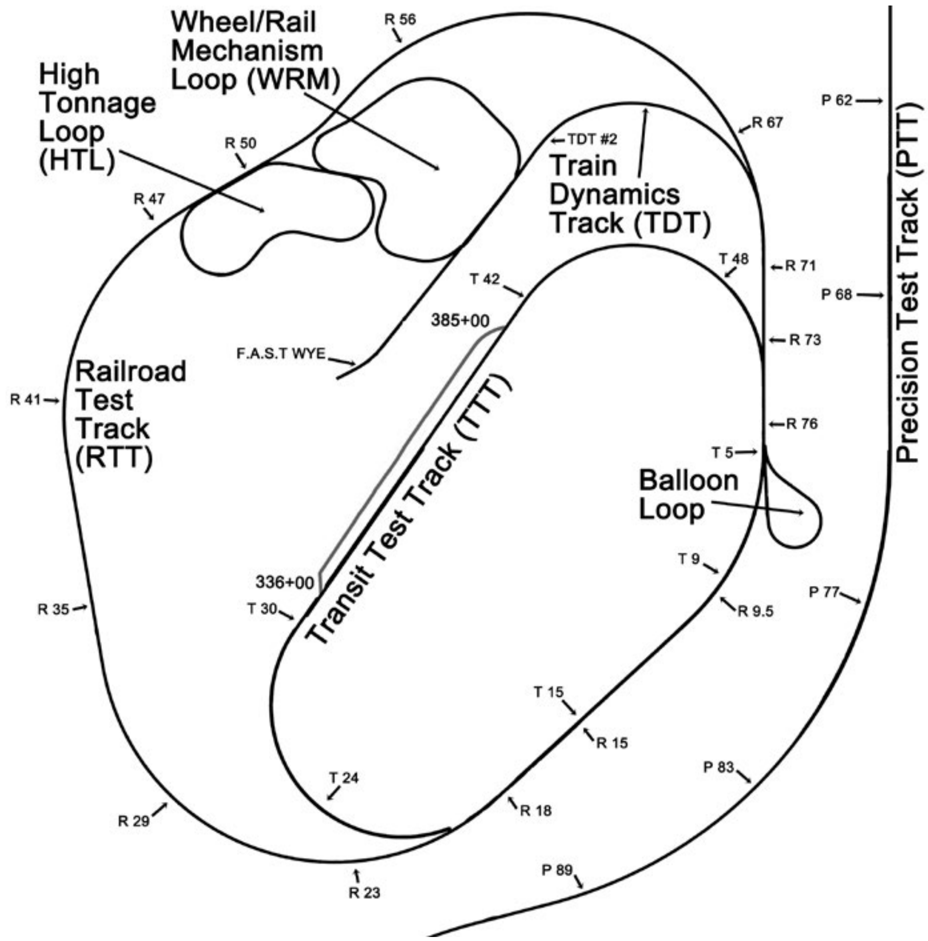


Train Dynamics Track (TDT) / Impact Track

The TDT is currently an access track to the Facility for Accelerated Service Testing (FAST), Impact Track, and ballast handling facility. The TDT is maintained as an FRA Class 4 track, with maximum operating speeds of 60 mph for freight and 80 mph for passenger trains. The curve on the TDT is a 1° 30' degree curve with a 4½-inch superelevation, approximately 1.7 miles long, with a 0.97% grade transiting into a 0 .90% grade on the remainder of the track. The Impact Track is used for impact and derailment testing. The Impact Track is straight (tangent), 4,400 feet (1341 m) long, with moderate (less than 1%) grades. The purpose of this track is to simulate and analyze carefully controlled “accidents” and various emergency situations. Impact tests at up to 60 mph have been performed on the track. A section of the track near the FAST Wye Track has been set up with an at-grade road crossing and wayside power outlets to run instrumentation and photographic equipment. Figure B-10 shows the TDT, FAST, and Impact Track.

Figure B-10

TDT, Impact Track, and FAST service facility



Balloon Loop Track

The Balloon Loop was constructed as a phased portion of the RTT under a Federal Highway Project with similar construction as the RTT. The track loop was designed to allow the turning of train consists on the RTT to reverse direction. The track is maintained to FRA Class 3 safety standards. The turnout from the RTT to the Balloon Loop and the turnout connecting the loop are No. 20 turnouts. A No. 10 turnout was installed in the west tangent section of the Balloon Loop, with a side spur track parallel to the tangent section. An automobile loader ramp is located on the end of the spur track to load tri-level automobile carriers.

Overhead catenary for the Balloon Loop transitions from compound style on the RTT, to a sagged simple style. The catenary around the loop can be isolated from the RTT to remove clearance restrictions when working on the track. The Balloon Loop has also been modified to install the Rail Defect Test Facility (RDTF). Rail defects have been added to the track on a set of parallel rails (gantlet track) installed on the same set of cross ties. Movable switch points are used at each end of the parallel rails for access to the defect set of rails.

Precision Test Track (PTT)

The PTT is a 7.36-mile track section. The track connects directly to the Pueblo Chemical Depot (PCD) access track and is used as a primary access to the BNSF railroad at Avondale, Colorado, for shipping and receiving railcars off site. The track is currently being used to test for vehicle dynamic response under perturbed track conditions that all freight cars must meet under Association of American Railroads (AAR) Specification M-1001, Chapter 11, Paragraph 11.8.

The primary curvature on the PTT is 0° 26', with the superelevation set at 6. Three AAR Chapter 11 test sections have been installed:

- Twist and roll test section in the north tangent section
- Pitch and bounce test section in the south end of the same tangent section
- Yaw and sway test section on the south end of the PTT

Wheel Rail Mechanism (WRM) Loop

The WRM loop is used to meet the curved track test requirements of AAR Specification M-1001, Chapter 11. Figure B-11 shows the track layout. The WRM is accessed off of the TDT on the east side with a crossover consisting of two No. 14 turnouts.

