An Interim Report

RAIL-HIGHWAY GRADE CROSSING SAFETY EVALUATION

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Grade Crossing
Study Number 2-8-67-111

Sponsored By
The Texas Highway Department
In Cooperation With
U. S. Department of Transportation
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TEXAS TRANSPORTATION INSTITUTE
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College Station, Texas

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INTRODUCTION

The purpose of this report is to outline the results of the work accomplished during the first year of a proposed three-year study entitled Rail-Highway Grade Crossing Safety Evaluation.

The study is under the joint sponsorship of both the Texas Highway Department and the U. S. Bureau of Public Roads. Although not financial contributors to the study, the railroad companies of Texas have contributed much time and effort to the initial development of an inventory of public rail-highway grade crossings within the state.

The format of this report will follow that of the Detailed Work Plan for the period February 1, 1967 through August 31, 1967. This plan was submitted to the Texas Highway Department on February 15, 1967.

OBJECTIVES OF THE STUDY

The purpose of this study is to provide the basic information necessary for the improvement of safety conditions at public rail-highway grade crossings in Texas.

The primary objectives of this study are:

1. To compile a history of and analyze the nature and extent of accidents at Texas rail-highway grade crossings over the past few years.
2. To determine the type of protection that would provide acceptable efficiency under the conditions encountered on the various classifications of grade crossings.

3. To determine the over-all cost of providing the recommended levels of protection at rail-highway grade crossings that are found to be ineffectively protected.

PLAN OF RESEARCH

To achieve the objectives stated above, the following plan of work will be followed:

1. A complete inventory of all rail-highway grade crossings withing the State of Texas will be accomplished.
2. A diagnostic team consisting of the study supervisor, a highway traffic research engineer, and a representative from the Texas Highway Department, the U. S. Bureau of Public Roads, and the railroad industry will be employed to determine the factors that should be included in the analysis of causes of accidents at rail-highway grade crossings.
3. Based upon the inventory of grade crossings, and recommendations from the diagnostic team, all grade crossings will be classified and a stratified random sample will be drawn from each of the designated strata for further analysis.
4. Historical accident records for a period of not less than ten (10) years for all sampled crossings will be assembled.
5. Supporting data relating to the volume of automobile and train traffic at the crossing, roadway surface conditions, weather conditions, angle of approach to the crossing, the grade at the crossing, obstructions to view on or near the

crossing, and other physical characteristics of the sampled crossings will be assembled.

6. Methodology and procedures for the development of a predictive model for the assignment of a hazard rating, for various classes of rail-highway grade crossings, will be established.

7. A determination of cost incurred in the installation and maintenance of various types and classes of protective devices will be accomplished.

8. An evaluation of the effectiveness of the current design in use of protective equipment will be made, and if practical, new protective devices will be installed and evaluated.

9. With the aid of the diagnostic team to observe conditions at these selected sites and the use of moving and still photographic equipment, a thorough analysis of selected grade crossings will be accomplished.

10. Recommendations for the improvement of safety conditions at various classes and types of rail-highway grade crossings will be developed.

Due to the time required to accomplish the work plan outlined above, it is suggested that a three-year period be established for the completion of this project.

FIRST-YEAR OBJECTIVES

Based upon the plan of research set forth in the original project proposal, the following list of activities were scheduled for the fiscal year 1966-1967:

Activity I - <u>Inventory of Rail-Highway Grade Crossings</u>

A complete inventory of all public rail-highway grade crossings within the State of Texas was to be accomplished.

Activity II - <u>A Review of Data on File with the Texas Highway Department</u>

A physical feature data form for the recovery of information relative to highway features of the grade crossings was to be designed. Highway Department Planning and Survey maps providing section, control and milepost information along with traffic count maps covering the entire state were to be assembled.

Activity III - <u>Accident Record Retrieval</u>

Accident records for all accidents at Texas Highway System grade crossings for the years 1962-1966 were to be assembled. Accident data for this same period were to be developed from the files of the Texas Railroad Commission to provide data relative to all accidents where they occurred at city street/state highway railroad intersections.

Activity IV - <u>Diagnostic Team Assignments</u>

Personnel of the Texas Highway Department, Texas railroad companies, Cities, Railroad Commission, Department of Public Safety, and traffic engineers from the TTI research staff were to be consulted and asked to serve as members of the diagnostic team.

Activity V - Sample Design and Selection

Statistical design and implementation of sampling procedures related to rural highway Department Administered Crossings was to be accomplished during the period.

Activity VI - Physical Feature Data Retrieval (Field Work)

Sample crossings selected under the objectives of Activity V were to be visited by the research team during this phase of the study.

Activity VII - Design of Analytical Procedures

Analytical procedures for the recovery of physical feature data were to be made available to the project advisor as well as members of the diagnostic team prior to the completion of field work.

Activity VIII - Analysis

Methodology and procedures for the development of the predictive model for the assignment of a hazard rating, for various classes and types of rail-highway grade crossings, was to be the principal objective of this activity.

FIRST-YEAR RESEARCH ACCOMPLISHMENTS

Work on this project did not get underway until October 1, 1966. Therefore, activities scheduled for the 1966-67 fiscal year were adjusted to reflect an eleven-month rather than twelve-month period. Even with the adjustment in scheduling, work on the project has been programmed and accomplished under the eight major activities suggested in the original project statement and outlined in the research agreement.

Activity I - Inventory of Rail-Highway Grade Crossings

In order to provide the basic data for an inventory of all public rail-highway grade crossings within the state of Texas, the Texas Railroad Association was approached with a request for participation in this phase of the study. In late 1966 a meeting of the Association's grade crossing committee and Transportation Institute staff was held in Dallas, Texas. At this meeting the railroad companies agreed to conduct the inventory of grade crossings. Also during the meeting the design of the inventory data card, procedures for conducting the inventory, and railroad contact representatives were agreed upon.

The next step in this phase of the study was to review the design of the inventory data card and procedures for conducting the inventory with members of the Texas Highway Department Project Advisory Committee. As a result of this review some minor changes were made in the basic format of the inventory card and additional items pertaining to the type of material between the tracks were added.

Prior to having the inventory cards printed, instructions for completing each item on the inventory card were prepared. Also the format of the card was arranged so as to allow quick and accurate recovery of the data during keypunch operations.

Figure 1 is a facsimile of the 5 x 7 card that was printed and made available to 27 railroad companies operating within the state of Texas. The number of crossings to be inventoried by these companies ranged from 5, for a small East Texas line, to over 3300 for a Class I carrier with trackage in more than 50 Texas counties.

Texas Rail-Highway Grade Crossings

Figure 1 illustrates the type of information that was collected for completing the inventory. It is noted that all of the information could be obtained by an employee of the railroad either from company records or during a short visit to each of the crossings.

Although tables have been constructed for each of the items included on the inventory card for the purpose of this report, only selected tables are presented in this report. The crossings were first classified according to administrative responsibility, e.g., state, county and city. The state crossings reported in these tables include only those locations outside urban areas. Therefore, the city crossings classification includes both state and city administered crossings.

Tentative findings indicate that there are 13,556 public rail-highway crossings in the State of Texas. Of these, 1,834 (13.5%) are located on the state highway system in rural areas, 6,472 (47.7%) are on the state highway system and city streets in urban areas and 5,250 (38.7%) are on county roads.

Crossing Classified by Type of Protection

Table 1 shows the distribution of crossings by type of

TEXAS RAIL-HIGHWAY GRADE CROSSING INVENTORY (1) DATE________

(2) NAME OF RAILROAD________ (3) SUBDIVISION (Or Branch)________ (4) MILEPOST________ Miles Tenths

(5) COUNTY________ (6) CITY________ (7) NEAREST CITY________ Miles

(8) HIGHWAY NUMBER OR STREET NAME________ (9) NUMBER OF HIGHWAY TRAFFIC LANES________

(10) TYPE OF HIGHWAY SURFACE

☐ Concrete ☐ Brick
☐ Black Top ☐ Dirt
☐ Gravel ☐ Unknown

(11) TYPE MATERIAL BETWEEN TRACKS

☐ Wood ☐ Steel Rails
☐ Asphalt ☐ Other

(12) NUMBER OF TRACKS

____Main Tracks (No) ____Siding (No)
____Spur (No) ____Wye (No)
____Lead Track (No) ____ ________ (No) (Other)

(13) TYPE & NUMBER OF PROTECTIVE DEVICES

____Crossbucks (No) ____Flashing Lights (No) ____Watchman (No)
____Crossbucks (Reflectorized) (No) ____Bells (No) ____Automatic Gates (No)
____Stop Sign (No) ____Wigwags (No) ____Illumination (No)

____Advanced Highway Flashing Warning Signal (Not Located on Railroad Right of Way) (No)

(14) NUMBER OF TRAINS DAILY ☐

(15) SPEED OF TRAIN AT CROSSING ☐

See Reverse Side for Instructions for Completing this Form

GENERAL INSTRUCTIONS

I. This card is to be completed for each public crossing. A public crossing is defined as a crossing where the city, county, or state maintains the roadway that intersects the railroad.

II. A rail-highway intersection will be defined as a grade crossing where one or more tracks intersect a public roadway and is protected by at least one protective device installation. Where tracks are separated by more than 100 feet, each intersection will be defined as a grade crossing regardless of the location of the protective device.

INSTRUCTIONS FOR COMPLETING REVERSE SIDE

1. Month and year card is completed.
2. Abreviated name of railroad will be sufficient.
3. Full name of subdivision or branch.
4. Give milepost nearest to crossing plus distance to crossing in tenths of mile.
5. Name of county in which crossing is located.
6. Name of city, or nearest city, if crossing is located in a rural or suburban area.
7. Approximate distance to nearest city if crossing is located in a rural or suburban area.
8. Highway number or name of street. Give both if crossing is located on highway within a city.
9. Total number of highway traffic lanes at the crossing.
10. Check in the appropriate space for highway surface approaching the crossing.
11. Check in the appropriate space for type of material between tracks.
12. Indicate total number of tracks in appropriate box for the categories listed.
13. Indicate total number of installations on both sides of the crossing in appropriate box for the categories listed.
14. Average number of trains passing through crossing during any 24 hour period.
15. Posted speed limit for trains at or approaching the crossing.

FIGURE 1

protective device. From this table, it can be seen that crossbucks and reflectorized crossbucks, account for approximately three out of four of all crossing protection devices in the state. While 95 percent of county road crossings are protected by crossbucks, only 58 percent of the rural state highway crossings are protected by this device.

Over 2,000 crossings are protected by flashing lights with approximately 60 percent of these crossings located in urban areas.

Although automatic gates require significant investments on the part of both public and railroad interest, tentative findings indicate that there are 131 sets of this type of protective device installed at grade crossings in Texas. Some cities and counties are experimenting with the installation of the regular highway intersection stop signs at the grade crossing. Although only 18 crossings in the state are protected by the stop sign, the popularity of this device with small cities and the railroads seems to be increasing quite rapidly.

The lack of illumination and activated advanced warning signs can be readily ascertained from Table 1. Although discrepancies in the inventory may later reveal that more than a single crossing is protected by advanced activated warning signs, the number is not expected to exceed more than ten.

The fact that the total inventory of public crossings is almost equally divided between rural and urban crossings indicated the need for an exhaustive review of rail-highway grade crossing accidents to determine whether the problem involves predominantly rural crossings, urban crossings or both and is a rural-urban problem.

Type of Highway Surface at the Grade Crossing Approach

Since the ability to stop an automobile on various surfaces with different coefficients of friction is a significant factor in determining the degree of hazard at the crossing, emphasis has been placed upon highway and street surface types throughout the development of the methodology.

