Development of a County Grade Crossing Protection Program

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INTRODUCTION

There has been an emphasis in recent years, under the leadership of the Department of Transportation, on increasing highway safety wherever possible. Why this emphasis? A major reason appears to be an awakening of the public and the government that this nation, with its great wealth and technical knowledge can no longer ignore an annual 53,000 plus vehicle-oriented fatalities and 1,900,000 disabling injuries involving a cost of over $10 billion (National Safety Council 1967 Statistics).

It is easy to rationalize and point out that the death rate per 100 million vehicle miles is decreasing—but the actual number is not decreasing. These figures are not going to be decreased overnight regardless of the magnitude of the program. However, it is going to take increased effort to keep these figures from increasing annually.

The problem of highway-railway grade crossing accidents has been singled out for an intensive attack on all contributing factors. There is a general feeling among safety experts that grade crossing safety would respond well to modern technology within reasonable costs. Several current studies of grade crossing safety were initiated in support of the President's message of March 2, 1966, urging all federal agencies to improve highway safety wherever possible.

The Department of Transportation sought the cooperation of the Federal Rail Administration and the Federal Highway Administration, to focus normally divergent views on this issue. Since a great percentage of grade crossings are not located on federal-aid highways and therefore are not eligible for federal funds, and since the problem of cost allocation is a tremendous problem yet to be solved; the department recognized the need for a safety program that was not "just another expensive federal project". The emphasis is on a program that will allow local implementation with a minimum amount of money. A program that will find solutions that will fit into city and county budgets.²
DOT ACTION PROGRAM

In August 1967, the Secretary of Transportation directed the federal highway and federal railroad administrators to undertake a joint program for reduction of hazards at railway-highway grade crossings. He defined an eleven-point immediate action program aimed at those aspects of the problem that can be tackled immediately and will offer immediate results. The program included provisions for:6

1. Establishing an accurate inventory of all rail-highway grade crossings, and diagnostic teams to consider on-the-site improvements,
2. Implementing an action program for an intensive study of protection at selected crossings,
3. Encouraging the railroads to rehabilitate existing protective devices and sites under their jurisdiction,
4. Identifying “high hazard” crossing due to heavy traffic vehicles such as tank trucks,
5. Improving accident data collection and enforcement,
6. Identifying crossings frequently used by school busses, and working with school officials to reroute buses or improve signals,
7. Examining the possibility of closing or limiting the use of some crossings,
8. Studying current motor carrier safety regulations pertaining to mandatory stopping of certain vehicles,
9. Intensifying the accident investigation programs of the Bureau of Motor Carrier Safety and the Bureau of Railroad Safety,
10. Undertaking a research and development program to come up with more and better protective measures and devices, and
11. Initiating a study to determine the logical sharing of responsibility.

Local Action

On January 5, 1968, the Bureau of Public Roads issued Instructional Memorandum 21-1-68, to its field offices in each state containing inventory and action guidelines for implementing the program. A complete up-to-date inventory of all grade crossings on the federal-aid system was required. States were further encouraged to expand their inventories to include all public road crossings of railroads at grade.

The State of Indiana, through the highway commission, took prompt action. The inventory and field investigation were completed and a program to improve grade crossing deficiencies and upgrade pro-
tection is now under way. Great effort has gone into this much-needed program and, hopefully, it will achieve great results.

To put things into proper perspective, accidents at railroad grade crossings actually account for less than 0.1 percent of all motor vehicle accidents. However, they do account for about 2.5 to 3 percent of the deaths. In Indiana, in the period 1965-1968, grade crossing accidents have accounted for 0.4 percent of all reported motor vehicle accidents and 6 percent of all highway deaths, double the national average. In the years 1963-1967, Indiana has been near the top, no lower than 5th highest in the nation, in total grade crossing casualties, and was 3rd highest in 1965 exceeded only by California and Illinois.

The severity of train-vehicle accidents is generally a well publicized fact. The death rate per accident is about 15 times greater than it is for highway accidents. The potential for tragic loss of life—such as a school bus being ripped apart—is ever present and is certainly a cause for public concern.

RESULTS OF PREVIOUS PROGRAMS

There is evidence to support the statement that grade crossing safety would respond well to modern technology. The following data and charts are from the U.S. Department of Transportation. Report of the Joint Action Group on Grade Crossing Safety of the Federal Highway Administration and the Federal Railroad Administration, March, 1969. If we study the year-by-year casualties resulting from highway-railway grade crossing accidents, for the 48-year period from 1920 through 1967, there are two noticeable trends. These can be seen in Fig. 1.

