

obstructions may block a motorist's view, or lights, signs, and other visual clutter may compete for a motorist's attention. In addition, with reflective materials in common use on the nation's highways, the opportunity exists for motorists to confuse freight cars with other roadway hazards, particularly reflectorized truck trailers and respond inappropriately. NHTSA regulations require trucks more than 80 inches wide and weighing more than 10,000 pounds to be reflectorized (49 CFR 571.108). Specifically, the regulation requires the use of a strip (two to four inches wide) in alternating colors (red and white) and covering at least 50% of the length of the trailer. Because trucks are shorter in length and pass through an intersection more quickly than the average train, an approaching motorist may only need to slow the vehicle to avoid a collision instead of stopping prior to reaching the intersection. Conversely, because the average train is longer than the average truck, it spends a greater amount of time in the intersection. For motorists approaching a grade crossing, the greater amount of time the train spends in the intersection means it is more likely that the motorists will need to stop at the intersection. Accordingly, the 2001 study was designed to determine whether, at night when relying upon retroreflective patterns for identification, motorists are likely to confuse reflectorized trains with reflectorized trucks.

In the 2001 study, four patterns, each utilizing 144 square inches of reflective material, were evaluated: An outline, a horizontal strip, a vertical strip, and a variable height vertical strip. The outline pattern outlined the shape of the freight car. The horizontal strip pattern concentrated the retroreflective material along the side sill of the car. The vertical strip pattern (also known as the "fence" pattern), distributed the material in six equally-sized vertical strips over a relatively large area of the car sides. The variable height vertical strip pattern distributed the material in six varying-sized vertical strips over a relatively large area of the freight car sides. The patterns were placed on two types of freight cars, hopper cars and flat cars. The study measured the degree to which drivers recognized reflectorized freight cars in the grade crossing when both the motor vehicle and the train were in motion, and the driver's ability to discriminate reflectorized freight cars from other objects in the intersection.

The 2001 Volpe Report concluded that motorists could, at least to a certain extent, discriminate between reflectorized freight cars and

reflectorized truck trailers for all of the patterns tested. The most effective patterns, in terms of detectability distance and recognition of the object as a freight car, however, were the fence pattern and the variable height vertical strip patterns. The report also concluded that using a vertically oriented pattern clearly distinguishable from the horizontally oriented patterns found on truck trailers will minimize the likelihood that motorists will confuse a train in a grade crossing with a truck trailer.

#### *D. Accident Reduction Potential of Reflective Markings and Alternative Approaches to Reducing Grade Crossing Accidents*

FRA recognizes that the effectiveness of rail car reflectorization will, to a certain extent, vary by circumstance. As discussed earlier, various factors will influence the degree of effectiveness of reflectors and in turn, the resulting accident reduction and mitigation achieved. While all RIT accidents are potentially affected by reflectorization, those RIT accidents that result from a highway vehicle striking the train after the lead unit has entered the crossing (Category 1 RIT accidents) are the accidents most likely preventable by reflectorization. In particular, reflectorization is expected to be most effective in reducing nighttime Category 1 RIT accidents, which currently make up almost 70% of all Category 1 RIT accidents, despite the generally lower volume of highway traffic at night as compared to the daytime.

Although reflectorization of rail cars is expected to be most effective at nighttime, some daytime RIT accidents are also expected to be prevented, or at least mitigated, by reflectorization. Under conditions of reduced daytime visibility (e.g., inclement weather), reflectors enhance the visibility of freight cars by providing an increased visible contrast with the freight car side wall, especially when an approaching motor vehicle's headlights are turned on. During the day, other light sources (e.g., the sun), may be at an appropriate orientation to cause reflected light to be seen by the motorist.

The type of warning device at the crossing can also influence the effectiveness of reflectorization. Crossings with only passive devices, where almost 50% of all Category 1 RIT accidents occur, will benefit the most from reflectorization. Passive warning devices include signs (e.g., crossbucks, stop signs, etc.) and other statically displayed information (e.g., pavement markings) that warn motorists of the potential of a train at a crossing. Passive

devices warn motorists that tracks are present; these devices do not indicate if a train is actually approaching or in the crossing. Reflectorization of rail cars improves the visual detection of the train by making its distance and relative state of motion more quickly and accurately gauged by drivers of other vehicles.

Crossings with active warning devices (e.g., flashing lights, gates, etc.) will also receive some benefit from reflectorization. Each year over 200 accidents occur when motorists drive around lowered gates or past flashing lights and strike trains at highway-rail grade crossings. Under conditions of limited visibility, such as darkness or inclement weather, the added, unique visual signal offered by reflectors will augment the visual warning of flashing lights. The same rationale, although to a lesser extent, applies to crossings with gates. In many instances, a train standing in or passing through a crossing encompasses the motorist's entire field of view because of its size and proximity. The motorist may not see the train in the crossing because there is no contrast between the train and the surrounding environment. The motorist can look both ways, but because there is no detectable train movement, may still attempt to cross the track. Crossing warning devices, active or passive, only provide a warning to the motorist. The signal delivered by reflective material on the sides of rail cars is clear and indicates to approaching motorists the actual presence and current movement of a train in or through a crossing.

FRA also recognizes the existence of numerous other methods for reducing the occurrences of RIT accidents (e.g., the elimination of highway-rail grade crossings, installation and upgrading of crossing warning devices, crossing illumination, etc.). FRA believes that a number of these alternatives used alone and in combination, are viable methods for mitigating collision risk at highway-rail grade crossings. However, FRA also believes that reflectorization of freight rolling stock is a feasible and cost-effective method of reducing and mitigating grade crossing accidents that provides unique safety benefits not obtainable with the other grade crossing warning devices and safety measures. Obviously, the most effective way to reduce highway-rail grade crossing accidents, RIT accidents or otherwise, is to eliminate highway-rail grade crossings. Closing access to highway-rail crossings where redundant or unnecessary crossings exist or constructing grade separating overpasses where necessary is an