Table 2 classifies the crossings by type of highway or street surface on the approach to the grade crossing. It may be seen from this table that one-half of all crossings have a blacktop surface at the approach, however, the proportion of blacktop surfaced approaches in the rural state highway class represents almost 86 percent of the crossings. Some 60 percent of the county road crossings have gravel and dirt approaches.

Train Speed at Crossing

The speed of trains at the grade crossing is a significant factor in determining the activation period of protective devices equipped with electronic operated warning features. In fact, a Federal regulation requires that the activated device provide a warning signal at least 20 seconds prior to the arrival of the fastest train approaching the crossing.

TABLE 1

INVENTORY OF TEXAS RAIL-HIGHWAY GRADE CROSSINGS
BY TYPE OF PROTECTIVE DEVICE AND ADMINISTRATIVE RESPONSIBILITY

Protective Devices	ADMINISTRATIVE RESPONSIBILITY: State Highway (Rural)		Highway & City St. (Urban)		County (Rural)		TOTAL	
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
Crossbuck	358	19.5	3451	53.3	3701	70.5	7510	55.4
Crossbuck (Reflectorized)	713	38.9	1112	17.2	1290	24.6	3115	23.0
Highway Stop Sign	-	-	15	0.2	3	0.1	18	0.1
Flashing Lights	698	38.1	1240	19.2	139	2.6	2077	15.3
Bells only	6	0.3	26	0.4	9	0.2	41	0.3
Wigwags	25	1.4	118	1.8	18	0.3	161	1.2
Flagman	-	-	6	0.1	-	-	6	-
Automatic Gates	12	0.7	115	1.8	4	0.1	131	1.0
Illumination	-	-	35	0.5	1	-	36	0.3
Advanced Activated Warning	1	0.1	-	-	-	-	1	-
Other	-	-	2	-	-	-	2	-
Unprotected	21	1.1	352	5.4	85	1.6	458	3.4
TOTAL	1834	100.0	6472	100.0	5250	100.0	13556	100.0

In an effort to determine the extent to which the vehicle operator's view of the railroad approach to the crossing is obstructed, train speed becomes a determining factor in the calculations. The significance of this factor to the current study will be discussed in a later section of this report describing the methodology and procedure for computing sight clearance.

Data from the inventory reveal that there is considerable difference in train speeds when comparing rural and urban crossings. For example, from Table 3 it may be seen that approximately 45 percent of all urban crossings have train speeds of less than 20 mph. On the other hand, only 25 percent of the rural state highway crossings and slightly more than 10 percent of the county road crossings are in this classification. While almost 30 percent of the county road crossings had train speeds in excess of 50 mph, approximately 20 percent of the rural state highway crossings and only 12 percent of the urban crossings are included in this category. It is also noted that although the highest incidence of crossings, according to train speed categories, occurs at 31-40 mph for both rural state highway and county road crossings the largest percentage of urban crossings occurs in the speed category of 10-20 mph.

Number of Trains per Day at Crossings

Train frequency and average daily vehicular traffic count information provide data necessary for the computation of a "probability of conflict" factor for each of the crossings

TABLE 2

INVENTORY OF TEXAS RAIL-HIGHWAY
BY HIGHWAY AND STREET SURFACE TYPE

Surface Type	ADMINISTRATIVE RESPONSIBILITY							
	State Highway (Rural)		Highway & City St. (Urban)		County (Rural)		TOTAL	
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
Not Indicated	61	3.3	213	3.3	212	4.0	486	3.6
Concrete	107	5.8	591	9.1	21	0.4	719	5.3
Blacktop	1575	85.9	4020	62.1	1207	23.0	6802	50.2
Brick	4	0.2	184	2.8	282	5.4	470	3.5
Gravel	11	0.6	968	15.0	1672	31.8	2651	19.6
Dirt	8	0.4	405	6.3	1462	27.8	1875	13.8
Unknown	68	3.7	91	1.4	394	7.5	553	4.1
TOTAL	1834	100.0	6472	100.0	5250	100.0	13556	100.0

included in the inventory. A later section of this report will describe methodology and procedures for computing the Probability of Conflict factor. The purpose of this section of the report is to provide a summary of the train frequency data derived from the inventory of all crossings.

The basic inventory records reveal that of the more than 13,500 crossings, 1,680 (12.4%) have a reported train frequency of only one train per day. Also, Table 4 shows that approximately 34 percent of all crossings have a train frequency of less than three trains per day. The difference between the operating characteristics of rural and urban crossings is indicated by the fact that approximately 80 percent of the rural highway crossings and 78 percent of the county road crossings have less than 9 trains per day while only 71 percent of the urban crossings are in this train frequency category. This relationship may be partially explained by the fact that most railroad switching yards are located within urban areas.

Urban Rail-Highway Grade Crossings

The number of rail-highway grade crossings located in Texas urban areas represent approximately 48 percent of all crossings. Table 5 provides a list of the twenty Texas cities having the largest number of crossings. Although 544 urban areas are included in the inventory of grade crossings, these twenty cities (listed in Table 5) account for approximately 43 percent of all urban crossings and about 20 percent of the total inventory of Texas rail-highway grade crossings.

TABLE 3

INVENTORY OF TEXAS RAIL-HIGHWAY
BY SPEED OF TRAIN AT THE CROSSINGS

	ADMINISTRATIVE RESPONSIBILITY							
	State Highway (Rural)		Highway & City St. (Urban)		County (Rural)		TOTAL	
Train Speed (in mph)	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
Not Indicated	75	4.1	375	5.8	64	1.2	514	3.8
Less than 10	214	11.6	1195	18.4	175	3.3	1584	11.6
10 - 20	252	13.7	1710	26.3	370	7.0	2332	17.2
21 - 30	283	15.5	990	15.3	843	16.1	2116	25.5
31 - 40	391	21.4	733	11.3	1283	24.5	2407	17.8
41 - 50	270	14.7	683	10.6	944	18.0	1897	14.0
51 - 60	143	7.8	376	5.8	638	12.1	1157	8.6
61 - 70	102	5.6	182	2.9	414	7.9	698	5.2
Over 70	104	5.6	228	3.6	519	9.9	851	6.3
TOTAL	1834	100.0	6472	100.0	5250	100.0	13556	100.0

TABLE 4

INVENTORY OF TEXAS RAIL-HIGHWAY
BY NUMBER OF TRAINS PER DAY AT THE CROSSINGS

Trains per Day	ADMINISTRATIVE RESPONSIBILITY							
	State Highway (Rural)		Highway & City St. (Urban)		County (Rural)		TOTAL	
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
Not Indicated	112	6.1	555	8.6	176	3.4	843	6.2
1 - 2	766	41.6	1908	29.4	1989	37.8	4663	34.5
3 - 4	314	17.1	1248	19.2	856	16.3	2418	17.8
5 - 6	223	12.1	901	13.7	724	13.8	1848	13.7
7 - 8	148	8.1	580	9.0	503	9.6	1231	9.1
9 - 10	86	4.7	350	5.4	296	5.7	732	5.4
11 - 12	68	3.7	232	3.5	246	4.7	546	4.1
13 - 14	39	2.1	116	2.6	135	2.6	290	2.1
15 - 16	20	1.1	170	2.6	97	1.8	287	2.1
17 - 18	21	1.1	100	1.6	74	1.4	195	1.5
19 - 20	11	0.6	126	1.8	59	1.1	196	1.4
Over 20	26	1.7	186	2.6	95	1.8	307	2.1
TOTAL	1834	100.0	6472	100.0	5250	100.0	13556	100.0

An examination of the map of Texas Railroads (Figure 2) indicates that those urban areas representing major railroad junctions have a greater incidence of grade crossings irregardless of the geographic size or population of the urban areas. It may be tentatively concluded that in some instances smaller and less financially able cities may have a greater need for additional grade crossing protection than larger more financially able cities.

Counties Having a Large Number of Rail-Highway Grade Crossings

Grade crossing inventory records indicate that some 233 of the 254 Texas counties have at least one public rail-highway crossing. The number of crossings in each county ranges from a single crossing reported in Crane County to more than one thousand in Harris County.

Approximately 40 percent of all Texas grade crossings are located in just 20 counties. Table 6 provides a list of these twenty counties arranged by the number of crossings located in each county. A close look at Figure 2 points out the fact that major railroad junction points are probably the most significant factor contributing to the number of grade crossings located in a county.

A comparison of the list of counties in Table 6 with financial data relative to the operation of these counties indicates that several counties having a relatively larger number of grade crossings may be hard pressed to provide adequate funds for the protection of all crossings under their administrative responsibility.

Activity II - A Review of Data on File with The Texas Highway Department

The preparation of physical feature data to be included in the analysis of study crossings required the design of a highway

TABLE 5

TWENTY TEXAS CITIES HAVING THE LARGEST NUMBER OF RAIL-HIGHWAY GRADE CROSSINGS

CITY	NUMBER OF PUBLIC CROSSINGS
Houston	788
Dallas	277
San Antonio	217
Fort Worth	192
Lubbock	152
Waco	124
Beaumont	110
Amarillo	102
Laredo	95
Corpus Christi	91
Austin	90
Victoria	79
Sherman	71
Brownsville	70
Harlingen	65
Plain View	62
Corsicana	58
Tyler	55
McAllen	52
San Angelo	49
TOTAL	2799

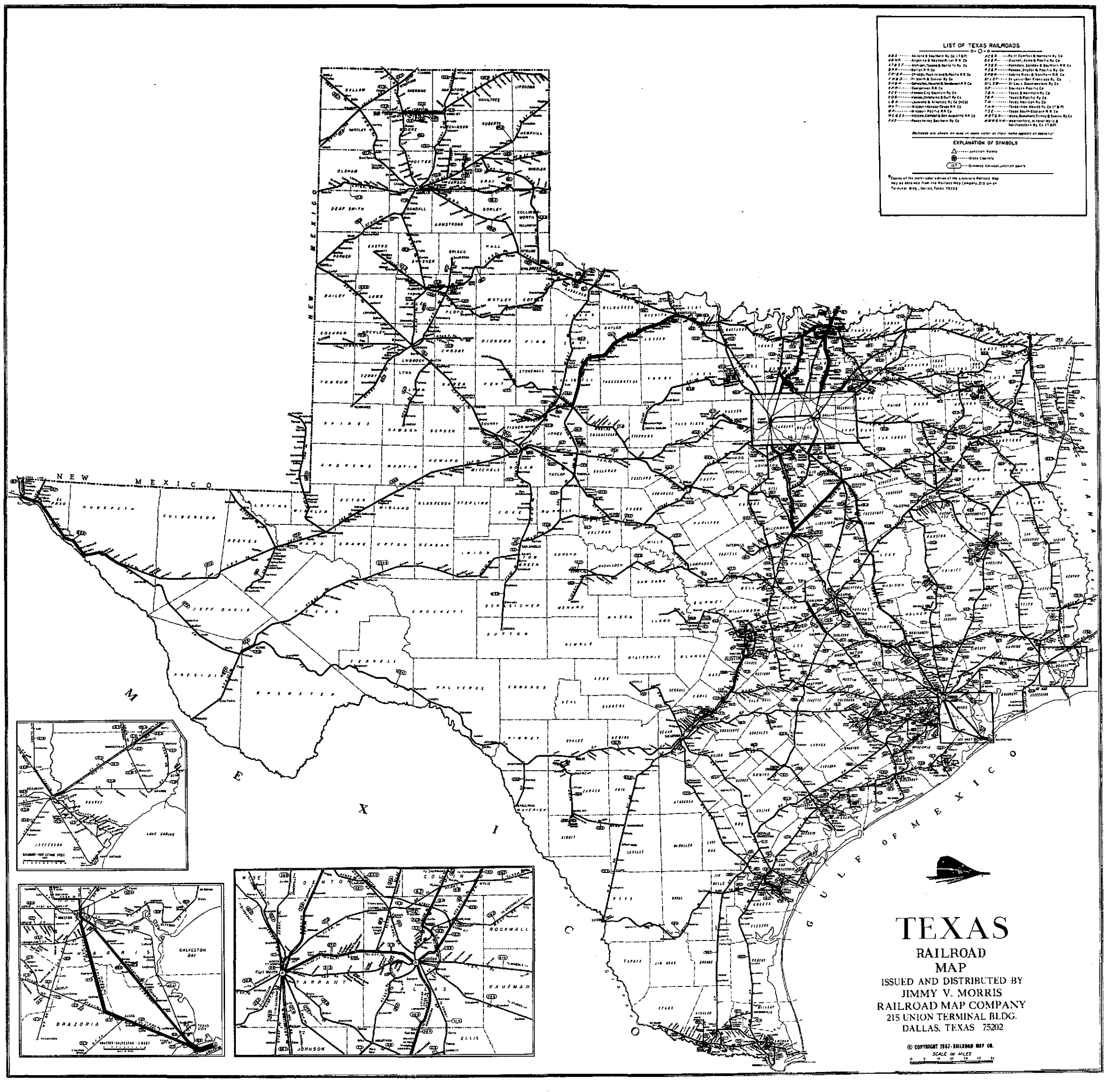
LIST OF TEXAS RAILROADS
EXPLANATION OF SYMBOLS
NEW MEXICO
MEXICO
GULF OF MEXICO
TEXAS
RAILROAD
MAP
ISSUED AND DISTRIBUTED BY
JIMMY V. MORRIS
RAILROAD MAP COMPANY
215 UNION TERMINAL BLDG.
DALLAS, TEXAS 75202