Over the 48-year period the general trend in casualties has been downward, but for the years since 1958, the trend has been upward.

Casualties vs. Traffic Movements

Although there are a great number of variables, it is generally accepted that grade crossing casualties are closely related to traffic movements. Fig. 2 shows the parallel downward trend of train miles and casualties from 1920 to 1958, whereas since 1958 the upward trend in casualties has followed the general upward trend in motor vehicle miles.

Fig. 3 simply shows the close relationship between the total number of casualties in grade crossing accidents and number of casualties in grade crossing accidents involving motor vehicles. It is currently (1967) 96 percent whereas in 1920 it was 26 percent.
Fig. 1. Record of Casualties Resulting from Highway-Railroad Grade Crossing Accidents. (11)
Fig. 2. Grade Crossing Casualties Related to Traffic Movements. (11)

Exposure Factor

In Fig. 4, grade crossing casualties are related to an exposure factor where:

\[
\text{Exposure Factor} = \frac{\text{Train Miles} \times \text{Motor Vehicle Miles}}{10^{18}}
\]

it can be seen that the general trend of the exposure factor is upward. Except for the past few years, where the two lines closely parallel each other upward, the general trend of the casualty line was downward, even though that of the exposure factor was upward.
Fig. 3. Total Grade Crossing Casualties Related to those Involving Motor Vehicles. (11)
Fig. 4. Grade Crossing Casualties Related to Exposure Factor. (11)

**Casualty Factor**

One reason for this apparent contradiction can be seen from studying the history of the highway-railway grade crossing safety programs, in terms of a casualty ratio, where:

\[
\text{Casualty Ratio} = \frac{\text{Number of Casualties (Each Year)}}{\text{Exposure Factor (Corresponding Year)}}
\]
as shown on Fig. 5. Following the casualty ratio brings out some interesting relationships. In 1920 the casualty ratio was 98.3. By 1967 it had declined to 9.4. One of the sharpest declines was in the period 1920-1930, where in 1930, the casualty ratio dropped to 30.4, only

Fig. 5. Historical Phases of Highway-Railroad Grade Crossing Safety Programs. (11)
31 percent of the 1920 figure. Certainly, one of the most important factors in this decline was the extensive program of grade separations and grade crossing protection carried out during this decade when railroad expenditures for improvements were very high.

After 1930, there was a four-year period when almost nothing was done in grade crossing improvement work and the casualty ratio did not improve during this four-year period. This leveling off period is indicated on figure 5 by circled number 1.

Starting in 1935 when some federal programs were initiated, there was again a significant improvement in the casualty ratio.

During the war period of the early 1940's, when grade crossing improvement work was stopped, improvement in the casualty ratio likewise stopped. Note circled number 2 in figure 5.

Between 1945 and 1958 the grade crossing work was resumed and the casualty ratio was reduced another 52 percent.

Current Trends

Since 1958, when the general trend of grade crossing accidents turned upward, there has been little improvement in the casualty ratio in spite of the fact that grade separation and grade crossing protection programs have continued under the Federal Highway Acts. Note circled number 3 on figure 5.

The report draws two significant conclusions from the above facts:

1. "Grade separation and grade crossing protection programs have resulted in a marked decrease in highway-railroad grade crossing casualties. If the casualty ratio in 1967 had been the same as it was in 1920, the grade crossing casualties in accidents involving motor vehicles in 1967 would have been about 55,000 instead of 5,246, and;

2. Since 1958, the trend of grade crossing casualties has been upward and the casualty ratio has not been improved, thus indicating that more effort is now necessary in order to bring about a reduction in casualties in the face of rapidly increasing motor vehicle traffic."

During the period from 1963 to 1967, the federal government spent about $160 million annually on grade crossing improvements. Yet this is a very modest amount compared with that spent on safety in aviation, even though more people were killed each year of this period at grade crossings than in all types of aviation accidents. Grade
crossing fatalities are also larger than deaths from all maritime activities in this country, including recreational boating.\textsuperscript{5}

**PRESENT NEEDS AND OBJECTIVES**

What should the goal be? Would zero casualties be a realistic goal? What are the costs? This goal could possibly be achieved by separating all of the approximately 225,000 public highway-railway grade crossings in the U.S. It has been estimated that this would cost over $100 billion, close to twice the amount of federal funds spent on all highway programs since World War I.\textsuperscript{5}

In Indiana alone, it has been estimated that it would cost $5 billion to construct grade separations at all grade crossings. An alternative of installing modern flashing lights with short-arm gates at all grade crossings in the state would cost in excess of $150 million.\textsuperscript{6}

Obviously, these amounts cannot be spent without destroying or shorting other programs of equal or greater importance to the safety and welfare of the public. Also, we must keep in mind that, as bad as they are, grade crossing accidents account for only 3 percent of the total national highway fatalities.