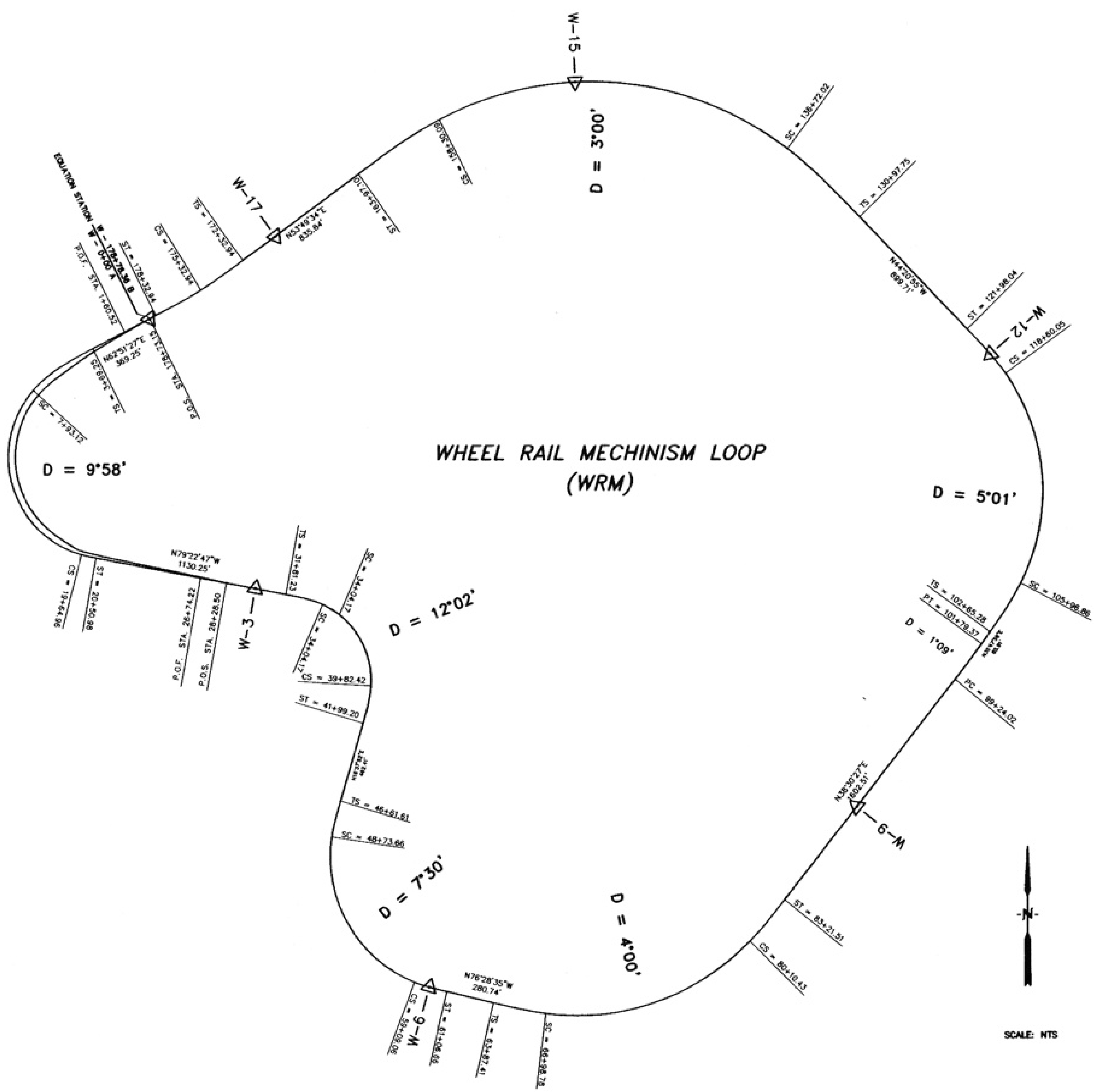


Figure B-11 *WRM loop*

The WRM is maintained as a non-lubricated track for test purposes. Strain gages have been installed in some of the curves for measuring wheel/rail interaction forces. A section of the 5° curve has a 2.0% grade that can be used for braking performance tests.

Figure B-11 also shows a siding on the inside of the 10° curve. This siding is also 10 degrees and is the location of dynamic curve track perturbations to meet the requirements of Chapter 11, Paragraphs 11.7.3, 11.7.4, and 11.8.5. In 2011, this perturbation section was reconstructed using a prototype system of adjustable tie plates (Figure B-12). These are intended to reduce maintenance and adjustment costs for the perturbations, and allow alteration of the perturbations to different amplitudes.

Figure B-12 *Adjustable tie plates for vertical and lateral track geometry perturbations*

The clockwise spiral entry to the 10° dynamic curve is constructed to meet the requirements of the Chapter 11, Section 11.7.4 Spiral Negotiation (Limiting Spiral). The clockwise exit spiral of the 12° curve was constructed to meet the requirements of the now obsolete Chapter 11 bunched spiral. The bunched spiral differs from a normal spiral in that all the superelevation change occurs in the middle 100 feet of the 200-foot-long spiral. Although no longer required as a Chapter 11 test, this test section has been retained because it provides a useful benchmark of vehicle dynamic performance over severe spiral and track twist conditions.

For future consideration, the area inside the WRM loop could be used for installation of other test sections to meet the requirements of other performance specifications such as a severe curve section.

Tight Turn Loop (TTL)

The TTL (also known as the screech loop) is located at the lower end of the south east tangent section of the TTT. Figure B-13 shows the TTL layout. It consists of a 150-foot-radius loop (38.9° curve) constructed as a ballasted track with 119 lb per yard continuous welded rail on wood ties. Figure B-14 shows the track construction. Third-rail power has been extended into the TTL. The loop is connected with a short spur track having a 17⅔° curve. The main purpose of the TTL is to provide a facility for the detailed investigation of wheel noise, truck curving behavior, and rail vehicle stability under extreme curvature conditions.