FIGURE 2

oriented grade crossing form. In considering the format that this form should take, personnel of the Texas Highway Department Planning and Survey Division made available to the project staff an obsolete form that was once used by the Texas Highway Department in rail-highway record maintenance. Figure 3 is the original form that was used in the pre-test phase of the field work. The principal use of this form was to sketch the location of the railroad, highway warning devices, sight obstruction, additional street networks, etc. The form was supplemented by a data sheet which provided specific information relative to the operating characteristics of the crossing.[1]

The field pre-test of this form and the supplemental data sheet revealed that a revision of the highway inventory form should be made. It was also determined that the revised form would include those physical features which had been identified by the diagnostic team as factors which may contribute to hazardous conditions at the crossings. A copy of the revised form that was developed for use in collecting field data is included in Appendix B of this report.

Other data obtained from the Texas Highway Department during this phase of the study include:

1) Engineering construction and design maps.

2) Rail-highway grade crossing protective device installation records.

3) Control and Section number identification of the Texas Highway System.

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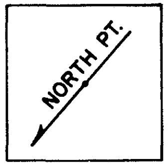
[1] A reproduction of the data sheet is shown in Appendix B., page 64.

NAME OF RAILROAD ____________________

MILE POST: HWY. __________ RR. __________

NO. OF TRACKS- MAIN LINE ______ OTHER ______

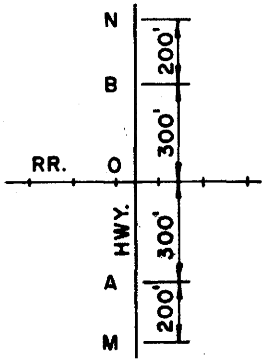


TYPE OF PROTECTION

0	NO WARNING SIGNAL	5	LIGHTS & BELLS
1	SIGNS ONLY	6	WIGWAG
2	BELLS	7	WIGWAG & LIGHTS
3	LIGHTS-STATION	8	WIGWAG & BELLS
4	LIGHTS-FLASHING	9	WIGWAG, LIGHTS, BELLS

WATCHMAN:
HOURS ON DUTY: FROM _____ TO _____ TOTAL _____

GATES		CHAIN OR CABLE	
BARRIERS		OTHER DEVICES	



PROFILE OF HIGHWAY

M O N

GRADE CROSSING SAFETY EVALUATION
SAMPLE CROSSING

CODED BY: __________ NAME __________ DATE

CHECKED BY: __________ NAME __________ DATE

CARD PUNCHED BY: __________ NAME __________ DATE

VERIFIED BY: __________ NAME __________ DATE

COUNTY __________

SHEET ____ OF ____

REVISED TO __________

FIGURE 3

TABLE 6

TWENTY TEXAS COUNTIES HAVING THE LARGEST NUMBER OF RAIL-HIGHWAY GRADE CROSSINGS

CITY	NUMBER OF PUBLIC CROSSINGS
Harris	1017
Dallas	485
Cameron	334
Tarrant	331
Hidalgo	300
Bexar	263
Lubbock	263
Jefferson	260
McLennan	260
Grayson	222
Ellis	170
Hunt	167
Victoria	163
Nueces	162
Hale	157
Collin	152
Navarro	136
Potter	141
Cherokee	135
Smith	128
TOTAL	5246

Activity III - Accident Record Retrieval

The assembly of records for all rail-highway grade crossing accidents occurring on the Texas Highway System during the period 1962-1966 was the single objective of this activity. The Texas Railroad Commission provided duplicate copies of the ICC monthly report of grade crossing accidents filed by the Railroads of Texas during the period 1965-1966. Individual Railroad companies furnished records of all rail-highway accidents occurring during the period 1962-1966 regardless of ICC reporting requirements. The Texas Highway Department made available a magnetic data tape and listing of all rail-highway accidents occurring in rural areas and small towns during the period 1962-1966.

Table 7 is a summary of grade crossing accidents reported to the Texas Railroad Commission by individual railroad companies during the period 1962-1966. These data include accidents involving automobile and trains occurring at State Highway, City street and County road crossings. During this period 1,563 accidents were reported. These accidents resulted in the death of 557 individuals and injury to an additional 1,685 persons. From these data it may be established that 2,242 auto passengers were involved with ICC reportable rail-highway accidents during the study period.

By comparing Texas train-auto accidents with total vehicular accidents for the period 1962-1966, it is to be noted that less than four percent of all vehicular fatalities and two percent of all vehicular injuries occurred in collisions involving automobiles and trains. During the same period total vehicular injuries outnumbered total vehicular fatalities by approximately 60 to 1, however Table 7 indicates that injuries resulting from auto-train accidents outnumbered fatalities by less than 3 to 1. A comparison of these ratios indicates a much higher average severity of rail-highway grade crossing accidents than for all other vehicular accidents.

It should be pointed out that the data reported in Table 7 do not include accidents at grade crossings which do not involve trains, e.g., automobiles colliding with fixed objects at the crossing or rear-end collision of automobiles. In addition, accidents that involve less than $750 property damage to railroad equipment and do not result in injury are not required to be reported by the railroads.

The increasing occurrence of rail-highway grade crossing accidents is evident from the annual reports published by the Texas Railroad Commission. Again referring to Table 7, it is noted that a summary of these reports suggests that during the period 1962-1966 rail-highway accidents, fatalities and persons injured have shown substantial increases.

Accidents at Rural Rail-Highway Grade Crossings

Recognizing the complications in identifying the more than 1,500 grade crossing accidents occurring in the State of Texas during the study period, this activity was reduced to only those accidents occurring at rural Texas Highway Department crossings. The accident data available from the Highway Department and Department of Public Safety became the primary data source for this activity. Table 8 provides a summary of these data by type of vehicle involved in the accident and type of roadway intersecting the railroad.

TABLE 7

RAIL-HIGHWAY GRADE CROSSING ACCIDENTS IN TEXAS DURING THE PERIOD 1962 THROUGH 1966[a]

	YEAR											
	1962		1963		1964		1965		1966			
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total	Total	%
Number of Accidents	274	17.56	282	18.04	314	20.09	319	20.41	347	23.93	1563	100
Number of Persons Killed	112	20.11	94	16.88	104	18.67	102	18.31	145	26.03	557	100
Number of Persons Injured	294	17.45	319	18.93	313	18.58	362	21.48	397	23.56	1685	100

[a]Source: Annual Reports Railroad Statistical Section of the Railroad Commission of Texas.

According to these data more than one-half of the rural Highway Department accidents occurred at Farm-to-Market road grade crossings with the U. S. and State Highway accounting for approximately an equal share of the remaining accidents. Passenger cars contributed to 68 percent of the accidents, single unit trucks 22 percent and tractor-trailer trucks 10 percent. It is significant to point out that the single unit truck grade crossing accident at Farm-to-Market road and railroad intersections accounted for approximately one of seven of all study period grade crossing accidents.

Table 9 is a summary of rail-highway accidents by vehicle type and type of protection at the grade crossing. Non-actuated protected crossings accounted for approximately 55 percent of all accidents with passenger cars involved in two out of three of these accidents. The accident rate is higher at the non-actuated protective device crossings for all vehicular types except tractor-trailer trucks. The fact that these types of vehicles have slightly higher accident rates at the activated protective device crossings indicates a need for additional study of the characteristics of the crossings at which these accidents are occurring. From other data sources it has been determined that during the five-year period vehicle registration in the state of Texas consists of 79.6% passenger cars, 19.4% single unit trucks, and 1% tractor-trailers. Although the traffic makeup on intercity highways may not be in these proportions by vehicle classes, it appears that a disproportionate number of rail-highway accidents involve tractor-trailer trucks.

TABLE 8

RAIL-HIGHWAY GRADE CROSSING ACCIDENTS
BY ROAD AND VEHICLE TYPE[a]

	VEHICLE TYPE							
	Passenger Cars		Single Unit Trucks*		Tractor-Trailer Trucks		TOTAL	
	No.	% of Total	No.	% of Total	No.	% of Total	No.	% of Total
Farm-to-Market	230	56.5	86	65.2	28	46.7	344	57.4
State Highway	91	22.4	28	21.2	14	23.3	133	22.2
U. S. Highway	86	21.1	18	13.6	18	30.0	122	20.4
TOTALS	407	100.0	132	100.0	60	100.0	599[b]	100.0

[a]Source: Texas Highway Department and Department of Public Safety Magnetic tape listing of 642 auto-train accident reports during the period 1962-1966.

[b]43 accidents not identified by road and vehicle type.

*Single Unit Trucks include pickup and other trucks without trailer combinations.

TABLE 9

RAIL-HIGHWAY GRADE CROSSING ACCIDENTS BY VEHICLE TYPE AND PROTECTIVE DEVICE[a]

	PROTECTIVE DEVICE				TOTAL	
	Non-Actuated		Actuated			
	Number	% of Total	Number	% of Total	Number	% of Total
Passenger Cars	230	37.14	199	32.04	429	69.08
Single Unit Trucks	78	12.56	51	8.21	129	20.77
Tractor-Trailer Trucks	31	4.99	32	5.16	63	10.15
TOTAL	339	54.59	282	45.41	621[b]	100.00

[a]Source: Texas Highway Department and Department of Public Safety magnetic tape listing of 642 auto-train accidents reported during the period 1962-1966.

[b]21 accidents were not identified by type of protective device or type of vehicle.

Accidents by Time of Day

Table 10 is a summary of rural highway accidents by time of day the accident occurred and vehicle type involved in the accident. Although passenger car day-time accidents exceeded night-time accidents, the percentage difference is quite small. On the other hand, single unit truck day-time accidents accounted for almost three of four of the accidents of this vehicle class. In the tractor-trailer vehicle class day-time accidents accounted for approximately 85 percent of all rail-highway grade crossing accidents occurring within this vehicle class.

Summary

Based upon these preliminary findings it appears that 642 of the 1,563 accidents reported by the railroads to the Railroad Commission of Texas during the period 1962-1966 occurred on U. S., State and FM Highways outside urban areas having a population of more than 2,500. Therefore, approximately 60 percent of the rail-highway grade crossing accidents occur either in large urban areas or on county roads.

