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passive STOP sign crossing to a crossing equipped with flashing lights and gates. Unlike New Quiet Zones, upgrades to warning devices in Pre-Rule Quiet Zones do contribute to the risk reduction necessary to qualify under the rule. Table 6 shows the quiet zone corridor after including the warning device upgrade at Z Street. The Quiet Zone Risk Index has been reduced to 29,500.

Table 6

<table>
<thead>
<tr>
<th>Street</th>
<th>Crossing risk index w/o horns</th>
<th>Crossing risk index w/ horns</th>
<th>SSM EFF</th>
<th>Crossing risk index w/ horns plus SSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>35,000</td>
<td>20,983.21</td>
<td>0</td>
<td>35,000</td>
</tr>
<tr>
<td>X</td>
<td>42,000</td>
<td>25,179.86</td>
<td>0</td>
<td>42,000</td>
</tr>
<tr>
<td>Y</td>
<td>33,500</td>
<td>20,083.93</td>
<td>0</td>
<td>33,500</td>
</tr>
<tr>
<td>Z</td>
<td>7,500</td>
<td>8,576.33</td>
<td>0</td>
<td>7,500</td>
</tr>
<tr>
<td>RIWH</td>
<td>18,705.83</td>
<td></td>
<td></td>
<td>29,500</td>
</tr>
</tbody>
</table>

(e) The public authority elects to install four-quadrant gates without vehicle presence detection at X Street. As shown in Table 7, this reduces the Quiet Zone Risk Index to 20,890. This risk reduction is not sufficient to qualify as quiet zone under the rule.

Table 7

<table>
<thead>
<tr>
<th>Street</th>
<th>Crossing risk index w/o horns</th>
<th>Crossing risk index w/ horns</th>
<th>SSM EFF</th>
<th>Crossing risk index w/ horns plus SSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>35,000</td>
<td>20,983.21</td>
<td>0.82</td>
<td>35,000</td>
</tr>
<tr>
<td>X</td>
<td>42,000</td>
<td>25,179.86</td>
<td>0</td>
<td>7,560</td>
</tr>
<tr>
<td>Y</td>
<td>33,500</td>
<td>20,083.93</td>
<td>0</td>
<td>33,500</td>
</tr>
<tr>
<td>Z</td>
<td>7,500</td>
<td>8,576.33</td>
<td>0</td>
<td>7,500</td>
</tr>
<tr>
<td>RIWH</td>
<td>18,705.83</td>
<td></td>
<td></td>
<td>20,890</td>
</tr>
</tbody>
</table>

(f) The public authority next decides to use traffic channelization devices at W Street. Table 8 shows that the Quiet Zone Risk Index is now reduced to 14,327.5. This risk reduction fully compensates for the loss of the train horn as it is less than the Risk Index with Horns. The quiet zone is qualified under the rule.

Table 8

<table>
<thead>
<tr>
<th>Street</th>
<th>Crossing risk index w/o horns</th>
<th>Crossing risk index w/ horns</th>
<th>SSM EFF</th>
<th>Crossing risk index w/ horns plus SSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>35000</td>
<td>20983.21</td>
<td>0.75</td>
<td>8750</td>
</tr>
<tr>
<td>X</td>
<td>42000</td>
<td>25179.86</td>
<td>0.82</td>
<td>7560</td>
</tr>
<tr>
<td>Y</td>
<td>33500</td>
<td>20083.93</td>
<td>0</td>
<td>33500</td>
</tr>
<tr>
<td>Z</td>
<td>7500</td>
<td>8576.33</td>
<td>0</td>
<td>7500</td>
</tr>
<tr>
<td>RIWH</td>
<td>18705.83</td>
<td></td>
<td></td>
<td>14327.5</td>
</tr>
</tbody>
</table>

APPENDIX D TO PART 222—DETERMINING RISK LEVELS

INTRODUCTION

The Nationwide Significant Risk Threshold, the Crossing Corridor Risk Index, and the Quiet Zone Risk Index are all measures of collision risk at public highway-rail grade crossings that are weighted by the severity of the associated casualties. Each crossing can be assigned a risk index.