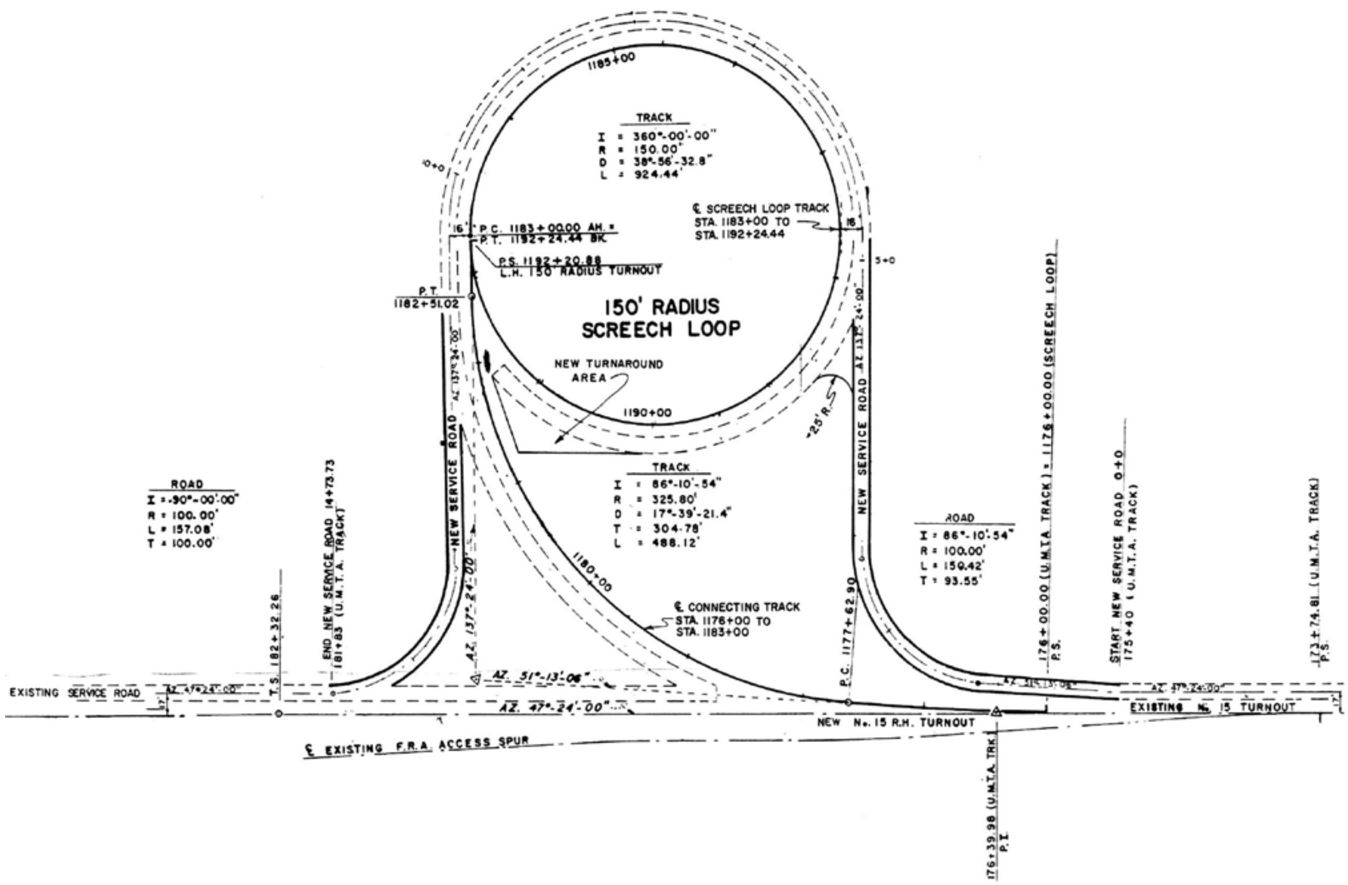


Figure B-13 *TTL layout*

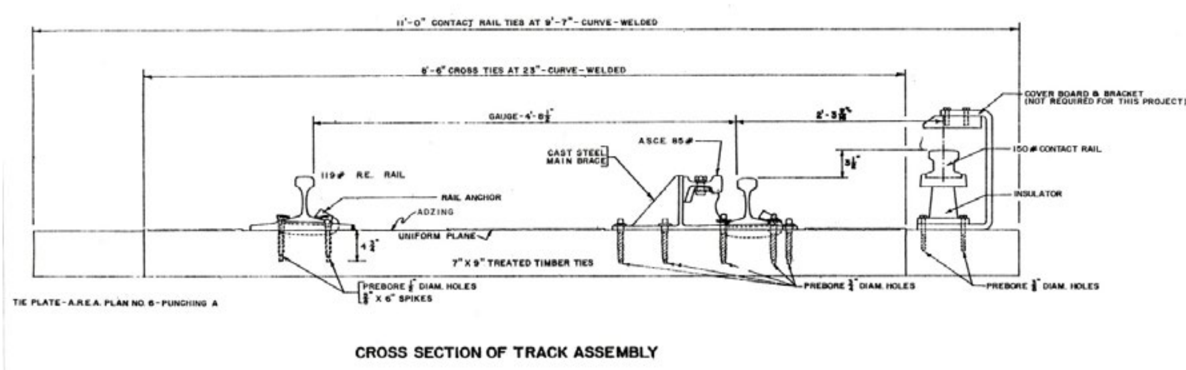


Figure B-14 *TTL cross-section*

Core Area Tracks

Yard and service tracks for the core area were constructed with used track materials with predominately wood ties. Tracks are maintained under FRA Class 2 safety standards. Track curves are limited to a 12° maximum curve.

Overhead catenary has been extended to the TMB and PSB facilities allowing access of electrified vehicles to those maintenance facilities under their own operation. Isolation switches allow for the isolation of the catenary power to these facilities when not in use. A locomotive service facility is located on the CSB / PTT Access Track. The facility consists of one fueling station, a sanding tower with dispensing station, used oil collection, a bulk oil filling station, and a horizontal lifeline for top of vehicle access.