Further analysis of the data that have been collected during the initial phase of the study should provide the following information for accident analysis purposes.

a) Number and type of accidents occurring at U. S., State and FM rail-highway grade crossings.

b) Number and type of accidents occurring at U. S., primary and secondary rail-highway grade crossings.

c) Number and type of accidents occurring at city street and county road railroad grade crossings.

TABLE 10

RAIL-HIGHWAY GRADE CROSSING ACCIDENTS BY VEHICLE TYPE AND TIME[a]

Vehicle Type	DAY		NIGHT		TOTAL	
	Number	% of Total	Number	% of Total	Number	% of Total
Passenger Cars	238	38.08	194	31.04	432	69.12
Single Unit Trucks	94	15.04	35	5.60	129	20.64
Tractor-Trailer Trucks	54	8.64	10	1.60	64	10.24
TOTAL	386	61.76	239	38.24	625[b]	100.00

[a]Source: Texas Highway Department and Department of Public Safety magnetic tape listing of 642 auto-train accidents reported during the period 1962-1966.

[b]17 crossings were not identified by type of vehicle or time of day.

d) Vehicle, driver, time of day, train, protection and other classification describing accidents occurring at the various locations of crossings listed above will be available for analysis.

Activity IV - Diagnostic Team Assignments

The detailed work plan provided for the assignment of the diagnostic team when determined necessary by the project supervisor. In the initial phase of the study a research traffic engineer, a railroad official, and Texas Highway Department representatives served as advisors to the project staff. As the need for technical assistance increased the project supervisor sent invitations to Federal, state, city and railroad personnel to attend an informational meeting of all groups having specific interest in this project. The meeting was well attended with some 35 participants representing these interested groups. At the close of the meeting the participants were asked to support the efforts of the study by providing the project staff with technical assistance in their various areas of expertise. Thus far the project staff have received excellent cooperation from various individuals and groups who have agreed to serve as members of the diagnostic team.

One example of the use that has been made of the diagnostic team approach is related to the identification and selection of rail-highway grade crossing physical features that may contribute to hazardous conditions at the crossing. By bringing together representatives of the Texas Highway Department, railroads, Federal and state agencies, local communities and research engineers to review a series of 35mm slides of some 50 crossings, the project staff was able to put together several factors which were considered by this group to be significant to the hazardous conditions at grade crossings. In field tests these factors were measured and recorded for further analysis as to their statistical significance in the development of a hazard index for grade crossing classes.

In another instance the diagnostic team was used to determine the possibility of coordinating city street traffic devices with railroad crossing protective devices. Members of the project staff, a research engineer, and a railroad signal engineer visited a grade crossing where a railroad signal crew was installing new protective devices at a city street intersection. At the location railroad officials explained to the diagnostic team the manner in which the signal device was controlled. The diagnostic team then discussed possible procedures for coordinating the street traffic control device with the grade crossing protective device.

On many other occasions diagnostic team members have been contacted on an individual basis by the project staff seeking advice and help in obtaining information necessary to meeting the objective of the study.

Activity V - Sample Design and Selection

The development of the predictive model for the assignment of a hazard rating, to various classes and types of rail-highway grade crossings, requires that definitive information be collected and recorded with a high degree of accuracy and completeness. In the initial phase of this study an attempt was made to assemble secondary information relating to physical features, rail-highway traffic operations and accident experience at each crossing included in the inventory. These data were sought from the files of both state and local governmental agencies. As this work progressed it became apparent that there existed a serious lack of information relating to a complete discription of the physical and operational characteristics of the crossings. In addition, it was found that little uniformity existed between grade crossing accident reports filed by the railroad companies and the Department of Public Safety.

Initially, the Railroad Commission of Texas provided all grade crossing accident reports for the period 1962-1966. It was assumed that these reports would provide sufficient information to distinguish accident crossings from non-accident crossings in order that the inventory of crossings could be coded by this classification. These records included accidents occurring at all grade crossings whether urban or rural. Due to specific injury and property damage reporting requirements for minor accidents were not included in the reports. The major problem encountered in the use of these data, however, had to do with the inability of the data to provide sufficient information for locating accident crossings. A close examination of the form reveals that street and/or highway identification of the accident occurrence is not a part of the required reporting.[2] Even though the nearest railroad station to the accident crossings is required this station is generally associated with the railroad company's operating procedure rather than a city or town appearing on official state maps.

A review of the ICC form also reveals little or no information relating to the driver, vehicle or grade crossing conditions is included.

Since the identification of accident crossing location could not be readily ascertained from these reports, an attempt was made to correlate these records with those provided by the Texas Highway Department and the Department of Public Safety. Although the DPS data provide sufficient data regarding the driver, vehicle and circumstances of the accident little or no information regarding the railroad company, train length, train speed and other conditions relating to the operation of the train was included. Appendix A includes a facsimile of the report that is used to generate the accident data provided by the Texas Highway Department and the Department of Public Safety.

After several unsuccessful attempts in the use of automatic data processing equipment in the correlation of these data sources,

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[2] Appendix A includes a facsimile of the railroad reporting form. Although this report was formerly under the jurisdiction of the Interstate Commerce Commission, the recent organization of the Department of Transportation places the responsibility of this activity within the Federal Railroad Administration.

the task of identifying accident crossings was undertaken by project staff. Although this task proved to be time consuming (referring to the ICC report, the DPS report and appropriate highway, railroad and city street maps), the identification and location of accident crossings was possible.

The urban accident reports were more difficult to recover in that they are recorded only on microfilm at the Austin office of the DPS. It was obvious early in the project that these data could not be recovered during the first year of the study. Therefore, the detailed work plan excluded this activity from the first year's activity and suggested that the work be accomplished early in the second year of the study.

Sample Design

While the validity of the inventory of grade crossings was being reviewed by personnel of the Texas Highway Department, railroad companies and project staff it was decided that a pilot study of Texas Highway Department rural grade crossings would be conducted. From this study it would be determined what data were necessary to develop hazard indices for rural and possibly urban crossings. Of the 13,556 crossings included in the inventory 1,470 were found to be located on State and Federal highways outside urban areas.[3] The location of each of the 1,470 crossings was plotted on a large scale map of the state. From a review of the

[3] Although previously in this report it was estimated that there are approximately 1,800 rural highway crossings in the state, some 350 of these crossings were located in urban areas of less than 5,000 population.

1962-1966 rail-highway accident records, each crossing was classified either as an accident or non-accident crossing. Since these data were compatible to the DPS accident reports, they were the basis for the accident vs. non-accident classification. Project personnel were able to identify and locate 339 accident crossings from the list of 1,470 rural crossings.[4] Due to the discrepancies of the accident report forms and the inventory listing reported earlier in this section, it was not possible to reconcile all of the accident crossings from the general state-wide survey.

The next step in the design of the sample was to determine the frequency of use of the crossing by both vehicular and train traffic. After consultation with diagnostic team members it was determined that a factor describing the probability of conflict of vehicles and trains at each of the rural crossings would provide a basis for crossing classification. In arriving at this factor it was reasoned that for a collision to occur between a vehicle and a train, it is necessary that the vehicle arrive at a given crossing while the intersection is occupied by a train. The factors that govern the probability of a vehicle arriving while the crossing is occupied by a train are (1) average daily automobile traffic, (2) speed of trains (3) length of trains, and (4) number of trains per day at the crossing. With the exception of train length the necessary data for computing the probability of conflict for each

[4] The DPS reported 495 crossings having accidents during the period 1962-1966 at all rural highway crossings including urban areas of less than 5,000 population.

of the 1,470 crossings was available from either THD records or the inventory listing. Consultation with railroad officials provided an estimate of the average length of train operated over Texas railroads. From these data a mathematical formula was derived for determining the probability that one or more vehicles would arrive at a given crossing while it was occupied by a train. The probability of conflict may be stated mathematically as follows:

$$\text{Probability of conflict} = 1 - e^{-am}$$

where:

$$am = ADT \left[\frac{\dfrac{\text{train length in feet}}{\text{train speed in ft. per sec.}} + 10 \text{ sec. (trains per day)}}{\quad} \right]$$

Using 1965 traffic data the formula was applied to each of the 1,470 rural highway crossings. The results of these calculations were studied to determine if there were obvious break points that would suggest differences in grade crossing classification. The examination revealed a continuous array of probabilities from a value of 0.0047 to unity. Consequently, an arbitrary decision was made to classify the crossings into two categories, those having probability of conflict values equal to or greater than 0.10 in one class and crossings having a probability of conflict value less than 0.10 in a second class.

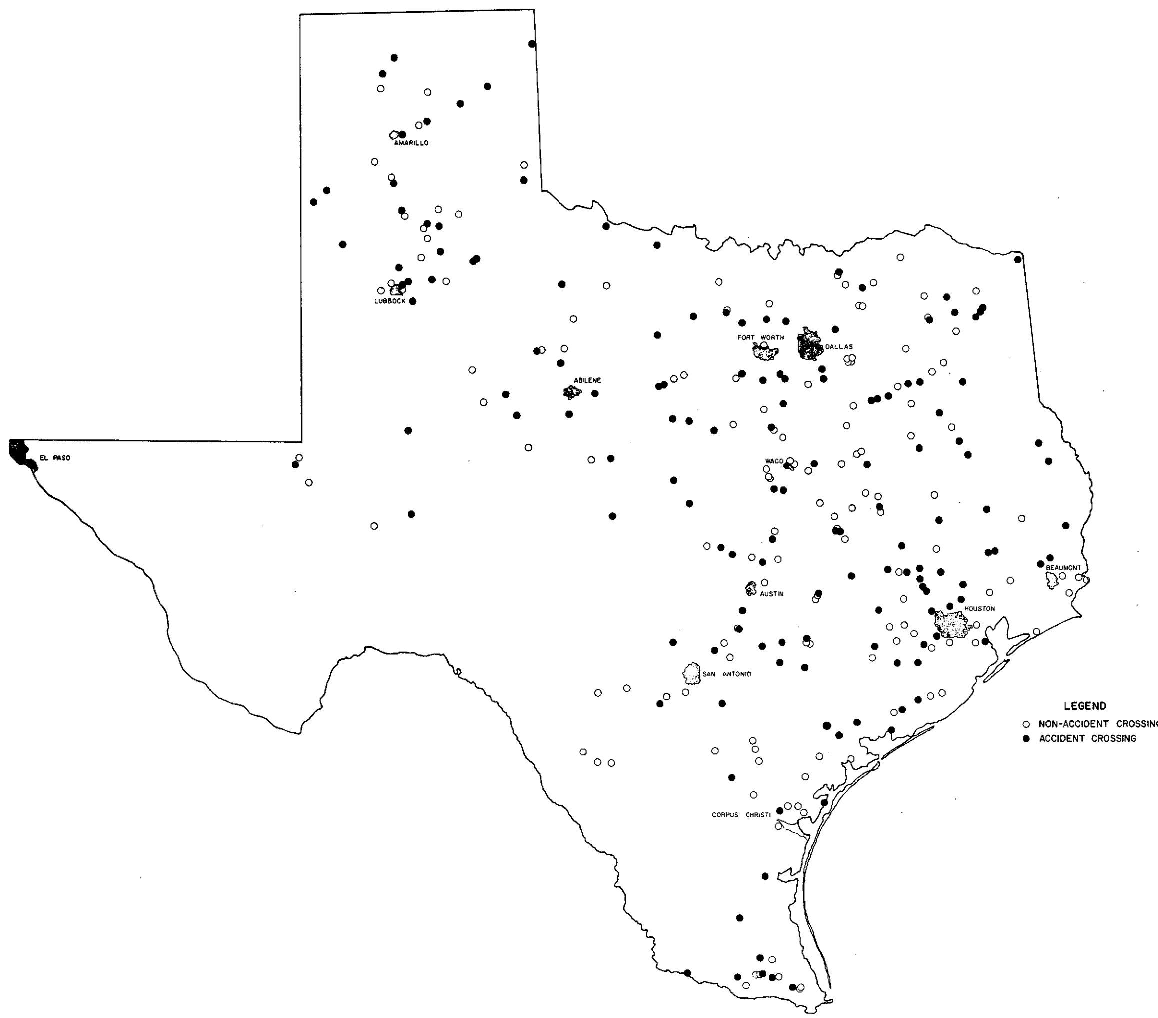
The third step in selecting the sample required the classification of 1,470 crossings by type of protective device. It may be recalled from Table 1 that at least ten different types of rail-highway protective devices are being used in the State of Texas.