**Realistic Goals**

Our proper goal then must be the reduction of casualties by means that provide the greatest possible accident reduction for a given expenditure of money. All available money must be spent in such a way as to achieve the greatest benefit in reduction of casualties and economic loss.

The two most obvious values of a grade crossing program are:

1. The establishment of priorities of dangerous crossings so that any improvement program can be based on rational engineering judgment, and,
2. The finding of numerous minor deficiencies that can be corrected by routine maintenance at low cost.

In this way, available money can be spent so as to do the most good—to save the most lives. Thus, the inventory, followed by a field investigation, are essential steps in any program to increase grade crossing safety.

**Common Deficiencies**

The recently completely on-site investigation of all crossings of roads on the Indiana state highway system noted several deficiencies:\textsuperscript{12} absence of standard pavement markings and advance warning
signs; highway signs located between the advance warning signs and
the crossing which obstructed the view of the grade crossing protec-
tion; crossings of inadequate width of approach; chuck holes and
deteriorated pavement on approach to crossings; extremely poor con-
dition of many painted crossbucks; crossbucks mounted on discarded
rails; steel rails to protect signals located close to pavement edge;
humped crossings; general lack of proper maintenance in the crossing
area; and others.

Inadequate sight distance is probably one of the most common
deficiencies. The importance of adequate sight distance cannot be
overemphasized.

PROVIDING ADEQUATE SIGHT DISTANCE

In a recent, comprehensive study of grade crossing safety, Alan
M. Voorhees and Associates, Inc. studied over 7500 grade cross-
tings.8 In the Voorhees report it was pointed out that the major
safety problem at crossings is caused by trains which become known
to the driver approaching the crossing after the driver has passed his
final opportunity to stop. In other words, poor sight distance.

Fig. 6 shows the distances associated with proper sight distances
at a crossing. At given highway and railway speeds a driver should
have certain minimum clear sight distances while he is still far enough
from the crossing to take action.

Providing clear sight distance is extremely important. Likewise,
where sight distances are unavoidably restricted, there is an obligation
to convey this information to the driver by adequate advance warning
signs. In Indiana, county commissioners have a definite responsibility for
installation, maintenance and replacement of advance warning signs
(Burns 55-2009, 55-2010).

Three Sight Distances to Consider

There are three sight distances associated with a grade crossing
that are important to an approaching driver.8

The first distance is associated with visibility of the crossing itself.
It is the distance ahead that a crossing is visible to the driver, con-
trolled by the vertical and horizontal highway alinement and topog-
raphy. The value of any crossing protection is dependent on this dis-
tance, and when this distance is unavoidably less than the safe stop-
ing distance, particular attention must be given to adequate advance
warning signs. The distance is shown as SD1 on figure 6.

The second sight distance which is of importance is the quadrant
visibility. After the driver is aware of an existing crossing ahead, he must be able to observe the approach of a train from either direction. If a train is approaching he must be aware of its approach when he is far enough from the crossing to make a safe stop. This distance is shown by $SD_2$ on figure 6.

The third distance pertains to the condition where a driver must stop at a crossing because it is controlled by a stop sign, or required to

\[SD_1 = \text{SAFE STOPPING SIGHT DISTANCE}\]

\[SD_2 = \text{DISTANCE ALONG TRACK SUCH THAT VEHICLES TRAVELING AT SPEED LIMIT CAN BEAT TRAIN FROM POINT A OR STOP}\]

\[SD_3 = \text{DISTANCE DOWN TRACK SUCH THAT TRAIN CANNOT ARRIVE IN LESS THAN 11.0 SECONDS}\]

Fig. 6. Illustration of Sight Distance. [After Schoppert (8)]
stop by law, or some other reason. In this case he must be able to see a sufficient distance along the track to allow him to proceed safely across. This distance is of particular importance for a slow moving vehicle such as a heavily loaded, or large truck. This distance is shown as SD3 on figure 6.