Vehicle Impact Wall

There were major efforts in the 1990s to improve the crashworthiness of rail passenger vehicles. While there are a number of organizations capable of carrying out theoretical studies into the crashworthiness of newly designed railway vehicles, there are very few full-scale impact barriers capable of impact testing railway vehicles. Figure B-15 shows the vehicle impact wall that was constructed at TTC to perform these tests. An inclined railway track leads to the rigid barrier constructed from structural steel and reinforced concrete and backed by an earth embankment. The wall itself is capable of taking an impact load of approximately 3,000,000 pounds (13.4 MN) at 17 feet above the rails. The track leading to the barrier is approximately 2,500 feet (760 m) in length. Figure B-16 shows the barrier under construction.

Figure B-15

Completed impact barrier

Figure B-16

Impact barrier under construction

The barrier itself is constructed on the site of a concrete guideway that was used in the 1970s to test a high speed air-cushion vehicle at speeds of up to 300 mph (483 km/h). The railway track is laid on wooden ties that are laid directly onto the concrete guideway and braced laterally against the vertical concrete pillars along the side of the guideway. The slope of the guideway is 0.86%, exactly the same as the PTT test track running parallel to it. The concrete barrier is built tied into the concrete guideway through its steel reinforcing.

The front wall of the barrier is 2 feet (610 mm) thick reinforced concrete, 25 feet (7.62 m) wide by 18 feet (5.49 m) high. This wall is supported by three vertical walls each 2 feet (610 mm) thick by 36 feet (10.97 m) deep and 18 feet (5.49 m) high. In between these three walls there are another two vertical support walls 18 inches (457 mm) thick by 20 feet (6.10 m) deep and 8 feet (2.44 m) high, designed to absorb high impact loads associated with side sills on railcars. Native soil was compacted into the gaps between these walls and piled up against the two side walls and the rear. More than 1,000 tons of earth was used in the construction.

The front of the barrier is faced with a 3-inch (75 mm) steel plate. Anti-climb bars or vehicle body ends can be mounted on the front of the wall if such a test is required. It would also be possible to mount a target wall separated by load cells from the main barrier if a direct measurement of force was required for a particular test.

Further additions have been made to the barrier since its original construction. A concrete pad with the rails built-in has been constructed immediately in front of the wall. This allows easier access to the wall and fixes the rails rigidly in front of the barrier. This concrete pad has a pit to allow a camera and lights to be positioned looking up at the impact zone. Extra power outlets have been provided on either side of the wall and on top of the wall, for cameras and lights. Figure B-17 shows a plan view of the barrier with its track and the parallel PTT track.

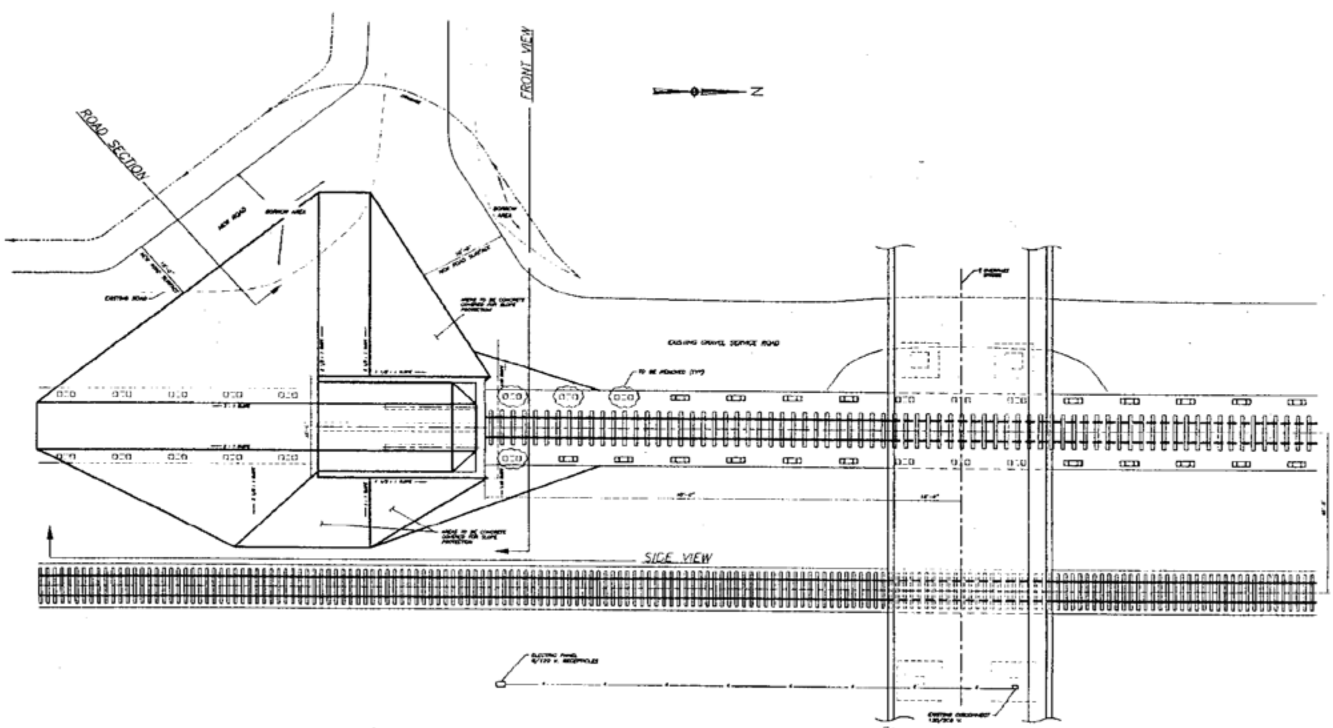


Figure B-17 *Plan view of impact barrier*

Laboratories and Other Facilities

Rail Dynamics Laboratory (RDL)

Figure B-18 shows the RDL, which is located in the TTC Core Area. The RDL high bay is 355 feet (106.7 m) long by 103 feet (45.7 m) wide and is 55 feet (16.7 m) from grade level to bottom of roof structure. The high-bay area is served by two 100-ton rated overhead cranes with a hook height of 42 feet (11.2 m). The cranes with support rigging are capable of lifting fully loaded freight cars, locomotives, or passenger vehicles and setting them on the simulators. The RDL houses two major rail vehicle simulators and facilities to support laboratory services (originally designed for three simulators). The two rail vehicle simulators are the Vibration Test Unit (VTU) and the Simuloader (SMU). The Mini-Shaker Unit (MSU) is also housed in the RDL.