The same table suggests that when the rural highway crossings were classified according to protective device several classes were not represented while other classes had less than a dozen observations. In order to have more representative classes it was decided that the crossings would be classified according to whether the protective device at the crossing was actuated or non-actuated.

The final step in selecting the sample crossings began by stratifying the 1,470 crossings according to the three classifications described previously i.e., accident vs. non-accident, probability of conflict, and actuated vs. non-actuated protective device. Time and budget restraints provided for a maximum of 300 crossings to be visited during this study period by project personnel. Therefore, a stratified random sample of a fixed size was employed in the selection of the sample crossings to be studied. Figure 4 is a map of the state indicating the geographic location of both accident and non-accident crossings selected by the sampling procedure.

FIGURE 4

LOCATION OF SAMPLE CROSSING



Activity VI - Physical Feature Data Retrieval (Field Work)

The data for this portion of the report were collected from field observations at 146 accident and 152 non-accident randomly selected sample rail-highway grade crossings. The primary purpose for collecting this information was to develop input data for the derivation of the hazard index. However, it is used in this section of the report to show contrast in the geometric features of accident and non-accident grade crossings.

Table 11 shows the number of traffic lanes observed at both the accident and non-accident crossings. As could be expected only 85 percent of the sample crossings were located on two-lane highway facilities.

TABLE 11

NUMBER OF TRAFFIC LANES AT SAMPLE CROSSINGS

	Number of Traffic Lanes[a]					
Type Crossing	Two	Percent	Four	Percent	Total	Percent
Accident	113	42.3	22	8.2	135	50.6
Non-Accident	114	42.7	18	6.7	132	49.4
TOTAL	227	85.0	40	15.0	267	100.0

[a]Highways at thirty-one additional crossings were either three lanes, transitional or one way.

The number of tracks at each of the sample crossings is presented in Table 12. Although 62% of the crossings involved single track situations it is interesting to note that the distribution

TABLE 12

NUMBER OF TRACKS AT SAMPLE CROSSINGS

	Number of Tracks									
Type Crossing	Single	%	Double	%	Triple	%	Four or More	%	Total	%
Accident	84	28.6	28	9.5	15	5.1	17	5.8	144	49.0
Non-Accident	99	33.7	35	11.9	12	4.1	4	1.4	150	51.0
TOTAL	183	62.3	63	21.4	27	9.2	21	7.2	294	100.0

between accident and non-accident crossings was approximately equal at crossings with three or less tracks. Considerably more accidents occurred where the highway intersected four or more tracks. It would appear from this brief analysis and other available information that rail-highway intersections with four or more tracks are more hazardous than crossings with fewer tracks.

Table 13 presents data describing the intersecting angle of the highway and railroad at the sample crossings. It is readily apparent that the preponderence of the crossings had intersecting angles of greater than 45 degrees. It should be noted, however, that over half of the crossings with the more acute angles experienced accidents. Accident rates were not as high for crossings with angles greater than 45 degrees.

TABLE 13

DISTRIBUTION OF SAMPLE CROSSINGS BY ANGLE OF INTERSECTION BETWEEN HIGHWAY AND RAILROAD

Type Crossing	Angle of Intersection Less Than 45 Degrees	Percent	Greater Than 45 Degrees	Percent	Total	Percent
Accident	15	5.1	130	44.2	145	49.3
Non-Accident	12	4.1	137	46.6	149	50.7
TOTAL	27	9.2	267	90.8	294	100.0

Table 14 is a summary of the sample crossings by highway gradient within 100 feet of the intersection. Since a driver may reduce speed because of an awareness of an elevated intersection, it seemed advisable to study accident records according to this classification.

TABLE 14

DISTRIBUTION OF CROSSINGS BY HIGHWAY GRADIENT AT THE RAIL-HIGHWAY INTERSECTION*

Type Crossing	Highway Gradient: Less than one %	% of Crossings	1 to 3 %	% of Crossings	Greater than 3 %	% of Crossings	TOTAL	% of Crossings
Accident	96	32.2	40	13.4	10	3.4	146	49.0
Non-Accident	87	29.2	56	18.8	9	3.0	152	51.0
TOTAL	183	61.4	96	32.2	19	6.4	298	100.0

*Type of Crossing Gradient is illustrated in Figure 6, Appendix A.

The data indicate that crossings with little or no elevation experience a relatively larger number of accidents than those with measurable gradients. This may indicate that even slight crossing elevation may be a factor in accident reduction.

Primary and Secondary Sight Channels

Previous research in the area of rail-highway grade crossing safety evaluation has given considerable attention to the subject of sight obstruction. Several methods for measuring the relationship between sight obstructions and the occurrence of accidents at rail-highway grade crossings have been developed during the course of these studies. As a result of a review of these studies and consultation with diagnostic team members, procedure for measuring primary and secondary sight channels has been developed for use in the current project.

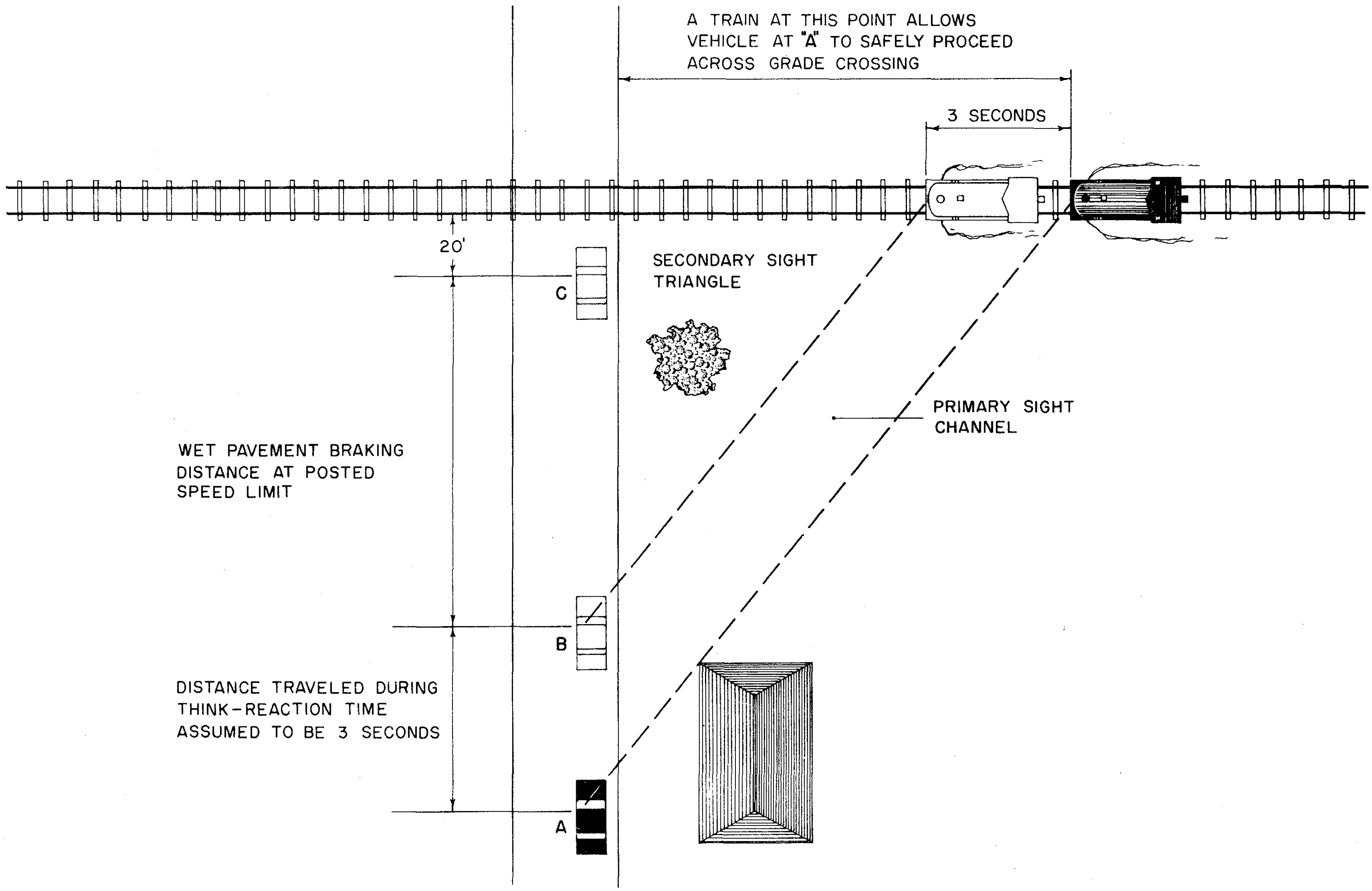
Basically the procedure was developed from the question "Is the highway vehicle operator able to see an approaching train in time to take evasive actions?" There are many actions a driver aware of an approaching train may take, but all can be classified as desirable or undesirable. Desirable actions would be those which do not result in damage to property or injury. This class would include braking to a safe stop prior to the crossing, accelerating sufficiently to clear the crossing before the train takes occupancy, or turning into a side street rather than proceeding. Undesirable actions would include attempting to stop by encountering a fixed object, such as the cross buck protecting the crossing, or swerving off of the roadway into a ditch or other fixed objects belonging to adjacent property owners.

For the purposes of the study it was decided that, in order to have clear sight, the driver must have continuous view of the train during his decision time. Second, there should be as little obstruction as possible between the driver and the crossing above this channel. The first is known as the primary sight channel and the second is the secondary sight triangle.

Figure 5 is a pictorial representation of the manner in which the primary sight channel and secondary sight triangle have been computed. As seen in this figure, the primary sight channel is defined by two points along the highway and two points along the railroad in each quadrant of the highway railroad crossing. The most distant point along the highway, point A, is defined by the distance traveled during the think-reaction time of the driver plus braking distance on wet pavement, plus twenty feet of clearance from the first track at the crossing. Point B is defined as the commitment point and excludes the think-reaction time. In other words, at point B the driver must be engaging either his brakes or accelerator if he is to avoid a collision with a train. At this point, the driver is committed to a course of action to either stop or go. Note that each of the points are defined only by vehicle speed and friction on the highway. The most distant point along the railroad is defined as a point where a train traveling at the posted speed limit would arrive at the intersection after an approaching vehicle, traveling at the posted highway speed has passed through the intersection.

FIGURE 5

SIGHT CLEARANCE



The highway vehicle is assumed to travel at a constant speed between the two highway points and take on truck acceleration rates at the second highway point (at speeds above 50 mph no acceleration was assumed). The second railroad point is the position of the train under the same conditions but with the vehicle at point B.

In any one quadrant these four points define a path or channel that includes the paths of both the highway vehicle and the train during the drivers think-reaction time. For the purpose of this study, a three-second think-reaction time, which is sufficiently long to include more than ninety percent of drivers, has been assumed. The study also assumes that the driver must have clear visibility of the train all during the think-reaction time to adequately assess his situation. Note that if the train is just entering the sight channel either decision the driver makes, to stop or go, is correct. Of course, if the train is within or through this channel, the driver only has one correct choice, to stop.