Determining Adequate Sight Distances

The sight distance SD1 is dependent on the highway speed limit and the maximum reasonable speed at which vehicles travel should govern.

The sight distance SD2 is dependent on both train and highway speeds and, knowing the highway speed and the train speed, the required design sight distances can be determined. These are shown in Table 1 and are based on the following assumptions:\(^8\)

1. Safe stopping sight distance from
   A Policy on Geometric Design of Rural Highways.
2. A 50-ft design vehicle.
3. Ten feet of clearance, both in advance and beyond the crossing, plus 15-ft length of crossing, for a total crossing width of 35 ft.
4. Due to possible rough conditions and limited acceleration capabilities of C 50 vehicles, a maximum speed of 10 mph or an average speed of 5 mph (at this average speed it takes 11 sec for a 50-ft truck to pass over the crossing and clear the other side by 10 ft).

Sight distance SD3 is dependent on train speed and maximum train speed should be used.
TABLE 1  REQUIRED DESIGN SIGHT DISTANCES FOR COMBINATIONS OF TRAIN AND HIGHWAY VEHICLE SPEEDS* [AFTER SCHAPPERT8]

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DISTANCE ON HIGHWAY FROM CROSSING (FT)

| 20 | 65 | 95 | 125 | 165 | 215 | 270 | 330 | 395 | 470 | 560 | 640 | 745 | 840 | 965 |

*For one track, and level gradient.
### TABLE 2 MINIMUM SIGHT DISTANCE REQUIREMENTS FOR "NORMAL" CONDITIONS.
(NOT TO BE USED FOR DESIGN) [AFTER SCHOPPERT^8]

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| DISTANCE ON HIGHWAY FROM CROSSING (FT) | 15 | 20 | 35 | 50 | 70 | 90 | 115 | 145 | 175 | 210 | 250 | 300 | 350 | 405 | 465 |
The values in Table 1 are design values. In checking existing crossings for adequacy, particularly on the county highway system, it is likely that very few crossings will meet these standards. In fact, in most cases it will probably be impractical to attempt to obtain these distances at existing crossings or to judge their adequacy by these distances. This fact was apparently recognized in the Voorhees report and another table was developed for adequate, minimum sight distances.

The values in Table 2 for minimum sight distances were developed on the following set of assumptions.8

1. Perception-reaction time of 1 sec.
2. Dry pavement
3. Passenger car (making length of vehicle plus clearance 40 ft instead of 85)
4. Normal acceleration ability of a passenger car.

The values presented in Table 2 are 22 to 48 percent of those in Table 1, and are more liberal in evaluating the adequacy of an existing crossing.8

Caution Regarding Truck Traffic

It should be emphasised that because of assumption three and four, based on passenger car length and passenger car acceleration, these distances may not be adequate and could possibly be dangerous where a grade crossing has truck traffic. Based on a 60 mph train speed and 50 mph highway speed and assumptions of average conditions of deceleration and acceleration, lengths, etc., the following comparisons were made in the Voorhees' report,8

1. Total distance to stop (when approaching crossing)
   passenger car 251 ft
   truck 354 ft
2. Total distance to beat train (when starting from a standing stop at crossing)
   passenger car 292 ft
   truck 442 ft

Note particularly the large distances (SD3 in figure 6) required for a safe crossing of an average truck from a standing stop. This fact also must be considered in the use of stop signs and when considering or evaluating laws regarding mandatory stopping of certain vehicles at crossings.

Sight Distance Example

An example from Table 2:

Highway speed = 50 mph; Train speed = 60 mph
Required sight distance = 642 ft along track when the driver is 470 ft from the crossing.

Summary

In summary, the crossing ahead must be visible to the driver while he has adequate time to stop safely. When the crossing is visible to the driver, he must have adequate sight distance along the railroad track in both quadrants to stop safely in the event a train is approaching. After a driver has stopped at a crossing for a stop sign or mandatory stop, he must have sufficient sight distance along the tracks to proceed safely across the tracks. All sight distances must be compatible with vehicle approach speeds and train speeds. The importance of providing adequate sight distance cannot be emphasized enough. It is possibly the most important single factor in grade crossing safety in rural areas.

LOCAL CONDITIONS AND OTHER DEFICIENCIES

A typical finding of field investigations throughout this State and throughout the country is that sight distances are inadequate and advance warning signs are in poor condition, non existant or inadequate. Certainly here is an example of an area where much good can be done without the expenditure of great sums of money.

