§ 299.607 Pre-revenue service system integration testing.

(a) Prior to commencing revenue operations, the railroad shall conduct tests of the trainsets throughout the system to—

(1) Verify mechanical positioning of the overhead catenary system; and

(2) Verify performance of the trainset, track, and signal and trainset control systems.

(b) The railroad shall demonstrate safe operation of the system during normal and degraded-mode operating conditions. At a minimum, the following operation tests shall be performed:

(1) Slow-speed operation of a trainset;

(2) Verification of correct overhead catenary and pantograph interaction;

(3) Verification of trainset clearance at structures and passenger platforms;

(4) Incremental increase of trainset speed;

(5) Performance tests on trainsets to verify braking rates in accordance with § 299.409;

(6) Verification of vehicle noise;

(7) Verification of correct vehicle suspension characteristics;

(8) Vehicle/track system qualification as defined in § 299.609;

(9) Load tests with vehicles to verify relay settings and signal and communication system immunization;

(10) Monitoring of utility supply circuits and telephone circuits to ensure the adequacy of power supplies, and to verify that transient-related disturbances are within acceptable limits;

(11) Verification of vehicle detection due to shunting of signal system circuits;

(12) Verification of safe operation of the signal and trainset control system as required by subpart B of this part;

(13) Tests of trainset radio reception during system-wide vehicle operation; and

(14) Verification of electromagnetic interference/electromagnetic compatibility between various subsystems.

§ 299.609 Vehicle/track system qualification.

(a) *General.* All vehicles types intended to operate in revenue service shall be qualified for operation in accordance with this subpart. A qualification program shall be used to demonstrate that the vehicle/track system will not exceed the wheel/rail force safety limits, and the carbody and bogie acceleration criteria specified in paragraph (h) of this section—

(1) At any speed up to and including 10 km/h (6 mph) above the proposed maximum operating speed; and

(2) On track meeting the requirements for the class of track associated with the proposed maximum operating speed as defined in § 299.309. For purposes of qualification testing, speeds may exceed the maximum allowable operating speed for the class of track in accordance with the test plan approved by FRA.

(b) *New vehicle/track system qualification.* Vehicle types not previously qualified under this subpart shall be qualified in accordance with the requirements of this paragraph (b).

(1) *Carbody acceleration.* For vehicle types intended to operate in revenue service at track class H4 speeds or above, qualification testing conducted over a representative segment of the route shall demonstrate that the vehicle type will not exceed the carbody lateral and vertical acceleration safety limits specified in paragraph (h) of this section.

(2) *Bogie lateral acceleration.* For vehicle types intended to operate at track class H4 speeds or above, qualification testing conducted over a representative segment of the route shall demonstrate that the vehicle type will not exceed the bogie lateral acceleration safety limit specified in paragraph (h) of this section.

(3) *Measurement of wheel/rail forces.* For vehicle types intended to operate at track class H4 speeds or above, qualification testing conducted over a representative segment of the route shall demonstrate that the vehicle type will not exceed the wheel/rail force safety limits specified in paragraph (h) of this section.

(c) *Previously qualified vehicle/track system.* Vehicle/track systems previously qualified under this subpart for a track class and cant deficiency on

one route may be qualified for operation at the same class and cant deficiency on another route through testing to demonstrate compliance with paragraph (a) of this section in accordance with the following:

(1) *Carbody acceleration.* For vehicle types intended to operate at track class H4 speeds and above, qualification testing conducted over a representative segment of the new route shall demonstrate that the vehicle type will not exceed the carbody lateral and vertical acceleration safety limits specified in paragraph (h) of this section.

(2) *Bogie lateral acceleration.* For vehicle types intended to operate at track class H4 speeds or above, measurement of bogie lateral acceleration during qualification testing shall demonstrate that the vehicle type will not exceed the bogie lateral acceleration safety limit specified in paragraph (h) of this section. Measurement of bogie lateral acceleration, if conducted, shall be performed over a representative segment of the new route.

(d) *Vehicle/track system qualification testing plan.* To obtain the data required to support the qualification program outlined in paragraphs (b) and (c) of this section, the railroad shall submit a qualification testing plan as required by §299.603(b) at least 60 days prior to testing, requesting approval to conduct the testing at the desired speeds and cant deficiencies. This test plan shall provide for a test program sufficient to evaluate the operating limits of the track and vehicle type and shall include—

(1) Identification of the representative segment of the route for qualification testing;

(2) Consideration of the operating environment during qualification testing, including operating practices and conditions, the signal system, and trainset on adjacent tracks;

(3) The maximum angle found on the gauge face of the designed (newly-profiled) wheel flange referenced with respect to the axis of the wheelset that will be used for the determination of the Single Wheel L/V Ratio safety limit specified in paragraph (h) of this section; and

(4) A target maximum testing speed in accordance with paragraph (a) of this section and the maximum testing cant deficiency.