After the train and the highway vehicle are within the near points defined above, the vehicle operator is completely committed to his decision; he can no longer change his mind unless he has superior brakes or acceleration ability. In this secondary sight triangle, which is formed by the highway, the railroad, and the inside line of the primary sight channel, it is not as critical for the driver to maintain view of the train. However, this area should be as clear as possible in order that the driver maintain a continuous path of vision. It would be most desirable to maintain this triangle free of any large solid mass objects, such as buildings or large signs; however, light vegetation, scattered trees, or small signs may be acceptable in this portion of the sight triangle. Because of the severity of auto-train accidents, even accidents which result from engaging in evasive action are usually preferable to these accidents. A continuity of vision in the secondary sight triangle is recommended in order that the driver has an opportunity to reevaluate his decision in light of the dynamic conditions which are encountered in the interval between his decision and the completion of the decision.

Sight Obstruction

Table 15 shows the distribution of sample crossings according to sight obstructions within the primary sight channels. By comparing the accident and non-accident categories it is apparent that a relatively higher percentage of the accident crossings occur in those classes having two or more quadrants obstructed than in those categories having little or no sight obstructions.

A relative measure of the effectiveness of the protective device can be seen in the sample crossing summary data presented in Table 16. Although the distribution of accident crossings, by protected and unprotected categories, for crossings of three or less obstructed quadrants is quite similar, 30 of the 49 accident crossings with all four quadrants obstructed were protected. These data suggest that primary sight channel obstructions may be contributing to accidents at protected crossings.

Tables 17 and 18 provide the same type of summary data for secondary sight triangle analysis as presented previously in regard

TABLE 15

DISTRIBUTION OF ACCIDENT AND NON-ACCIDENT CROSSINGS
BY NUMBER OF OBSTRUCTED PRIMARY SIGHT CHANNELS

	No Obstruction		Quadrant 1		Quadrant 2		Quadrant 3		Quadrant 4		TOTAL	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Accident	21	14.4	19	13.0	34	23.3	23	15.7	49	33.6	146	100.0
Non-Accident	28	18.8	29	19.5	31	20.8	22	14.7	39	26.2	149	100.0

TABLE 16

DISTRIBUTION OF ACCIDENT AND NON-ACCIDENT CROSSINGS
BY NUMBER OF OBSTRUCTED PRIMARY SIGHT CHANNELS AND PROTECTION

	No Obstruction		Quadrant 1		Quadrant 2		Quadrant 3		Quadrant 4			
	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected
Accident	9	12	11	8	16	18	10	13	30	19	76	70
Non-Accident	10	18	17	12	21	10	13	9	23	16	84	65

to primary sight channel analysis. In general, it may be observed from these tables that the secondary sight triangle obstruction contributes to the occurrence of accidents at rail-highway grade crossings at approximately the same degree as the primary sight channel obstructions.

Activity VII - Design of Analytical Procedures

A major objective of this study is to determine the type of protection that would provide acceptable efficiency under the conditions encountered on the various classifications of grade crossings. In order to achieve this objective, methods and procedures for the development of a predictive model for the assignment of a hazard rating, for various classes of rail-highway grade crossings must be established.

A review of previous research suggests that there are several approaches to the development of a hazard rating (or index). For example Newnan, in his California study used a "regression model"[5]; the Voorhees report develops a "probability of an accident model"[6] and the Indiana study uses both factor analysis and regression analysis in the development of "the index of hazard."[7]

Each of these methods, along with other statistical methods suggested by consulting statisticians from the University's Institute

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5 Newnan, Donald G. An Economic Analysis of Railway Grade Crossings on the California State Highway System. Institute in Engineering Economic Systems, Stanford University, Stanford California, June 1965.

6 Alan M. Voorhees & Associates, Inc., Factors Influencing Safety at Highway-Rail Grade Crossings, NCHRP Research Project 3-8, (An unpublishe report), Washington D. C., January 1967.

7 Shultz, T. G. Evaluation of Safety at Railroad-Highway Grade Crossings. Purdue University, March 1964.

TABLE 17

DISTRIBUTION OF ACCIDENT AND NON-ACCIDENT CROSSINGS
BY PERCENT OF OBSTRUCTION IN SECONDARY SIGHT TRIANGLE

	Percent of Obstruction									
	Less than 25		26-50		51-75		Over 75		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%
Accident	63	43.2	32	21.9	22	15.1	29	19.8	146	100.0
Non-Accident	74	49.7	26	17.4	23	15.4	26	17.5	149	100.0

TABLE 18

DISTRIBUTION OF ACCIDENT AND NON-ACCIDENT CROSSINGS
BY PERCENT OF OBSTRUCTIONS IN SECONDARY SIGHT TRIANGLE AND PROTECTION

	Percent of Obstruction									
	Less than 25		26-50		51-75		Over 75		TOTAL	
	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected
Accident	29	34	16	16	13	9	18	11	76	70
Non-Accident	35	39	19	7	11	12	19	7	84	65

of statistics, are being given careful consideration for adaptation to the data analysis requirement of the current project.

For the purpose of this report only the regression model application to the pilot study sample crossings will be discussed.

Since it was obvious from beginning of the study that the difference between hazard ratings computed for various classes of rail-highway grade crossings would be the result of a number of variables, all acting at the same time, it was decided that the regression model would be the most logical departing point in the design of analytical procedures.

Mathematically the regression model can be expressed in the following manner:

$$X_1 = a + b_2X_2 + b_3X_3 \ldots\ldots b_mX_m$$

where, X_1 = dependent variable

$X_2X_3\ldots X_m$ = the several independent variables

The equation is termed the multiple regression equation. The coefficients b_2 and b_3 are termed the net regression coefficients. An additional term which is significant to the equation is gross regression coefficient (byx X). This coefficient is a measure of the apparent relation between dependent and independent variables without considering whether the relation is due to the independent variable alone, or partly or wholly due to other independent variables. Allowing for the effect of each of the independent variables so as to determine the true relation of each one to the dependent variable, by adjusting each independent variable separately, is the application of a statistical technique referred to as the method of successive elimination.

The review of several formulas currently being used by state and local traffic engineering departments indicates that there is little or no difference between their predictability qualities. This analysis agrees with the findings of a paper prepared by Mr. Georgy Bezkorovainy in which he states that the eleven formulas that are most commonly used are "either all equally good or all equally bad."[8]

It is the objective of this project to develop a hazard index formula which will represent the true hazard at any rail-highway grade crossing whether rural or urban. The key to meeting this objective may be found in the recovery of accurate and well defined data relating to the physical and operating characteristics of various classes of rail-highway grade crossing rather than in the development of a more sophisticated statistical analysis technique than is currently available.

SUMMARY AND CONCLUSIONS

Tentative findings indicate that there are 13,556 public rail-highway grade crossings in the State of Texas. Of these, 1,834 (13.5%) are located on the state highway system in rural areas, 6,472 (47.7%) are on the state highways and city streets within urban areas and 5,250 (38.7%) are on county roads.

Over 78 percent of the Texas rail-highway grade crossings are protected only by the crossbuck device. Flashing lights, wigwags

[8] Bezkorovainy, Georgy. Optimum Hazard Index Formula for Railroad Crossing Protection for Lincoln, Nebraska. The 1967 ITE Past Presidents' Award Paper.

and bells account for 17 percent of the crossings having protective devices while crossings protected by automatic gates represent only one percent of the Texas inventory of grade crossings.

The highest incidence of crossings, according to train speed categories, occurs at 31-40 mph for both rural highway and county road crossings. However, the largest percentage of urban crossings occurs in the speed category of 10-20 mph.

The basic inventory records reveal that 1,680 (12.4%) of the crossings have a reported train frequency of only one train per day. The two-train-per-day crossings represent approximately 34 percent of the total inventory.

Approximately 48 percent of the inventoried crossings are located in urban areas. Although 544 urban areas are included in the inventory, just 20 Texas cities account for 43 percent of the urban crossings and 20 percent of the total inventory.

Approximately 40 percent of all Texas grade crossings are located in just 20 counties.

During the period 1962-1966, 1,563 rail-highway grade crossing accidents were reported to the Texas Railroad Commission. These accidents resulted in the death of 577 individuals and injury to an additional 1,685 persons. These data do not include accidents occurring at the grade crossing which did not involve a train. Early estimates indicate that automobile collisions with fixed objects and other automobiles at rail-highway grade crossings may be as high as 200 per year.

While total vehicular injuries outnumbered total vehicular fatalities by approximately 60-1 during the 1962-1966 period, auto-train accident injuries outnumbered fatalities by less than 3 to 1. These data are indicative of the severity of rail-highway grade crossing accidents.

Preliminary findings indicate that 642 of the 1,563 accidents reported by the railroad companies during the period 1962-1966 occurred in rural areas on highway facilities administered by the Texas Highway Department. Therefore, approximately 60 percent of the rail-highway grade crossings occur in either urban areas or at county administered crossings.

The diagnostic team approach to the evaluation of factors contributing to hazardous conditions at rail-highway intersections is a significant contribution to this type of research.

The computation of a probability of conflict factor for each of the rail-highway grade crossings to be evaluated is an important tool in the assignment of the crossings to homogenous categories.

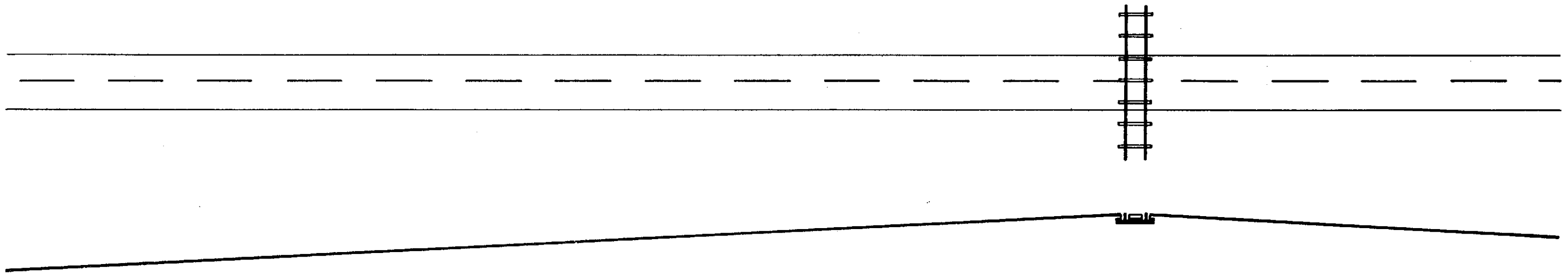
Primary and secondary sight channel computation has provided a means for measuring the relationship between sight obstruction and the occurrence of accidents at rail-highway grade crossings.

Tentative findings indicate that the regression model may be the "best" statistical approach to the solution of a hazard index formula that will represent the true hazard at any rail-highway grade crossing whether rural or urban.