Just a few days ago, this writer spent a few hours looking at some county highway grade crossings in four or five of the counties surrounding Lafayette. These counties are not being singled out intentionally. Other counties all over the state have similar situations and problems. The most significant point is that it is possible, in only a few hours of inspecting crossings at random to find a great number of obvious deficiencies.

Figures 7 through 12 are typical of the deficiencies noted at numerous locations. Several pictures of each type could have been taken.

SUCCESS OF AN ACTION PROGRAM

A fairly recent article (February 1967) in Rural and Urban Roads reports similar findings in Spokane County, Washington. The following paragraph from that article is quite informative in this regard. It also shows that conditions can be corrected.

"As the information started to flow in there was no difficulty in finding things which could be done immediately to improve crossing safety. Field checks indicated that fully one-third of the crossings were improperly signed and not in accordance with the
Manual on Uniform Traffic Control Devices. Advance warnings signs (W10-1) were found to be missing, too close to the crossing, obscured by brush, or vandalized beyond use. The sign department was set to work correcting these sign deficiencies as they were located. Many of the railroad crossbuck signs were found in sore
neglect and these were reported to the railroad companies. Their cooperation and quick response in fixing the signs was encouraging.

"Sight obstructions were the next immediate problem. Obstructions located on either road or railroad right-of-ways were surprisingly few. These were removed by the responsible agency. The problems of private ownership were another matter. These were rife with obstructions of every shape, size and degree of permanency. Right-of-way agents were sent out to contact the owners. When the problem was explained, the vast majority were very cooperative, entering into agreements to keep trees and shrubs
trimmed, to remove fences and even sheds and to give permission for the county to remove the more awkward objects such as large trees, signs and poles."

It is effort of this type, without the expenditure of great sums of money, that are probably most applicable to Indiana's rural areas.

It will be the prerogative of the county commissioners's to decide whether or not to implement an improvement program, to what extent, and what format this program should have. Referring once
again to the article mentioned above, the program established in this case, appears to have merit. It is as follows:

Outline of the Program

"A complete report of the study and a recommended 10-year program of grade crossing improvement were presented to the board
of county commissioners. The report included the following recommendations:

1. Adopt a long-range improvement program for railroad grade crossings.
2. Present the program to the railroad companies involved at a combined meeting with the board.
3. Acquaint the Washington Utilities and Transportation Commission with the program and invite their representation at the meeting proposed above.
4. Attempt to develop formal agreements with each of the railroad companies covering:
   a. All the crossings in the program.
   b. Schedules of construction.
   c. Maintenance agreement.
   d. Financial participation
5. Continue the study of crossing safety through investigation of:
   a. Public observance of warning devices.
   b. Washington State statutes regarding crossing safety.
6. Encourage the railroad companies to instigate train-crew reports on “near miss” incidents as recommended by the American Railroad Engineers Association.
7. Encourage a policy of strong enforcement of existing crossing safety statutes.
8. Make every attempt to educate the public of the hazards of poor grade crossing habits.”

PROPOSED PROGRAM FOR INDIANA COUNTIES

Regardless of the program format, after existing conditions are known, priorities can be established so that available funds can be used to improve protection at the most hazardous locations, as well as correct minor deficiencies.

It is generally agreed among experts that the relative hazard of a number of grade crossings can be determined by a factor, generally called a hazard index. This index is an empirical formula that contains a number of factors which correlate with grade crossing accidents. There are many such formulas that give slightly different answers, but any one of them can be expected to rank a group of crossings as to hazard with the same relative listing.

In the Voorhees study it was found that the average accident rate was less than one accident per crossing every ten years.8 In general, if a grade crossing were to have one, or even two accidents
this week, this is no indication that this means that it will have another accident next week, next year, or even in the next 10 or 20 years. The point is, a sound accident improvement program cannot be based on accidents alone!

With the inventory information in hand, with deficiencies noted, and with all crossings rated as to their relative hazard, it is then possible to implement a sound, long-range improvement program using a rational approach instead of one based on intuition, subjective warrants, or emotional outcries. For it is only after finding out what conditions you have that a plan of attack based on reasonable distribution of available funds can be formulated.

The program proposed for all county highway grade crossings essentially follows the same lines as the state’s program. Let me now outline this program.