Figure B-18

Rail Dynamics Laboratory (RDL)

The VTU is a computer-controlled, full-scale laboratory test device used in evaluating suspension characteristics of rail vehicles, components, and vehicle natural frequencies, ride comfort, and lading responses. Figure B-19 shows the VTU. The VTU is used in modal characterization to determine rigid body roll, pitch, bounce, yaw, and flexible modes of railcars, locomotives, and lading as well as in ride quality and lading damage evaluations. It uses 12 actuators with piston capacities varying up to 50 kips (thousand pounds) and with up to 6-inch stroke or displacement.

Figure B-19

Vibration Test Unit (VTU) with autorack car in test mode

The VTU shakes a rail vehicle vertically and laterally through the wheels to simulate, through computer controlled inputs, the track interface with the railcar over varied track geometry. Computer generated track profiles, or recordings of actual track profiles, are used to drive the actuators, which can be positioned to accept a variety of truck spacings or axle arrangements. The VTU has the capability of inducing vibrations in the frequency range of 0.2 to 30 Hz to the test car. The VTU can also be used to test non-rail vehicles such as buses and off-road construction equipment. The test device can be modified to accommodate a 4-axle rail vehicle up to 90 feet long and 160 tons and up to a 66-inch wheel gage. The unit can also be modified to accommodate other truck configurations.

The SMU is a computer-controlled, electro-hydraulic structural test device for applying dynamic forces directly to a full-scale railcar body, highway vehicles and other heavy structures. It is used for full-scale multi-axial fatigue and durability testing of railcars, locomotives, on and off highway vehicles, and truss sections. Figure B-20 shows the SMU. Using random parameter control, the SMU inputs motions directly into the vehicle's carbody through the carbody bolster. The SMU uses up to 13 actuators with piston capacities varying up to 750 kips and up to 12-inch stroke or displacement. It is designed to simulate stress accumulated over a long period of train operations in a very short time, making fatigue life predictions available in weeks instead of years. The resulting fatigue analysis serves as an excellent source of design information and safety evaluation for railcar designers.

Figure B-20

Simuloader (SMU)

The MSU is located on Track 2, directly north of the VTU. The MSU is used to measure vehicle truck suspension system characteristics. The MSU is a system of reaction masses and a computer-controlled hydraulic actuator capable of applying vertical, lateral, or roll input dynamic forces. Figure B-21 shows the MSU. This unit is especially useful in modal characterization of railcar components and partial railcar systems. It is also used for quantifying the suspension characteristics of assembled suspensions for use in mathematical simulation models. The test vehicle can experience up to 210 kips through the suspension during a full suspension stroke. The MSU is equipped with special instrumented rail sections to measure wheel/rail forces. The suspension deflection and the reaction measurements from the actuators and rail are used to determine engineering values for the suspension characteristics. The use of airbag assisted bearing tables under the wheels of a vehicle and/or axles with independently rotating wheels allows for inter-axle shear and yaw stiffness measurements. The MSU can be configured to perform the rigid and flexible body modal studies of the strategic components of the vehicle structure.

Figure B-21

Mini-Shaker Unit (MSU) attached to a flat car

Center Services Building (CSB)

The CSB is the primary maintenance facility for TTC and provides for minor overhauling, repair, maintenance, and test preparation of test vehicles in the high bay. Outside facilities at the CSB include a loading dock, a one-million-pound squeeze fixture, yard tracks, vehicle fueling stations, and a locomotive servicing facility.

The CSB high-bay service area, measuring 367 feet by 100 feet (118 m by 30 m) has a clear height of 50 feet (80.5 m) to the roof structure and accommodates major services performed on rail vehicles. This space is served by two 30-ton cranes with a 43.6-foot (13.2 m) hook height. Four tracks enter the high-bay area from the west. The northern track (Track 4) continues through the building to a concrete slab on grade east of the building. This features a repair pit with air, water, and power at convenient locations. A drive-on, under floor wheel-truing machine is located at the center of the building on this track. The second track from the north (Track 3) has a pit and services, but extends only to about mid-length of the building, terminating adjacent to the wheel-truing pit. The southern two tracks (Tracks 1 & 2) are surface tracks (without pits), and Track 2 also extends to about mid-length of the building. Track 1 extends to the far end of the high bay. The floor structure under the two southerly tracks will support 60-ton jack loads at any point along the tracks.

Craft areas include workspace for maintenance and storage of equipment related to the high bay activities. Shop areas include a Machine/Weld, Electrical, Wood, Plumbing, Motor Pool, Locksmith, and Rail Vehicle Maintenance shops. The Machine Shop includes such items as CNC-controlled milling machines, digital-controlled lathes and milling machines, drills to a 6-foot radial arm drill press, power shear, power nibbler, table grinder, cutoff saws, and an assortment of tools and equipment to perform high precision machining on a variety of metals. The Weld Shop includes a tracer torch cutter/table; Arc, MIG and TIG welders; and a portable vacuum/blast cleaner, with both shop and field welding equipment. Personnel are AWS-certified to perform aluminum, stainless steel, and carbon steel welding. The total shop area within the CSB is approximately 15,000 square feet (1,017 m2).

Transit Maintenance Building (TMB)

The TMB is a facility primarily used for mass transit (commuter) vehicle testing (Figure B-22). The facility is a pre-engineered metal building, insulated and heated, 40 feet by 192 feet long, with a single through track. The building has a 100-foot long service pit between the rails with flat track for the remainder of the building. An overhead catenary line extends from the RTT through the building and terminates on the inside end of the building wall. The catenary power can be isolated outside the building or at the RTT. Minimum catenary minimum clearance height is 17 feet inside the building. An air table/pit are located on one end, which is capable of floating a 2-axle truck with a maximum of 9.25 feet axle spacing under a rail vehicle to measure resistance to truck rotation. A parallel track to the southeast of the building allows access from either end of the building. A track vehicle scale is located on this track directly outside the center of the TMB. The building also contains a small office, a storage area, a fenced outside storage on paved surfaces, a restroom, and a small compressed air system.

