

warning systems in Pre-Rule Quiet Zones are upgraded, or new warning systems are installed, power-out indicators are required.

d. The gap between the ends of the entrance and exit gates (on the same side of the railroad tracks) when both are in the fully lowered, or down, position must be less than two feet if no median is present. If the highway approach is equipped with a median or a channelization device between the approach and exit lanes, the lowered gates must reach to within one foot of the median or channelization device, measured horizontally across the road from the end of the lowered gate to the median or channelization device or to a point over the edge of the median or channelization device. The gate and the median top or channelization device do not have to be at the same elevation.

e. "Break-away" channelization devices must be frequently monitored to replace broken elements.

Additionally, FRA is recommending that new installations conform to the following:

f. Gate timing should be established by a qualified traffic engineer based on site specific determinations. Such determination should consider the need for and timing of a delay in the descent of the exit gates (following descent of the conventional entrance gates). Factors to be considered may include available storage space between the gates that is outside the fouling limits of the track(s) and the possibility that traffic flows may be interrupted as a result of nearby intersections. It should be noted that the MUTCD recommends that exit gates should fail in the "up" position unless a traffic engineering study indicates otherwise.

g. A determination should be made as to whether it is necessary to provide vehicle presence detectors (VPDs) to open or keep open the exit gates until all vehicles are clear of the crossing. VPDs should be installed on one or both sides of the crossing and/or in the surface between the rails closest to the field. Among the factors that should be considered are the presence of intersecting roadways near the crossing, the priority that the traffic crossing the railroad is given at such intersections, the types of traffic control devices at those intersections, and the presence and timing of traffic signal preemption.

h. Highway approaches on one or both sides of the highway-rail crossing may be provided with medians or channelization devices between the opposing lanes. Medians should be defined by a non-traversable curb or traversable curb, or by reflectorized channelization devices, or by both. The

installation of traffic channelization increases the effectiveness of the four quadrant gates and should be considered when looking at situations where it appears that motorists may be tempted to circumvent the warning devices.

i. Remote monitoring (in addition to power-out indicators, which are required) of the status of these crossing systems is preferable. This is especially important in those areas in which qualified railroad signal department personnel are not readily available.

*Effectiveness:*

FRA estimates effectiveness as follows:

*Four-quadrant gates only, no presence detection: .82.*

*Four-quadrant gates only, with presence detection: .77.*

*Four-quadrant gates with medians of at least 60 feet (with or without presence detection): .92.*

The estimate of .82 for free-standing four-quadrant gates (no medians and no presence detection) is a highly conservative figure involving a discount from documented experience. As noted above, four-quadrant gates installed in the United States thus far have been highly successful. North Carolina Department of Transportation (NCDOT) conducted a pilot study of a four quadrant gate system at the Sugar Creek Road crossing in Charlotte, NC. Following installation of the four quadrant gates, the number of violations fell by 86 percent. Traffic channelization was added later to the four quadrant gates, reducing violations to an even greater extent, by 97 percent. During the test, the train horn was also sounding. To account for any complementary effects of the train horn, FRA uses more conservative effectiveness rates of 82 percent and 92 percent for four quadrant gates without and with medians, respectively.

Four-quadrant gate installations undertaken thus far in the United States have generally not employed vehicle presence detection (VPD). However, some future installations will incorporate this feature to ensure coordination with other traffic signals and for other purposes. For instance, tight geometry may not allow for any storage space within the gates should queuing of traffic at a STOP sign on one side of the crossing prevent prompt clearance by a motor vehicle. In such cases, leaving the exit gates in the raised position may be elected. Installing VPD will cause exit gates to remain up indefinitely as one or more vehicles pass over the crossing. Although providing VPD avoids the scenario of "entrapment" (long feared by some in

the railroad community as a liability risk), it also allows the possibility that some motorists will follow violators through the crossing in a steady stream, defeating the intended warning.

Accordingly, where traffic channelization is not provided to prevent this pattern, we assume a lower effectiveness rate. FRA estimates that four-quadrant gates with presence detection, but without traffic channelization, would have an effectiveness rate of approximately .77.

By contrast, where four-quadrant gates are supplemented by lengthy traffic channelization to discourage the violation minded driver, the use of presence detection should make little or no difference in the safety effectiveness of the arrangement. The North Carolina demonstration showed that, when the four-quadrant gate installation was supplemented by medians (channelization devices) of at least 50 feet on each highway approach, the crossing experienced a 97 percent drop in violations. Again applying a discount to this illustration, FRA estimates an effectiveness rate of .92 for four-quadrant gates with traffic channelization of reasonable length.

It is important to re-emphasize that use of data regarding violations to estimate collision risk itself involves some hazard that effectiveness will be over- or under-estimated. FRA believes that the likelihood is that these estimates for four-quadrant gates are conservative, not only because of the excellent effectiveness of in-service four-quadrant installations, but also because of the North Carolina findings. In the North Carolina observations, as the number of violations decreased, the average number of seconds prior to arrival of the train also significantly increased (predicting that collisions might fall off at a faster rate than violations). The effectiveness of four-quadrant gates may thus be higher than the range stated above, both with and without medians and with presence detection.

It is also true that a variety of applications for these systems may result in a variety of effectiveness rates.

### 3. Gates With Medians or Channelization Devices

Keeping highway traffic on both highway approaches to a public highway-rail grade crossing in the proper lane denies the highway user the option of circumventing gates in the approach lanes by switching into the opposing (oncoming) traffic lane in order to drive around a lowered gate to cross the tracks.