Inventory

An inventory of all county highway grade crossings has been compiled by the HERPIC staff. The latest available information has been obtained from several sources through the cooperation of the Indiana State Highway Commission. Initiately, the state’s inventory cards were searched for a listing of all crossings in each county, and the protection at the crossing. This information is contained on the back of the cards, as shown in figure 13. HPS (highway planning survey) numbers were matched with each crossing. Then their appropriate location was found and delineated on a county map, as shown in figure 14.

**BRIDGES**

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<tr>
<th>BRIDGE NO.</th>
<th>CONDITION</th>
<th>TYPE</th>
<th>LENGTH</th>
<th>CLEARANCE</th>
<th>STREAM HEIGHT</th>
<th>NO SPANS</th>
<th>MATERIAL</th>
<th>SAFE LOAD</th>
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<td>G</td>
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<td>5</td>
<td>1 S</td>
<td>C</td>
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<td>T.F.T.</td>
<td>139</td>
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<td>10</td>
<td>S</td>
<td>C</td>
<td>Elkhart River</td>
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</table>

**RAILROAD CROSSINGS**

<table>
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<th>CROSSING NUMBER</th>
<th>RAILROAD</th>
<th>MAIN TRACKS</th>
<th>OTHERS</th>
<th>Passenger Trains</th>
<th>Freight Trains</th>
<th>PROTECTION</th>
<th>No Accidents</th>
<th>FACTOR</th>
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<tbody>
<tr>
<td>35</td>
<td>N.Y.C.</td>
<td>2</td>
<td></td>
<td>2 M.S.</td>
<td>1 X Bucks</td>
<td>2 Warn Signs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 13. Source of Railroad Grade Crossing Inventory Data.
Fig. 14. Adams County Map With HPS Numbers Denoting Grade Crossings.

By using the latest maps all FAS routes with grade crossings were noted and by examining ISHC traffic survey maps and data from the planning section, the latest average daily traffic counts were found for all grade crossings on the federal-aid system. Unfortunately
Fig. 15. Explanatory Notes from Computer Printout.

Traffic data is not available for non federal-aid routes and could not be included. Railroad ADT’s were obtained from the ISHC inventory of state grade crossings prepared by the railroad section.

It can be seen from Figure 15 of explanatory notes, and as indicated above, that a great quantity of data was obtained from several sources. This was cross checked whenever possible. The inventory phase of a county highway railroad grade crossing program is essentially complete or is at least compiled to a stage where it could be easily completed. All available data, after being compiled, was coded, punched on data cards and reproduced as shown here as computer output. The 13 headings and a brief explanation are presented below.

**Headings**

- **(1)** HPS
- **(2)** KEY
- **(3)** INVEN
- **(4)** FAS
- **(5)** FUNCT
- **(6)** X-ING
- **(7)** MAP
- **(8)** ROUTE
- **(9)** ROUTE
- **(10)** CLASS
- **(11)** PROTECT
- **(12)** SIGN
- **(13)** NO.

**Legend of abbreviations**

- **(1)** HPS = HPS KEY INVEN.
- **(2)** KEY = KEY.
- **(3)** INVEN = INVEN.
- **(4)** FAS = FAS.
- **(5)** FUNCT = FUNCT.
- **(6)** X-ING = X-ING.
- **(7)** MAP = MAP.
- **(8)** ROUTE = ROUTE.
- **(9)** ROUTE = ROUTE.
- **(10)** CLASS = CLASS.
- **(11)** PROTECT = PROTECT.
- **(12)** SIGN = SIGN.
- **(13)** NO. = NO.

**Explanation**

- **Headings**
- **Legend of abbreviations**

---

All available data, after being compiled, was coded, punched on data cards and reproduced as shown here as computer output.
Column 1. *HPS X-ING NO.*, contains numbers that were assigned some time ago to all grade crossings in the State. In recent years these numbers have not been kept up as they are being superceded in the planning section by log mile numbers. For this reason, not all crossings can be given a number. However, since these are useful as a simple reference, it was decided to use them.

Column 2. *KEY MAP LOC*, contains location of crossings that do not have an HPS number. The location in this column refers to the County Road Inventory Key Map by ISHC.

Column 3. *INVEN ROUTE NO.*, is also from the County Road Inventory Key Map by ISHC.

Column 4. *FAS ROUTE NO.*, is from the County Federal Aid Route Map by ISHC. The non-federal aid routes are designated in this column as NFA.