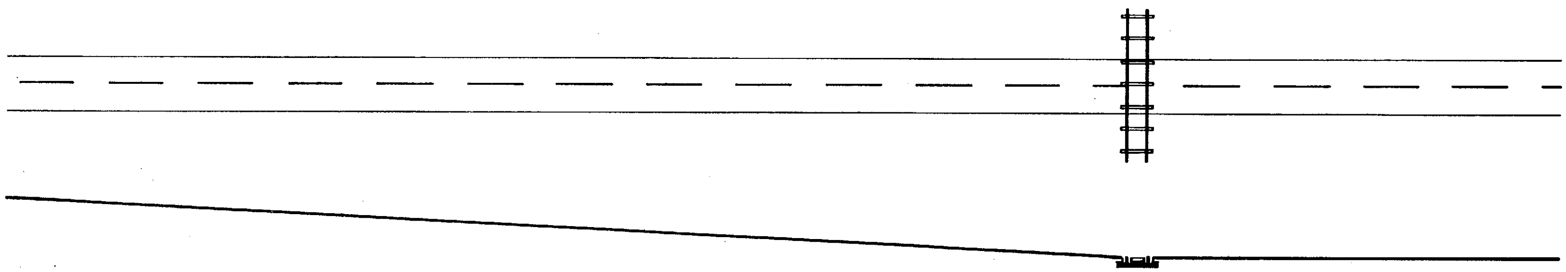
APPENDIX A

FIGURE 6

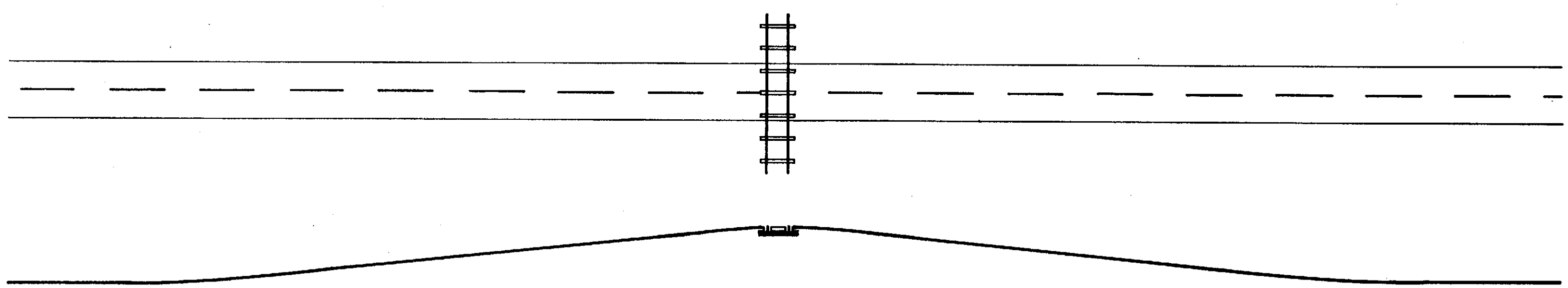
TYPE OF CROSSING GRADIENT



APPROACH GRADE



APPROACH GRADE



INTERSECTION SLOPE

1962 Revision

Form Approved
Budget Bureau No. 60-R273 11

INTERSTATE COMMERCE COMMISSION
BUREAU OF TRANSPORT ECONOMICS AND STATISTICS

MONTHLY REPORT
ACCIDENT AT HIGHWAY GRADE CROSSING

Supplemental to T Sheet No.______

1. Reporting Carrier	2. Date of Accident	3. Reporting Month

I. ACCIDENT

4. Cause of Accident
   - ☐ Struck by Train
   - ☐ Ran into side of Train

5. Part of Train Struck
   - ☐ Engine pulling
   - ☐ ______ Quarter
   - ☐ Lead car
   - ☐ Last car or unit pushing

6. Object Struck, or Striking
   - ☐ Auto ☐ Truck ☐ Other
   - ☐ Bus ☐ Motorcycle

7. Vehicle was
   - ☐ Stalled on crossing
   - ☐ Stopped on crossing

   Estimated speed of vehicle (if moving) ______mph

8. If vehicle subject to Motor Carrier Act, give name and address of operating company.

   Name: Address:

9. If vehicle carried dangerous commodity* (i.e., explosives, petroleum, etc.) name commodity carried.

II. CROSSING PROTECTION

10. Type of Protection
    - ☐ Gates, Automatic
    - ☐ Gates, Manual
    - ☐ Watchman
    - ☐ Other employee
    - ☐ Audible and Visual
    - ☐ Audible Signal
    - ☐ Visual Signal
    - ☐ Crossbuck
    - **☐ Other
    - ☐ Unprotected

11. Protection was located on
    - ☐ Both sides of crossing
    - ☐ Side from which vehicle approached
    - ☐ Side opposite

12. Was protection operating? ☐ Yes ☐ No
    State any factor impairing effective operation.

13. Was view of track obscured by
    - ☐ Permanent structure
    - ☐ Standing RR equipment
    - ☐ Passing train
    - ☐ Topography
    - ☐ Vegetation
    - ☐ Vehicle
    - ☐ Other, explain

14. Did person or object struck, or striking go *over*, *around*, *under* or *through* gates?
    ☐ Yes ☐ No

15. If accident occurred at night (one-half hour after sunset to one-half hour before sunrise) was crossing illuminated?
    ☐ Yes ☐ No

16. Signature Title

*Dangerous commodities: Liquid petroleum, and liquid petroleum products, explosives, flammable or poisonous compressed gases, volatile liquids and solids which emit poisonous fumes, corrosive liquids, and radioactive materials, etc.

**Explain whether State signs, advance warning signs, etc.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1962 OF—658262

1962 REVISION

INTERSTATE COMMERCE COMMISSION
BUREAU OF TRANSPORT ECONOMICS AND STATISTICS

Form Approved
Budget Bureau No. 60-R263.13

FORM T

SHEET NO.

MONTHLY REPORT OF RAILROAD ACCIDENT

(See instructions on reverse side.)

1. REPORTING CARRIER	2. CARRIER'S FILE NO.	3. FOR THE MONTH OF

4. IF "JOINT OPERATION" OR CROSSING COLLISION NAME ROADS INVOLVED.	5. IF "JOINT OPERATION" NAME ROAD WHOSE SUPERINTENDENT IS IN CHARGE OF TRACK.
6. KIND OF ACCIDENT ☐ TRAIN ☐ TRAIN-SERVICE ☐ NONTRAIN	7. ICC CLASS & SUB CLASS *(§125.22, 125.23, 125.24)*

8. NEAREST STATION AND NAME OF STATE WHERE ACCIDENT OCCURRED.	9. DATE OF ACCIDENT	10. TIME *(Use standard)* ..........A.M. ........P.M.

11. VISIBILITY AND WEATHER (CHECK APPROPRIATE BOXES)				12. DAMAGE IN DOLLARS *(Train accidents only)*			
				NAME OF ROAD	EQUIPMENT	TRACK	TOTAL
	DAYLIGHT		FOGGY		$	$	$
	DARK		RAINING				
	CLEAR		SNOWING				
	CLOUDY		SLEETING	TOTAL			

13. CAUSE *(Briefly)*

14. KIND OF TRACK		15. METHOD OF OPERATION AND SIGNALLING						16. KIND OF EQUIPMENT	
	MAIN		MANUAL BLOCK		AUTO. BLOCK SIG.		AUTO. TRAIN STOP		LOCOMOTIVE
	BRANCH		CONT. MANUAL		INTERLOCKING		AUTO. TRAIN CONT.		FREIGHT TRAIN CAR
	YARD		TRAIN ORDER		CENT. TRAF. CONT.		CAB SIGNAL		PASS. TRAIN CAR

17. KIND OF TRAIN	18. MOTIVE POWER	19. NO. OF CARS	20. TIMETABLE DIRECTION	21. SPEED
P ☐ ☐ TF ☐ ☐ LF ☐ ☐ Y ☐ ☐ W ☐ ☐ O ☐ ☐	D ☐ ☐ E ☐ ☐ RMC ☐ ☐ O ☐ ☐	______ ______	N S E W	______ MPH ______ MPH

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
																												I.C.C. use only																

22. DETAILS OF CASUALTIES TO PERSONS

Class of person *(a)* (§125.50)	Age in case of employee *(b)*	I.C.C. use only 29	30	31	32	33	Killed or nature and extent of injuries *(c)* [§125.14(a), 125.47(a), 125.47(c)]	I.C.C. use only 34	35	36	Days disability A=Actual P=Probable *(d)* [§125.47(b)]

23. FULL DETAILS OF CAUSE, NATURE, AND CIRCUMSTANCES OF ACCIDENT

CONTINUE ON REVERSE SIDE OF SHEET IF NECESSARY

SIGNATURE	TITLE

TEXAS POLICE OFFICERS' CONFIDENTIAL ACC NT REPORT **MAIL TO: Texas Department blic Safety, No. Austin Sta., Austin, Texas. 78751**

DO NOT WRITE IN THIS SPACE

Local No. ....
DPS No. ....
Loc. ....
S.R. ....
Fat. rec. ....
Dr. rec. ....
Code ....
Type ....
FAT. P.I. P.D.

LOCATION

PLACE WHERE ACCIDENT OCCURRED County .... City or town ....

If accident was outside city limits, indicate distance from nearest town .... miles ☐ North ☐ S ☐ E ☐ W of .... City or Town

ROAD ON WHICH ACCIDENT OCCURRED .... Give name of street or highway number (U.S. or State). If no highway number, identify by name. Under Construction? ☐ Yes ☐ No

Check and complete one only
- AT ITS INTERSECTION WITH .... Name of intersecting street or highway number
- IF NOT AT INTERSECTION .... feet ☐ North ☐ S ☐ E ☐ W of .... Show nearest intersecting street or highway, house no., bridge, RR crossing, alley, driveway, culvert, milepost, underpass, or other landmark.

TIME

Date of Accident .... 19 .... Day of Week .... Hour .... ☐ A.M. ☐ P.M. If exactly noon or midnight, so state.

VEHICLES

VEHICLE NO. 1

Year Model .... Make and Type of Vehicle .... Sedan, tractor-semi-trailer, taxi, etc. Vehicle Registration .... Year State Number Commodity Carried .... Butane, mixed freight, etc. Had Seat Belts ☐ Yes ☐ No

DRIVER .... Name Address City and State .... Sex .... Drinking?* ☐ Yes ☐ No

Race of Driver .... Driver's Occupation .... Carpenter, doctor, sales clerk, etc. Date of Birth .... Month, Day, Year Driver's License .... State Number ☐ Chauffeur ☐ Operator ☐ Com. Op.

Speed Before Accident* .... m.p.h. Legal Speed Limit .... m.p.h. Maximum Safe Speed* .... m.p.h. Physical Condition* .... Approximate cost to repair vehicle* $ ....

OWNER .... Name Address Vehicle Removed To .... Name of garage, home by owner, driven away, etc.

VEHICLE NO. 2

Year Model .... Make and Type of Vehicle .... Sedan, tractor-semi-trailer, taxi, etc. Vehicle Registration .... Year State Number Commodity Carried .... Butane, mixed freight, etc. Had Seat Belts ☐ Yes ☐ No

DRIVER .... Name Address City and State .... Sex .... Drinking?* ☐ Yes ☐ No

Race of Driver .... Driver's Occupation .... Carpenter, doctor, sales clerk, etc. Date of Birth .... Month, Day, Year Driver's License .... State Number ☐ Chauffeur ☐ Operator ☐ Com. Op.

Speed Before Accident* .... m.p.h. Legal Speed Limit .... m.p.h. Maximum Safe Speed* .... m.p.h. Physical Condition* .... Approximate cost to repair vehicle* $ ....

OWNER .... Name Address Vehicle Removed To .... Name of garage, home by owner, driven away, etc.

For Other Vehicles Use Another Form

Total Vehicles Involved ....

DAMAGE TO PROPERTY OTHER THAN VEHICLES .... Name object and state nature of damage $ .... Estimated Cost *

Name and address of owner of damaged property ....

CODE FOR INJURY SEVERITY
(Use only the most serious one in each space for injury.)
A – Serious visible injury, as deep, bleeding wound, distorted member, etc.
B – Minor visible injury, as bruises, abrasions, swelling, limping, etc.
C – No visible injury but complaint of pain or momentary unconsciousness.