(e) *Qualification testing.* Upon FRA approval of the vehicle/track system qualification testing plan, qualification testing shall be conducted in two sequential stages as required in this subpart.

(1) Stage-one testing shall include demonstration of acceptable vehicle dynamic response of the subject vehicle as speeds are incrementally increased—

(i) On a segment of tangent track, from acceptable track class H4 speeds to the target maximum test speed; and

(ii) On a segment of curved track, from the speeds corresponding to 76 mm (3 inches) of cant deficiency to the maximum testing cant deficiency.

(2) When stage-one testing has successfully demonstrated a maximum safe operating speed and cant deficiency, stage-two testing shall commence with the subject equipment over a representative segment of the route as identified in paragraph (d)(1) of this section.

(i) A test run shall be conducted over the route segment at the speed the railroad will request FRA to approve for such service.

(ii) An additional test run shall be conducted at 10 km/h (6 mph) above this speed.

(3) When conducting stage-one and stage-two testing, if any of the monitored safety limits are exceeded on any segment of track, testing may continue provided that the track location(s) where any of the limits are exceeded be identified and test speeds be limited at the track location(s) until corrective action is taken. Corrective action may include making adjustments to the track, to the vehicle, or to both of these system components.

(4) Prior to the start of the qualification testing program, a qualifying Track Geometry Measurement System (TGMS) shall be operated over the intended route within 30 calendar days prior to the start of the qualification testing program to verify compliance with the track geometry limits specified in §299.311.

(f) *Qualification testing results.* The railroad shall submit a report to FRA

detailing all the results of the qualification program in accordance with § 299.613. The report shall be submitted at least 60 days prior to the intended operation of the equipment in revenue service over the route.

(g) *Cant deficiency*. Based on the test results and all other required submissions, FRA will approve a maximum trainset speed and value of cant deficiency for revenue service, normally within 45 days of receipt of all the required information. FRA may impose conditions necessary for safely operating at the maximum approved trainset speed and cant deficiency.

(h) *Vehicle/track interaction regulatory limits*. The following vehicle/track interaction regulatory limits shall not be exceeded during qualification testing in accordance with this section.

Table 1 to paragraph (h)			
Vehicle/Track Interaction Safety Limits			
Wheel-Rail Forces[1]			
Parameter	Safety Limit	Filter / Window	Requirements
Single Wheel Vertical Load Ratio	≥ 0.15	1.5 m (5 ft)	No wheel of the vehicle shall be permitted to unload to less than 15 percent of the static vertical wheel load for 1.5 m (5 ft) or more continuous meters. The static vertical wheel load is defined as the load that the wheel would carry when stationary on level track.
Single Wheel L/V Ratio	$\leq \frac{\tan(\delta) - 0.5}{1 + 0.5\tan(\delta)}$	1.5 m (5 ft)	The ratio of the lateral force that any wheel exerts on an individual rail to the vertical force exerted by the same wheel on the rail shall not be greater than the safety limit calculated for the wheel's flange angle (δ) for 1.5 m (5 ft) or more continuous meters.
Net Axle Lateral L/V Ratio	$\leq 0.4 + \frac{22.24}{Va}$	1.5 m (5 ft)	The net axle lateral force, in kN, exerted by any axle on the track shall not exceed a total of 22.24 kN (5 kips) plus 40 percent of the static vertical load that the axle exerts on the track for 1.5 m (5 ft) or more continuous meters. Va = static vertical axle load (kN)
Bogie Side L/V Ratio	≤ 0.6	1.5 m (5 ft)	The ratio of the lateral forces that the wheels on one side of any bogie exert on an individual rail to the vertical forces exerted by the same wheels on that rail shall not be greater than 0.6 for 1.5 m (5 ft) or more continuous meters.

Carbody Accelerations[2]		
Parameter	All Vehicles	Requirements
Carbody Lateral (Transient)	≤ 0.35g peak-to-peak 1 sec window[3] excludes peaks < 50 msec	The peak-to-peak accelerations, measured as the algebraic difference between the two extreme values of measured acceleration in any 1-second time period, excluding any peak lasting less than 50 milliseconds, shall not exceed 0.35g for all vehicles.
Carbody Lateral (Sustained Oscillatory)	≤ 0.10g RMS_t[4] 4 sec window[3] 4 sec sustained	Sustained oscillatory lateral acceleration of the carbody shall not exceed the prescribed (root mean squared) safety limits of 0.10g for all vehicles. Root mean squared values shall be determined over a sliding 4- second window with linear trend removed and shall be sustained for more than 4 seconds.
Carbody Vertical (Transient)	≤ 0.45g peak-to-peak 1 sec window[3] excludes peaks < 50 msec	The peak-to-peak accelerations, measured as the algebraic difference between the two extreme values of measured acceleration in any one second time period, excluding any peak lasting less than 50 milliseconds, shall not exceed 0.45g for all vehicles.
Carbody Vertical (Sustained Oscillatory)	≤ 0.16g RMS_t[4] 4 sec window[3] 4 sec sustained	Sustained oscillatory vertical acceleration of the carbody shall not exceed the prescribed (root mean squared) safety limit of 0.16g for all vehicles. Root mean squared values shall be determined over a sliding 4-second window with linear trend removed and shall be sustained for more than 4 seconds.

Bogie Lateral Acceleration[5]			
Parameter	Safety Limit	Filter / Window	Requirements
Bogie Lateral Acceleration	≤ 0.30g RMS_t[4]	2 sec window[3] 2 sec sustained	Bogie hunting shall not develop below the maximum authorized speed. Bogie hunting is defined as a sustained cyclic oscillation of the bogie evidenced by lateral accelerations exceeding 0.30g root mean squared for more than 2 seconds. Root mean squared values shall be determined over a sliding 2-second window with linear trend removed.

[1] The lateral and vertical wheel forces shall be measured and processed through a low pass filter (LPF) with a minimum cut-off frequency of 25 Hz. The sample rate for wheel force data shall be at least 250 samples per second.
[2] Carbody accelerations in the vertical and lateral directions shall be measured by accelerometers oriented and located in accordance with § 299.337(c)(3).
[3] Acceleration measurements shall be processed through an LPF with a minimum cut-off frequency of 10 Hz. The sample rate for acceleration data shall be at least 100 samples per second.
[4] RMS_t = RMS with linear trend removed.
[5] Bogie lateral acceleration shall be measured by accelerometers mounted on the bogie frame at a longitudinal location as close as practicable to an axle's centerline, or if approved by FRA, at an alternate location.

§ 299.611 Simulated revenue operations.

(a) The railroad shall conduct simulated revenue operations for a minimum period of two weeks prior to revenue operations to verify overall system performance, and provide operating and maintenance experience.

(b) The railroad shall maintain a log of tests conducted during the simulated revenue operations period. This log of tests shall identify any problems encountered during testing, and actions necessary to correct defects in workmanship, materials, equipment, design, or operating parameters.

(c) The railroad shall implement all actions necessary to correct safety defects, as identified by the log prior to the initiation of revenue service.

§ 299.613 Verification of compliance.

(a) The railroad shall prepare a report detailing the results of functional and performance qualification tests, pre-revenue service system integration testing, and vehicle/track system qualification tests required under §§ 299.605, 299.607, and 299.609 respectively. The report shall identify any problems encountered during testing, and alternative actions necessary to correct defects in workmanship, materials, equipment, design, or operating parameters.

(b) The railroad shall implement all actions necessary to correct defects, as identified by the report.

(c) The railroad shall submit the report(s) required by paragraph (a) of this section to FRA prior to commencing simulated revenue operations and at least 60 days prior to the intended start of full revenue service per § 299.609(f).

(d)(1) Prior to implementing a major upgrade to any safety-critical system component or sub-system, or prior to introducing any new safety-critical technology, the railroad shall submit for FRA approval the detailed test procedures and/or analysis in accordance with § 299.603(d).

(2) The railroad shall prepare a report detailing the results of functional and performance qualification tests, pre-revenue service system integration testing, and vehicle/track system qualification tests required under §§ 299.605, 299.607, and 299.609 respectively pertaining to a major upgrade to any safety-critical system component or subsystem, or introduction of any new safety-critical technology. The report shall identify any problems encountered during testing, and alternative actions necessary to correct defects in workmanship, materials, equipment, design, or operating parameters.

Subpart G—Inspection, Testing, and Maintenance Program

§ 299.701 General requirements.

Under the procedures provided in § 299.713, the railroad shall obtain FRA approval of a written inspection, testing, and maintenance program. The program shall provide detailed information, consistent with the requirements set forth in §§ 299.337 through