Column 5. *FUNCT CLASS*, is left for the counties to designate the functional classification of the route. This designation may become increasingly more important in future years.

Column 6. *X-ING PROTECT*, contains the data on the back of the inventory cards on file for each route by ISHC. Copies of these cards are available to the counties for a nominal copying fee and contain much valuable information in addition to railroad crossing data.

Column 7. *STOP SIGN NO.*, indicates whether or not there is a stop sign at a crossing and the number (0 = none, 1 = one side, 2 = both sides). This data may not be too reliable because there may have been changes since the last inventory and this item needs to be field checked.

Column 8. *AWS NO.*, indicates whether or not there are advance warning signs and the number. This information was not available and must be supplied by the field inventory.

Column 9. *SPM NO.*, indicates whether or not there are standard pavement markings and the number. This information also was not available and must be supplied by the field inventory.

Column 10. *RR ADT*, gives the average daily traffic on the railroad. In a few instances this information was not available and will have to be completed. This data was taken from ISHC Railroad Crossing Inventory Reports.

Column 11. *HWY ADT*, gives the average daily traffic on Federal Aid routes. These figures were taken from the ISHC
traffic survey reports. Counts were not available for the non-federal aid routes and these must be filled in by county personnel.

Column 12. **HAZARD INDEX**, is computed by the formula:

\[
\text{Hazard Index} = \text{Railroad ADT times Highway ADT times Protection Factor.}
\]

**Protection Factors**

\[
\begin{align*}
\text{X-Bucks} &= 1.00 \\
\text{Stop Signs} &= 0.58 \\
\text{Wig-wags} &= 0.34 \\
\text{Flashers} &= 0.20 \\
\text{Gates} &= 0.11 \\
\text{Bells} &= 1.00 \\
\text{Watchman} &= 1.00 \\
\text{None} &= 1.00
\end{align*}
\]

This is the same formula used by the ISHC. It is essentially the one suggested in the Voorhee’s report. An example of its use can be seen in figure 16. Where highway and railway ADT’s were available, the hazard index has been computed. In order to complete this column, county personnel must take traffic counts on the highways for which ADT’s were not available.

Column 13. **CONDITION RATING**, is for county personnel to supply a word description of conditions at the crossing, noting all deficiencies such as, inadequate sight distance, missing or deteriorated advance warning signs, crossing protection in need of repair, and all other undesirable features of the crossing.

**On-Sight Investigation**

The next step would be an on-the-site investigation by county and railroad personnel to verify the output and establish a condition rating indicating whether or not the crossing needs physical improvement and to what extent. The hazard index has been computed for the crossings on the federal aid routes. To compute this index on other county roads traffic counts are needed.

**Hazard Index**

The hazard index used is essentially the same one used by the ISHC, which was the primary reason that it was selected over several available. The formula, and example can be seen in figure 16.

The formula is also the one suggested by the Voorhee’s report. It is a simple formula, and requires only knowledge of the rail and highway traffic and of the protection.

The inventories for all counties will be sent out to each county in the near future along with a copy of a use manual, HERPIC Bulletin No. 11., *Railroad Crossing Protection on Indiana County Highway Systems*. Detailed guidelines that counties may follow to complete the inventory and on-the-site investigation will be included.
HAZARD INDEX = V x T x P

V = AVERAGE 24 HOUR TRAFFIC VOLUME
T = AVERAGE 24 HOUR TRAIN VOLUME
P = PROTECTION FACTOR

X-BUCKS = 1.00
STOP SIGNS = 0.58
WIGWAGS = 0.34
FLASHERS = 0.20
GATES = 0.11

EXAMPLE:

V = 2000
T = 5

X-BUCKS  H1 = 2000 x 5 x 1 = 10,000
FLASHERS  H1 = 2000 x 5 x 0.20 = 2,000
GATES  H1 = 2000 x 5 x 0.11 = 1,100

Fig. 16. Hazard Index Formula and Example.

CONCLUSIONS

It is hoped that each county will take advantage of this collection of data, complete it, and initiate a program of grade crossing safety improvement. It should be evident that any real results in improving grade crossing safety can only be achieved by cities, counties, and states seeking solutions that exist within their areas of responsibility, and doing whatever is within their means to affect grade crossing
improvement. The data supplied to the counties will do nothing by itself. The counties must use the data to initiate a positive improvement program if results are to be achieved. The program supplies the basic data needed. It is hoped that it will be used.

BIBLIOGRAPHY