CASUALTIES

NO. 1

Name .... Address ....
Age .... Sex .... Race .... Was person killed? .... Date of Death ....
Taken to .... By ....

☐ Driver ☐ Passenger — In veh. No. .... ☐ Pedestrian
Severity ☐ A ☐ B ☐ C
Seat Belt ☐ Used ☐ Not Used

NO. 2

Name .... Address ....
Age .... Sex .... Race .... Was person killed? .... Date of Death ....
Taken to .... By ....

☐ Driver ☐ Passenger — In veh. No. .... ☐ Pedestrian
Severity ☐ A ☐ B ☐ C
Seat Belt ☐ Used ☐ Not Used

Total ....

PASSENGERS AND/OR WITNESSES

Name .... Address .... Location .... In veh. 2 RF, ped. 60 ft. east, etc.
Name .... Address .... Location ....
Name .... Address .... Location ....
Name .... Address .... Location ....
Name .... Address .... Location ....
Name .... Address .... Location ....
Name .... Address .... Location ....
Name .... Address .... Location ....

FORM ST-3 *THESE ITEMS REFLECT THE INVESTIGATOR'S OPINIONS. REV. 1-1-64

KIND OF LOCALITY
(Check one)
1. ☐ Apartments, Stores Factories, Schools
2. ☐ One-family homes
3. ☐ Farms, Fields
4. ☐ No marginal development

TRAFFIC CONTROL
(Check one or more)
1. ☐ Stop sign
2. ☐ Stop-and-go signal
3. ☐ Officer or watchman
4. ☐ R.R. gates or signals
5. ☐ .... Specify other
6. ☐ No traffic control

LIGHT CONDITIONS
(Check one)
1. ☐ Daylight 3. ☐ Darkness
2. ☐ Dawn 4. ☐ Dusk

WEATHER
(Check one)
1. ☐ Clear 3. ☐ Snowing
2. ☐ Raining 4. ☐ Fog
5. ☐ .... Specify other

ROAD LANES (TOTAL)
(Check lanes on road used by each driver.)
Driver 1 2
1. ☐ ☐ 1 lane
2. ☐ ☐ 2 lanes
3. ☐ ☐ 3 lanes
4. ☐ ☐ 4 or more lanes
☐ ☐ Divided roadway
☐ ☐ Expressway, freeway, toll road, etc.

ROAD SURFACE
(Check one)
1. ☐ Dry
2. ☐ Wet
3. ☐ Snowy or Icy
4. ☐ .... Specify other

ROAD CHARACTER
(Check two)
1. ☐ Straight road
2. ☐ Curve
3. ☐ Level
4. ☐ On grade
5. ☐ Hillcrest

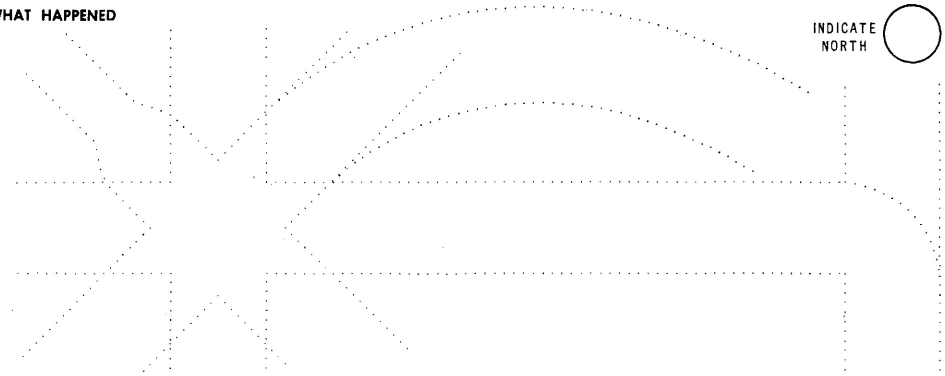
W. DRIVERS WERE GOING TO DO BEFORE ACCIDENT
(Check one for each driver)
Driver 1 2
1. ☐ ☐ Go straight ahead
2. ☐ ☐ Overtake and pass
3. ☐ ☐ Make right turn
4. ☐ ☐ Make left turn
5. ☐ ☐ Make U turn
6. ☐ ☐ Slow or stop
7. ☐ ☐ Start in traffic lane
8. ☐ ☐ Start from Parked position
9. ☐ ☐ Back
10. ☐ ☐ Remain stopped in traffic lane
11. ☐ ☐ Remain parked

WHAT PEDESTRIAN WAS DOING
Pedestrian was going ☐ N ☐ S ☐ E ☐ W ☐ Along ☐ Across or into .... (Street name, highway No.) From .... To .... (N.E. corner to S.E. corner, or west to east side, etc.)
1. ☐ Crossing or entering at intersection
2. ☐ Crossing or entering not at intersection
3. ☐ Getting on or off vehicle
4. ☐ Walking in roadway – with traffic
5. ☐ Walking in roadway – against traffic
6. ☐ Standing in roadway
7. ☐ Pushing or working on vehicle
8. ☐ Other working in roadway
9. ☐ Playing in roadway
10. ☐ Other in roadway
11. ☐ Not in roadway
12. ☐ Had been Drinking *

VIOLATIONS CONTRIBUTING TO ACCIDENT
(Check one or more for each driver)
Driver 1 2
1. ☐ ☐ Speeding – over limit
2. ☐ ☐ Speed – under limit–unsafe
3. ☐ ☐ Fail to Yield ROW to Vehicle
4. ☐ ☐ Disregard Stop Sign or light
5. ☐ ☐ Disregard Stop and Go Signal
6. ☐ ☐ Disregard Flashing Yellow Signal
7. ☐ ☐ Improper turn – wide right
8. ☐ ☐ Improper turn – cut corner on left
9. ☐ ☐ Improper turn – wrong lane
10. ☐ ☐ Wrong side – not passing
11. ☐ ☐ Wrong way 1 way road
12. ☐ ☐ Following too closely
13. ☐ ☐ Overtake and pass – insufficient clearance
14. ☐ ☐ Pass in No Passing Zone
15. ☐ ☐ All other illegal passing
16. ☐ ☐ No signal or wrong signal of intention
17. ☐ ☐ Improper start from parked position
18. ☐ ☐ Fail to yield ROW to pedestrian
19. ☐ ☐ Improper parking
20. ☐ ☐ Driving under influence (liquor or drugs)
21. ☐ ☐ Defective Brakes
22. ☐ ☐ Defective lights
23. ☐ ☐ Other Defective equipment
24. ☐ ☐ Other Violations ....
25. ☐ ☐ No violation as accident cause

INDICATE ON THIS DIAGRAM WHAT HAPPENED

INSTRUCTIONS
1. Follow dotted lines to draw outline of roadway at place of accident.
2. Number each vehicle and show direction of travel by arrow: —[1 X 2]—
3. Use solid line to show path before accident ——[2>
dotted line after accident: - - - -[2>
4. Show pedestrian by: ——O
5. Show railroad by: —┼┼┼┼┼┼┼—
6. Show distance and direction to landmarks; identify landmarks by name or number.



INDICATE NORTH ◯

DESCRIBE WHAT HAPPENED
(Refer to vehicles by number) ....

POLICE ACTIVITY

SHOW ARRESTS AND CHARGES
Name .... Charge .... Ticket No. ....
Name .... Charge .... Ticket No. ....

Time notified of accident .... (Date) .... (Hour) M
Time arrived at scene of accident .... (Date) .... (Hour) M
Was investigation made at scene of accident? ☐ Yes ☐ No
Driver report form furnished to ☐ Driver 1 ☐ Driver 2
Where else was investigation made? ....
Were photographs taken? ☐ Yes ☐ No
Is investigation complete? ....

SIGNATURE .... (Investigator's name and rank or number) .... (Department) .... Date of report ....

IMPORTANT! Drivers must also submit a report to DPS if there were casualties and/or total damage of $25 or more. Drivers accident report forms are available at all state, county, and city police offices.

APPENDIX B

SURVEY SAMPLE CROSSING

DATE ______________________ I. D. NUMBER ______________________

COUNTY ______________________ CITY ______________________

TYPE OF HIGHWAY ______________ HIGHWAY NUMBER ______________ NUMBER OF TRAFFIC LANES ________

HIGHWAY CONTROL ______________ HIGHWAY SECTION ______________ HIGHWAY MILEPOST ________

RAILROAD COMPANY ____

R. R. DIVISION ________________ R. R. MILEPOST ________________

TYPE TRACK ( ) MAINTRACK ( ) BRANCH ( ) SIDING ( ) SPUR ( ) WYE

NO. OF TRAINS DAILY ______________ AVERAGE DAILY TRAFFIC ________

TRAIN SPEED ______________________ AUTO SPEED ______________________

ROADWAY TYPE ______________________ ROADWAY WIDTH ______________________

SHOULDER TYPE ______________________ SURFACE TYPE ______________________

<u>ACCIDENT</u>

WEATHER ____

MONTH ______________ YEAR ______________ TIME OF DAY ____

NUMBER OF TOTAL ACCIDENTS ______________________________

NUMBER KILLED ______________ NUMBER INJURED ______________

TYPE OF COLLISION ______________________________________

DATE ____________________

FORM FOR FIELD DATA
Sample Crossings

(1-2) Card Number ____________

(3-7) I. D. Number ____________

(8-11) Highway Control ____________

(12-13) Highway Section ____________

(14-16) Highway Milepost ____________

(17) Roadway Type ____________

(18-19) Highway Width ____________

(20-21) Surface Width ____________

(22) Surface Type ____________

(23) Shoulder Type ____________

(24-25) Shoulder Width ____________

(26) Highway Direction
(N, E, NE or NW) ____________

(27) Approach Grade
(N, E, NE or NW) ____________

(28) Approach Grade
(S, W, SW or SE) ____________

(29-30) Angle of
Intersection ____________

(31-32) Highway Curvature
(N,E, NE or NW) ____________

(33-34) Highway Curvature
(S, W, SW or SE) ____________

(35-36) Posted Speed ____________

(37-38) Number Tracks ____________

(39-40) Crossing Slope
Vertical ____________
Horizontal ____________

(41) Track Level with Respect to Natural
Ground Level ____________

Below ____________
Above ____________
Same ____________

City ____________

County ____________

Highway Number ____________

District Number ____________

Railroad Company ____________

Railroad Subdivision ____________

Railroad Milepost ____________

Visibility Triangle Quadrant

(42) ____________ NE

(43) ____________ NW

(44) ____________ SE

(45) ____________ SW

Visibility Sight Channel Quadrant

(46) ____________ NE

(47) ____________ NW

(48) ____________ SE

(49) ____________ SW

Number and Type of Protective Devices

(50) Cross Buck ____________________

(51) R. Cross Buck _________________

(52) Stop Sign _____________________

(53) Flashing Lights ______________

(54) Bells _________________________

(55) Wagwags _______________________

(56) Watchman ______________________

(57) Auto Gates ____________

(58) Illumination __________

Advanced Warning _____

(59) RR ______________

(60) Highway __________

(61) Signal ___________

(62) Other ________________

(63) __________________

(64) Class of Protection ___

Number of Intersecting Streets and Highways

(65-68) 0-100 ft. ( ) ( ) ( ) ( )
Primary St. Secondary St. Primary Hwy. Secondary Hwy.

(69-72) 100-200 ft. ( ) ( ) ( ) ( )
Primary St. Secondary St. Primary Hwy. Secondary Hwy.

(73-76) 200-300 ft. ( ) ( ) ( ) ( )
Primary St. Secondary St. Primary Hwy. Secondary Hwy.

(77-80) 300-400 ft. ( ) ( ) ( ) ( )
Primary St. Secondary St. Primary Hwy. Secondary Hwy.

COMMENTS: