traveling (i) at the maximum speed at which the vehicle will operate (ii) at an impact angle no less severe than horizontal to the vehicle, with no penetration or spall. An impact angle that is perpendicular to the window’s surface shall be considered the most severe impact angle for purposes of this requirement.

(2) Each side-facing exterior window shall resist the impact of a:
   (i) 12-pound solid steel sphere at 15 mph, at an angle of 90 degrees to the window’s surface, with no penetration or spall; and
   (ii) A granite ballast stone weighing a minimum of 0.5 pounds, traveling at 75 mph and impacting at a 90-degree angle to the window’s surface, with no penetration or spall.

(3) All exterior windows shall:
   (i) Resist a single impact of a 9-mm, 147-grain bullet traveling at an impact velocity of 900 feet per second, with no bullet penetration or spall; and
   (ii) Demonstrate anti-spalling performance by the use of a 0.002-inch thick aluminum witness plate, placed 12 inches from the window’s surface during all impact tests. The witness plate shall contain no marks from spalled glazing particles after any impact test; and
   (iii) Be permanently marked, prior to installation, in such a manner that the marking is clearly visible after the material has been installed. The marking shall include:
      (A) The words “FRA TYPE IH” for end-facing glazing or “FRA TYPE IH” for side-facing glazing, to indicate that the material has successfully passed the testing requirements of this section;
      (B) The name of the manufacturer; and
      (C) The type or brand identification of the material.

(d) Glazing securement. Each exterior window on a passenger car and a power car cab shall remain in place when subjected to:

(1) The forces due to air pressure differences caused when two trains pass at the minimum separation for two adjacent tracks, while traveling in opposite directions, each train traveling at the maximum authorized speed; and

(2) The impact forces that the glazed window is required to resist as specified in this section.

(e) Stenciling. Each car that is fully equipped with glazing materials that meet the requirements of this section shall be stenciled on an interior wall as follows: “Fully Equipped with FRA Part 238 Glazing” or similar words conveying that meaning, in letters at least ¾ of an inch high.

§ 238.423 Fuel tanks.

(a) External fuel tanks. Each type of external fuel tank must be approved by FRA’s Associate Administrator for Safety upon a showing that the fuel tank provides a level of safety at least equivalent to a fuel tank that complies with the external fuel tank requirements in § 238.223(a).

(b) Internal fuel tanks. Internal fuel tanks shall comply with the requirements specified in § 238.223(b).

§ 238.425 Electrical system.

(a) Circuit protection. (1) The main propulsion power line shall be protected with a lightning arrester, automatic circuit breaker, and overload relay. The lightning arrester shall be run by the most direct path possible to ground with a connection to ground of not less than No. 6 AWG. These overload protection devices shall be housed in an enclosure designed specifically for that purpose with the arc chute vented directly to outside air.

(2) Head end power, including trainline power distribution, shall be provided with both overload and ground fault protection.

(3) Circuits used for purposes other than propelling the equipment shall be connected to their power source through circuit breakers or equivalent current-limiting devices.

(b) Main battery system. (1) The main batteries shall be isolated from the cab
§ 238.427 Suspension system.

(a) General requirements. (1) Suspension systems shall be designed to reasonably prevent wheel climb, wheel unloading, rail rollover, rail shift, and a vehicle from overturning to ensure safe, stable performance and ride quality. These requirements shall be met:
   (i) In all operating environments, and under all track conditions and loading conditions as determined by the operating railroad; and
   (ii) At all track speeds and over all track qualities consistent with the Track Safety Standards in part 213 of this chapter, up to the maximum operating speed and maximum cant deficiency of the equipment.

(2) Passenger equipment shall meet the safety performance standards for suspension systems contained in appendix C to this part, or alternative standards providing at least equivalent safety if approved by FRA under the provisions of §238.21.

(b) Car body accelerations. (1) A passenger car shall not operate under conditions that result in a steady-state lateral acceleration greater than 0.12g as measured parallel to the car floor inside the passenger compartment. During pre-revenue service acceptance testing of the equipment under §238.111 and §213.345 of this chapter, a passenger car shall demonstrate that steady-state lateral acceleration does not exceed 0.1g at the maximum intended cant deficiency.

(2) While traveling at the maximum operating speed over the intended route, the train suspension system shall be designed to:
   (i) Limit the vertical acceleration, as measured by a vertical accelerometer mounted on the car floor, to no greater than 0.55g single event, peak-to-peak over a one second period;
   (ii) Limit lateral acceleration, as measured by a lateral accelerometer mounted on the car floor, to no greater than 0.3g single event, peak-to-peak over a one second period; and
   (iii) Limit the combination of lateral acceleration ($a_L$) and vertical acceleration ($a_V$) occurring over a one second period as expressed by the square root of ($a_L^2 + a_V^2$) to no greater than 0.6g, where $a_L$ may not exceed 0.3g and $a_V$ may not exceed 0.55g. Compliance with