(a) The Nationwide Significant Risk Threshold represents the average severity weighted collision risk for all public highway-rail grade crossings equipped with lights and gates nationwide where train horns are routinely sounded. FRA developed this index to serve as a threshold of permissible risk for quiet zones established under this rule.
The Crossing Corridor Risk Index represents the average severity weighted collision risk for all public highway-rail grade crossings along a defined rail corridor. The Quiet Zone Risk Index represents the average severity weighted collision risk for all public highway-rail grade crossings that are part of a quiet zone.

**The Prediction Formulas**

(a) The Prediction Formulas were developed by DOT as a guide for allocating scarce traffic safety budgets at the State level. They allow users to rank candidate crossings for safety improvements by collision probability. There are three formulas, one for each warning device category:

1. automatic gates with flashing lights;
2. flashing lights with no gates; and
3. passive warning devices.

(b) The prediction formulas can be used to derive the following for each crossing:

1. the predicted collisions (PC)
2. the probability of a fatal collision given that a collision occurs (P(FC|C))
3. the probability of a casualty collision given that a collision occurs (P(CC|C))

(c) The following factors are the determinants of the number of predicted collisions per year:

1. average annual daily traffic
2. total number of trains per day
3. number of highway lanes
4. number of main tracks
5. maximum timetable train speed
6. whether the highway is paved or not
7. number of through trains per day during daylight hours

(d) The resulting basic prediction is improved in two ways. It is enriched by the particular crossing’s collision history for the previous five years and it is calibrated by resetting normalizing constants. The normalizing constants are reset so that the sum of the predicted accidents in each warning device group (passive, flashing lights, gates) for the top twenty percent most hazardous crossings exactly equals the number of accidents which occurred in a recent period for the top twenty percent of that group. This adjustment factor allows the formulas to stay current with collision trends. The calibration also corrects for errors such as data entry errors. The final output is the predicted number of collisions (PC).

(e) The severity formulas answer the question, “What is the chance that a casualty collision will happen, given that a collision has occurred?” The fatality formula calculates the probability of a fatal collision given that a collision occurs (i.e., the probability of a collision in which a fatality occurs) (P(FC|C)). Similarly, the casualty formula calculates the probability of a casualty collision given that a collision occurs (P(CC|C)). As casualties consist of both fatalities and injuries, the probability of a non-fatal injury collision is found by subtracting the probability of a fatal collision from the probability of a casualty collision. To convert the probability of a fatal or casualty collision to the number of expected fatal or casualty collisions, that probability is multiplied by the number of predicted collisions (PC).


**Risk Index**

(a) The risk index is basically the predicted cost to society of the casualties that are expected to result from the predicted collisions at a crossing. It incorporates three outputs of the DOT prediction formulas. The two components of a risk index are:

1. Predicted Cost of Fatalities = PC × (Average Number of Fatalities Observed in Fatal Collisions) × $3 million
2. Predicted Cost of Injuries = PC × (P(CC|C)−P(FC|C)) × (Average Number of Injuries in Collisions Involving Injuries) × $1,167,000

PC, P(CC|C), and P(FC|C) are direct outputs of the DOT prediction formulas.

(b) The average number of fatalities observed in fatal collisions and the average number of injuries in collisions involving injuries are calculated by FRA as described in paragraphs (c) through (e).

(c) FRA will match the highway-rail incident files for the past five years against a data file containing the list of grade crossings where the train horn was not routinely sounded over that five-year period to identify two types of collisions involving trains and motor vehicles: (1) Those that occurred at crossings where the train horn was not routinely sounded during the period, and (2) those that occurred at crossings equipped with automatic gates where the train horn was routinely sounded. Certain records will be excluded, including records pertaining to incidents where the driver was not in the motor vehicle or where the motor vehicle struck the train beyond the fourth locomotive or rail car that entered the crossing. FRA believes that sounding the train horn would not be very effective at preventing such incidents.¹

¹The data used to make these exclusions is contained in blocks 18—Position of Car Unit in Train; 19—Circumstance: Rail Equipment

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Continued
(d) Collisions in the group containing the gated crossings nationwide where horns were routinely sounded will then be identified as fatal, injury only or no casualty. Collisions will be identified as fatal if one or more deaths occurred, regardless of whether injuries were also sustained. Collisions will be identified as injury only when injuries, but no fatalities, resulted.

(e) The collisions (incidents) will be summarized by year for the five-year period preceding the year in which the risk index is being updated. The fatality rate for each year will be calculated by dividing the number of fatalities by the number of fatal incidents. The injury rate will be calculated by dividing the number of injuries in injury only incidents by the number of injury only incidents. FRA will publish updated fatality and injury rates on an annual basis in the Federal Register.

(f) Per guidance from DOT, $3 million is the value placed on preventing a fatality. The Abbreviated Injury Scale (AIS) developed by the Association for the Advancement of Automotive Medicine categorizes injuries into six levels of severity. Each AIS level is assigned a value of injury avoidance as a fraction of the value of avoiding a fatality. FRA rates collisions that occur at train speeds in excess of 25 mph as an AIS level 5 ($2,297,500) and injuries that result from collisions involving trains traveling under 25 mph as an AIS level 2 ($46,500). About half of grade crossing collisions occur at speeds greater than 25 mph. Therefore, FRA estimates that the value of preventing the average injury resulting from a grade crossing collision is $1,167,000 (the average of an AIS-5 injury and an AIS-2 injury).

(g) Notice that the quantity \(PC\times\{P(CC|\mathcal{C})-P(FC|\mathcal{C})\}\) represents the expected number of fatalities. Similarly, \(PC\times\{P(CC|\mathcal{C})-P(FC|\mathcal{C})\}\) represents the expected number of injury collisions. These are then multiplied by their respective average number of fatalities and injuries (from the table above) to develop the number of expected casualties. The final parts of the expressions attach the dollar values for these casualties.

(h) The Risk Index for a Crossing is the integer sum of the Predicted Cost of Fatalities and the Predicted Cost of Injuries.

NATIONWIDE SIGNIFICANT RISK THRESHOLD

The Nationwide Significant Risk Threshold is simply an average of the risk indexes for all of the gated public crossings nationwide where train horns are routinely sounded. This value will be recalculated annually and published in a notice in the Federal Register. For the most recent value of the Nationwide Significant Risk Threshold, please visit FRA’s public Web site at http://www.fra.dot.gov.

CROSSING CORRIDOR RISK INDEX

The Crossing Corridor Risk Index is the average of the risk indexes of all the public crossings in a defined rail corridor.

QUIET ZONE RISK INDEX

The Quiet Zone Risk Index is the average of the risk indexes of all the public crossings in a Quiet Zone. It takes into consideration the absence of the horn sound and any safety measures that may have been installed.

[71 FR 47634, Aug. 17, 2006, as amended at 72 FR 44792, Aug. 9, 2007]

APPENDIX E TO PART 222—REQUIREMENTS FOR WAYSIDE HORNS

This appendix sets forth the following minimum requirements for wayside horn use at highway-rail grade crossings:

1. Highway-rail crossing must be equipped with constant warning time device, if reasonably practical, and power-out indicator;

2. Horn system must be equipped with an indicator or other system to notify the locomotive engineer as to whether the wayside horn is operating as intended in sufficient time to enable the locomotive engineer to sound the locomotive horn for at least 15 seconds prior to arrival at the crossing in the event the wayside horn is not operating as intended;

3. The railroad must adopt an operating rule, bulletin or special instruction requiring that the train horn be sounded if the wayside horn indicator is not visible approaching the crossing or if the wayside horn indicator, or an equivalent system, indicates that the system is not operating as intended;

4. Horn system must provide a minimum sound level of 92 dB(A) and a maximum of 110 dB(A) when measured 100 feet from the centerline of the nearest track;

5. Horn system must sound at a minimum of 15 seconds prior to the train's arrival at the crossing and while the lead locomotive is traveling across the crossing. It is permissible for the horn system to begin to sound simultaneously with activation of the flash lights or descent of the crossing arm; arm;

6. Horn shall be directed toward approaching traffic.

APPENDIX F TO PART 222—DIAGNOSTIC TEAM CONSIDERATIONS

For purposes of this part, a diagnostic team is a group of knowledgeable representatives of parties of interest in a highway-rail grade crossing accident/incident.