Figure B-22

Transit Maintenance Building (TMB)

Urban Rail Building (URB)

Figure B-23 shows the URB, which was built in 1980 as a permanent maintenance facility for transit vehicles (Metro and Light Rail) using the TTT. A Wye track configuration extends to the building from the TTT to allow turning of vehicles for logistics purposes without leaving the TTT test area. Third-rail power is extended along the Wye Tracks into the building, with the power source controlled from the building. A portable stinger system can move the cars from the end of the third rail into the building. The DC power supply is separate from the TTT, allowing isolation of the URB facility from TTT testing. Two yard tracks extend through the building and an additional 350 feet to the west of the facility. Two additional yard tracks were added to the facility on the north side of the main access track.

The north track inside the building extends over a 40-foot-long service pit, with the south track and portions of the north track constructed as a flat track with jacking capability. The building is a pre-engineered metal building, insulated and heated, 102 feet wide by 190 feet long.

Figure B-23

Urban Rail Building (URB)

Passenger Rail Services Building (PSB)

The PSB is an insulated and heated, 40 feet by 230 feet long, with a single track running through the building. Figures B-24 and B-25 show the PSB. The access track south of the building includes a Wye Track for turning vehicles, with access from either the core area buildings and facilities or the RTT.

Figure B-24

Passenger Rail Services Building (PSB) high bay, facing south

Figure B-25
Existing PSB

The building has a 12-foot wide by 82-foot long track service pit, with movable jacking stands for vehicle jacking over the pit. The remainder of the track in the building is flat track with jacking capability. Total building square footage is 46,160 square feet. A second addition includes a 90-foot by 300-foot high bay for rail vehicle activity, with a 31-foot by 150-foot low bay. There are three tracks that extend through the building. Track 1 (west track) has an overhead catenary line that extends through the building to provide electrified cars access under power from the RTT. Height of the contact wire is 22 feet 6 inches, which will allow all full height vehicles in the building that are allowed in interchange. The catenary power can be isolated at the building or at the RTT.

Track length is 550 feet inside the building. Tracks 2 and 3 also extend through the building and have two 75-ton rated overhead cranes with 10-ton auxiliary hoists to service vehicles on the tracks. A service pit was also installed for a future 125-ton, 3-Axle Drop Table unit to span between the two tracks. The service top and bi-fold doors have been integrated into the floor slab in preparation for the unit. A pit also was installed in Track 3 for a future in-floor, CNC Wheel Truing Machine.

DC Rectifier Substations 1 and 2

Two substation buildings were constructed in 1976 to house the DC Rectifiers and associated controls for the TTT. Figure B-26 is a photograph of Substation 1. The units are a mirror image of each other, with DC Substation 1 located on the east side of the TTT near Post 85 road crossing and DC Substation 2 near the west side of the TTT. Locations of the two substations are such as to provide power to the contact third rail at equal distances around the 9.1-mile test loop. Each rectifier substation is capable of providing a voltage up to 1,150 VDC at 5,000 amps continuous, with substation rectifiers in parallel. Overload protection is set at 5,500 amps DC for two hours. With the LC output filter connected, DC harmonics are at less than 10% at 850 volts DC and 5,050 amps, 360 Hz. With the filter disconnected, DC harmonics are at less than 0.25 amps at 850 volts DC and 5,050 amps, 360 Hz.

Figure B-26
Substation 1

The rectifiers in the substations can be modified to operate in series with some relatively minor modifications. This would allow the voltage to be increased to a maximum of 2,500 volts DC, but would limit the maximum current at that voltage to 2,500 amps DC. Some light rail systems operate at 1,800 volts DC. TTC substations would be current limited to 3,000 amps at that voltage.

There are also two rectifiers in the Urban Rail Building (URB) to power up transit vehicles with portable paddle stingers (one per service track entering the building). This allows vehicles to be moved to and from the building until contact is made with the third rail outside of the building. Each rectifier will provide up to 1,000 volts DC, with 1,000 amps.

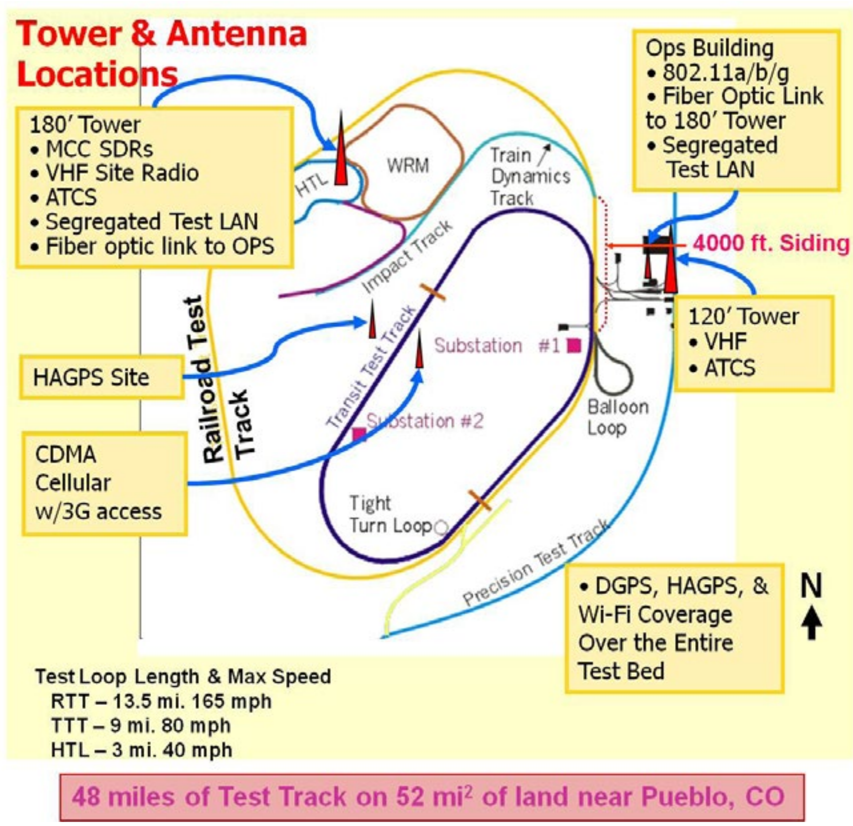
Communications Based Train Control – Positive Train Control (PTC) Test Bed

Under the Rail Safety Improvement Act of 2008, each Class 1 railroad carrier and each entity providing regularly scheduled intercity or commuter rail passenger transportation is to develop a plan for implementing a PTC system by December 31, 2015. A PTC Test Bed has been developed and installed at TTC as a phased program to support the industry in this effort, with funding from FRA, Railroad Research Foundation, and TTCI. The PTC Test Bed provides a controlled test environment for conducting functional testing, safety testing, interoperability testing, performance evaluation, and development support for PTC systems, components, and related equipment. The PTC Test Bed integrates PTC equipment with existing railroad signaling and communication infrastructure on the RTT to provide a realistic operating environment that is independent of the revenue service operation of any railroad.

PTC is an emerging and dynamic technology in the North American Freight Rail Industry. Since the functionality, interfaces, and specific hardware implementation of PTC systems are currently in a development phase and are not yet completely defined, the PTC Test Bed is designed to be modular, easily expanded, and configurable so that the testing of new PTC equipment and additional varieties of PTC systems, such as the Interoperable Train Control (ITC)-specified system (also referred to as the Interoperable Electronic Train Management System (I-ETMS)) and the Advanced Civil Speed Enforcement System (ACSES), may be supported. In general, the configuration of the PTC Test Bed is dictated by what is being tested, the scope of the tests, and the detailed requirements of test scenarios. For example, the test of a single function of a PTC segment, such as the testing of a train stop distance prediction algorithm, may require a minimum test bed configuration using a locomotive and track, along with the PTC onboard component under test, while the testing of a more global aspect of the PTC system, such as the performance evaluation of the communications network, may require that a full PTC system be available. Figure B-27 provides an overview of communication infrastructure located at TTC that is available for testing PTC systems and equipment.

Figure B-27

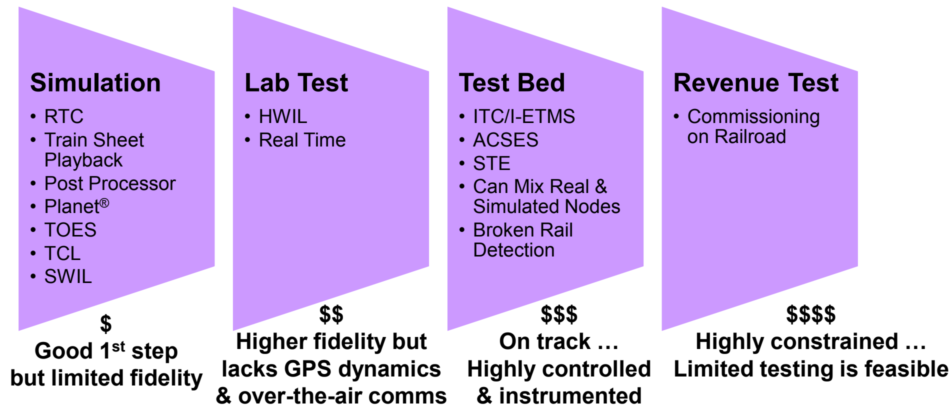
Positive Train Control (PTC) communications infrastructure at TTC



In addition to the testing capabilities with actual hardware components, the PTC Test Bed has the capability of interacting with a number of simulators to perform testing that may not be practical or efficient with hardware alone. For example, stress testing aspects of the communications system could be accomplished by simulators generating the network traffic to evaluate the performance of actual hardware radios. This capability leads to a methodology for testing PTC systems and components, as shown in Figure B-28, that follows a logical progression from laboratory simulations with software in the loop (SWIL) to laboratory tests with hardware in the loop (HWIL) to full-scale testing in a controlled test environment and finally, commissioning on revenue track. A methodology such as this can be adapted to the specific test requirements, and may include one or more of these phases.

Figure B-28

General methodology for efficient and effective development/ testing of PTC systems and components using PTC Test Bed



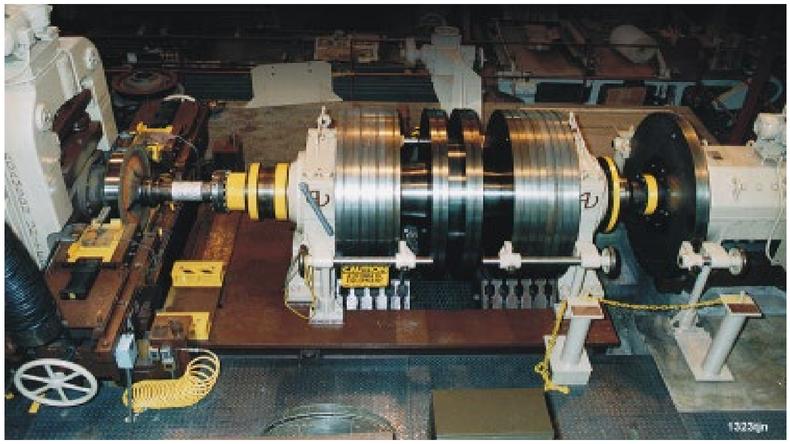
TTCI's modeling capabilities include complete rail network traffic simulation with custom post-processing for communications system analysis, communications propagation models for design and coverage/interference analysis, longitudinal train dynamics modeling for analysis of PTC braking algorithms and train simulations, as well as a number of other custom tools and simulators. These capabilities add to the full testing capabilities of the PTC Test Bed to provide a complete testing and analysis package for communications and train control systems.

Brake Dynamometer

In 1983, the AAR purchased and installed a used single-ended inertia dynamometer at the Chicago Technical Center to conduct research and tests on railroad wheels, and brake shoes. Subsequently, a new control and data acquisition system was installed in 1987 with an upgrade in 2004. The dynamometer has the capability to apply a wide range of normal and excessive thermal and mechanical loads to railroad wheels. A unique feature is the large circular reaction rail through which vertical and lateral contact forces can be applied. The control system provides repeatable automatic control of test sequences, speed, and brake shoe force (or torque control). The data acquisition system provides automatic digital data collection, storage, and reduction. During an official ceremony in 1988, the American Society of Mechanical Engineers (ASME) designated the AAR Railroad Wheel Dynamometer as the 91st National Historic Mechanical Engineering Landmark. Figure B-29 shows a photograph of the dynamometer.

Figure B-29

Dynamometer



The Adamson-United dynamometer was originally designed to test railroad wheels at speeds, and with vertical, lateral, inertial, and brake shoe load conditions that duplicate and exceed service conditions. For example, the machine can be driven at 1,500 rpm, or 147 mph for a 33-inch diameter freight car wheel. Vertical and lateral load capabilities are 60,000 pounds and 15,000 pounds, respectively. By comparison, maximum static loads on railroad wheels in interchange service range from 24,000 to 39,000 pounds. A 110-inch diameter rail wheel, in combination with a motor-driven screw and a hydraulic cylinder, provides the contact loads. The inertia load capacity of the dynamometer ranges from 65,000 pounds to 128,000 pounds equivalent wheel load, depending on wheel diameter. The original braking capacity of 50,000 pounds on each of the two, 180° opposed, brake actuators was reduced by the installation of new brake air cylinders. The braking capacity is now 6,500 pounds for one brake actuator, and 13,000 pounds for the other brake actuator. Brake shoe loads normally do not exceed 6,000 pounds for freight car wheels, or 12,000 pounds for locomotive wheels braked with high friction composition brake shoes.

The stringent test requirements of the AAR's Specification for High Friction Composition Brake Shoes, M-926-92, could not be achieved with the original (1955) control and data acquisition system. As a result, state of the art control, data acquisition, and data reduction systems were installed in late 1987 to provide capability to conduct AAR brake shoe certification and quality control tests. In July 1995, the dynamometer control system was upgraded to an IBM Pentium® microprocessor-based software format when the AAR dynamometer was moved to the TTC at Pueblo, Colorado. Currently, the AAR dynamometer is used to conduct both commercial developmental testing and official AAR certification testing. The dynamometer is also used by the AAR in the development of improvements to the current brake shoe standards.

One Million Pound Squeeze Test Fixture

The Squeeze Test Facility is designed to apply compressive forces at standard rail coupler height through the bodies of rail vehicles. The fixture is used to show compliance with compressive end load tests under AAR Standard Specifications for Freight Cars, M-1001, Chapter 11, Service Worthiness Tests and Analyses for New Freight Cars.

The Squeeze Test Facility was upgraded in 2011 to allow compressive load tests of passenger cars equipped with crash energy management (CEM) systems. Four longitudinal actuators have the ability to be operated in stroke control, meaning that all actuators stroke in unison. Actuators can also be operated in force control if a test requires it. Two actuators have 1,000,000-pound load capacity, and two have 300,000-pound capacity. The total longitudinal load capacity is 2,600,000 pounds. Locations of the actuators can be adjusted to the particular needs of a test vehicle. Eight load cells measure forces applied by the actuator and forces reacted by restraints at the passive end of the car. Measurement of all applied and reacted longitudinal loads allows determination of the load path through a test vehicle when multiple actuators are used. Figure B-30 shows an experimental CEM equipped passenger vehicle during testing.

Figure B-30

One-million-pound squeeze test fixture

APPENDIX

C

Software Survey

Vehicle Dynamics Modeling Software Survey for FTA Project on Assessment of Facilities

The Transportation Technology Center, Inc. (TTCI) has been awarded an FTA grant for the Assessment of Facilities for Qualification Testing of Rail Passenger Equipment and Signal and Control Systems. The scope of this work is to identify tests required for all types of passenger rail equipment and the signal systems that control them to qualify or be accepted for service, assess the adequacy of the TTCI facilities for performing each of these tests, and define required upgrades to TTC's facilities or recommend alternative facilities for tests that cannot currently be performed at TTC.

As you may know, some of the static and many of the dynamic tests identified in the work above can be modeled using modeling software. As part of this project, we have been asked to review and evaluate existing modeling software routines. We plan to provide a cursory listing of benefits, e.g., capabilities, ease of operation, pricing based on public information and survey responses. The information provided in this survey will be published in a publically available document.

For questions, please contact the MaryClara Jones, TTCI Project Manager, maryclara_jones@aar.com, +1 (719) 585-1808.

Software Name: ____

- **Price of software (please describe module options and prices and if the cost is an annual subscription or one-time purchase)**
- **Software Capabilities:**
  - Can measured wheel and rail profiles be used in the simulation?
  - Is there a specific W/R measurement device that is supported? (for example, miniprof)
  - Can measured track geometry be used in simulation (GEO, for example)?
  - Can special track work (switches, turnouts, crossings, etc.) be an input?
  - What parametric variations are available?
  - Is there animated output?
  - Does the software come with North American templates?

- Are there supplemental packages for analysis of the input and output?
- Does the software have batch analysis capability? (analysis of numerous files)
- Is there a CAD interface?
- Is there Finite Element Modeling (FEM) interface? If so, with what FEM software?
- Are there other software packages that can interface with this package?
- 64 bit or 32 bit?

- **Use of the Software:**
  - What is the maximum number of connections and bodies allowed in the modeling?
  - What kind of interface does the software have (window type with pull down menus, for example)?
  - Is the software easy to use (Rate 1–9, with 1 being anybody can use with little training to 9 being an expert engineer with several days of training)?
  - What kind of training is available?
  - Is there pictorial animation of the simulation?
  - Is there pictorial animation for the model building?
  - Is there a help desk a user can call for help?
  - Is there online support (online groups for example)?
  - Are the new releases on a typical timeline?
  - If there are new releases, what timeline are they released (for example, every year)?
- **Any other important information?**
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