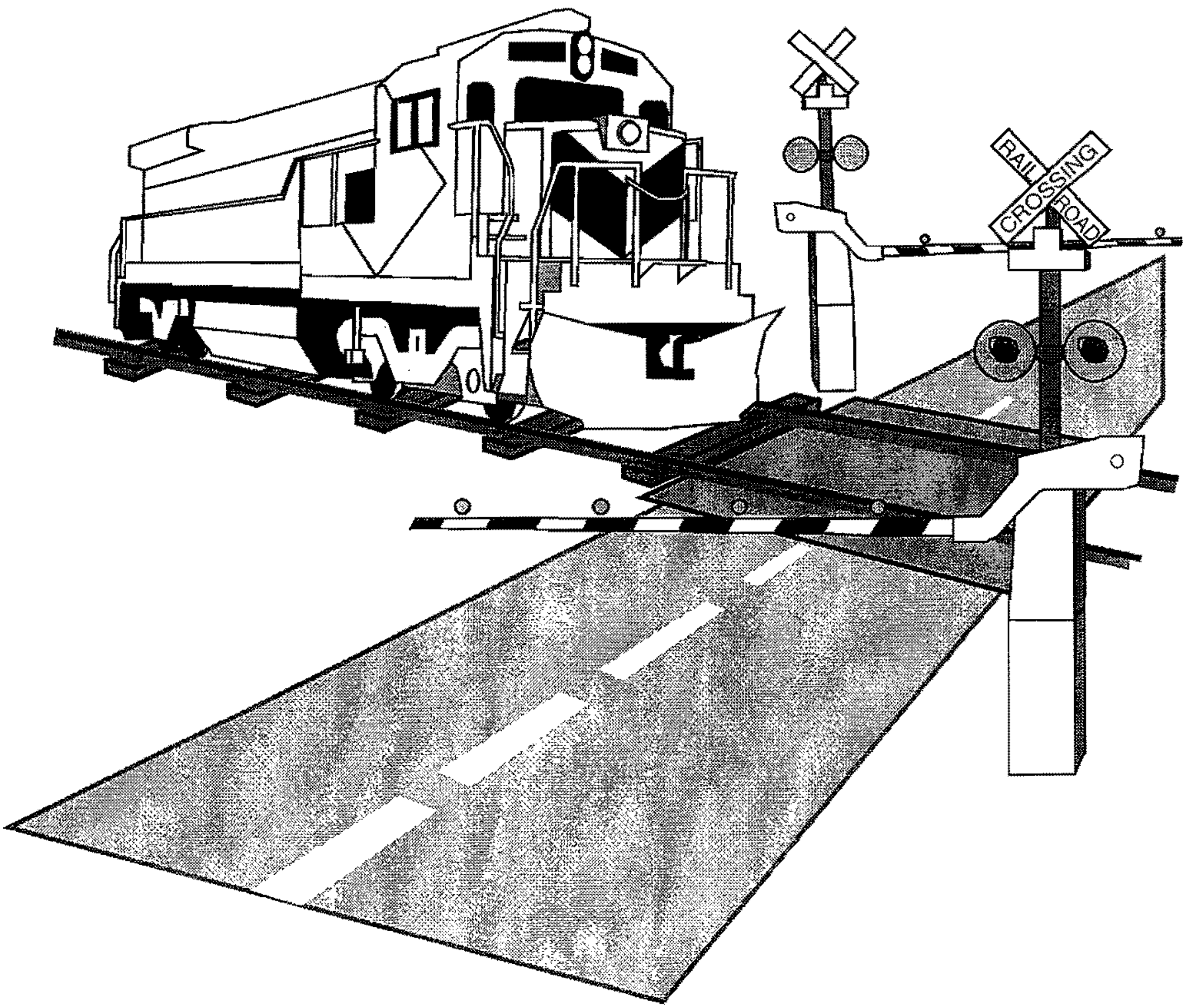
Railroad Maintenance and Operations Handbook

For Local Governments and Rail Carriers

2nd Edition



North Central Texas Council of Governments

What is NCTCOG?

The North Central Texas Council of Governments is a voluntary association of cities, counties, school districts, and special districts which was established in January 1966, to assist local governments in **planning** for common needs, **cooperating** for mutual benefit, and **coordinating** for sound regional development.

It serves a 16-county metropolitan region centered around the two urban centers of Dallas and Fort Worth. Currently the Council has **220 members**, including 16 counties, 157 cities, 25 independent school districts and 22 special districts. The area of the region is approximately **12,800 square miles**, which is larger than nine states, and the population of the region is over **4.2 million**, which is larger than 30 states.

NCTCOG's structure is relatively simple; each member government appoints a voting representative from the governing body. These voting representatives make up the **General Assembly** which annually elects an 11-member Executive Board (9 local elected officials and 2 regional citizens). The **Executive Board** is supported by policy development, technical advisory, and study committees, as well as a professional staff of approximately 100.

NCTCOG's offices are located in Arlington in the Centerpoint Two Building at 616 Six Flags Drive (approximately one-half mile south of the main entrance to Six Flags Over Texas).

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NCTCOG's Department of Transportation

Since 1974 NCTCOG has served as the Metropolitan Planning Organization (MPO) for transportation for the Dallas-Fort Worth area. NCTCOG's Department of Transportation is responsible for the regional planning process for all modes of transportation. The department provides technical support and staff assistance to the Regional Transportation Council and its technical committees, which compose the MPO policy-making structure. In addition the department provides technical assistance to the local governments of North Central Texas in planning, coordinating, and implementing transportation decisions.

Prepared in cooperation with the Texas Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration and Federal Transit Administration.

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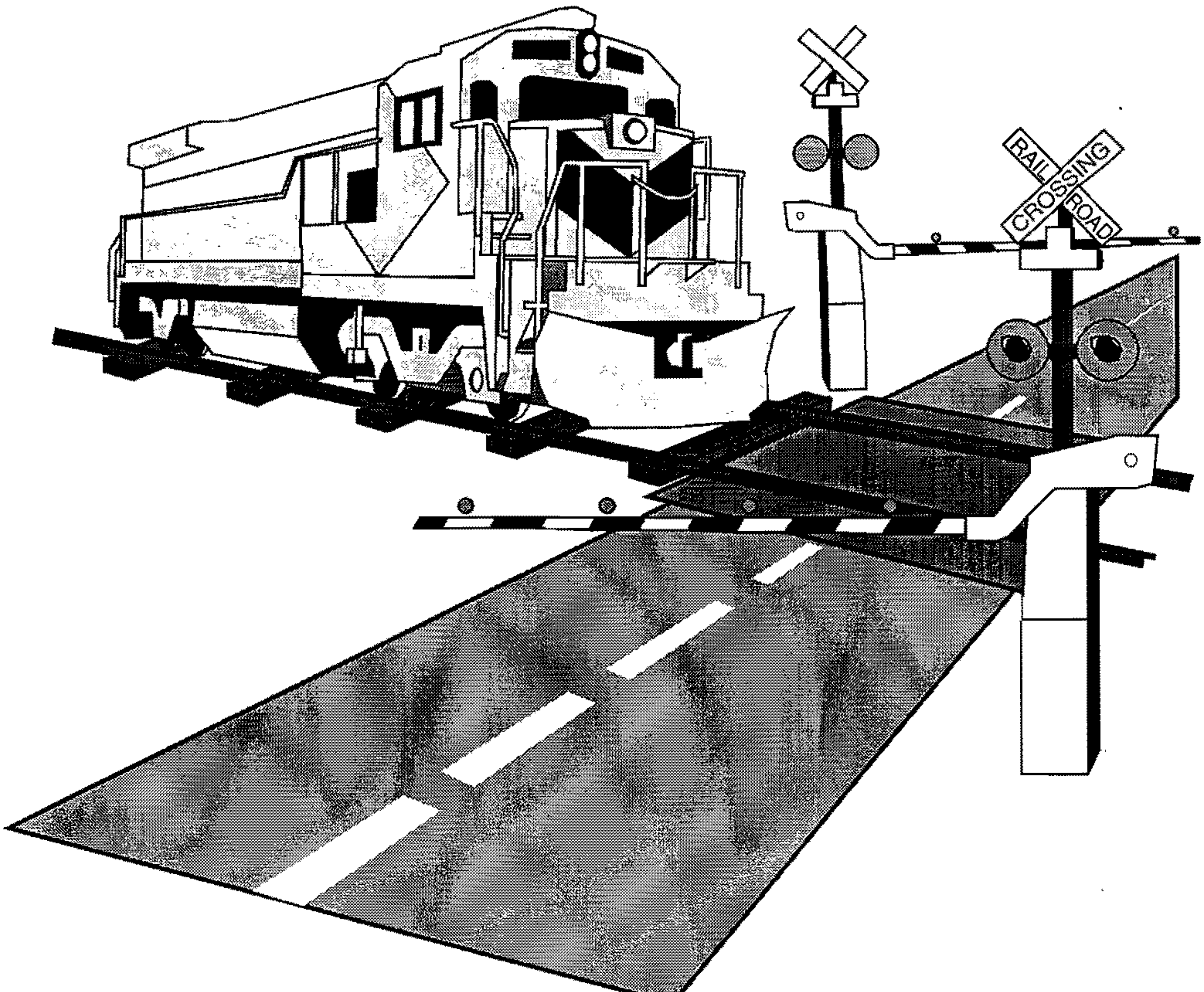

North Central Texas Council of Governments
April 1995

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Abstract

TITLE: Railroad Maintenance and Operations Handbook for Local Governments and Rail Carriers

AUTHOR: North Central Texas Council of Governments

SUBJECT: A summary of railroad guidelines for selected maintenance and operation procedures in the NCTCOG region.

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ABSTRACT: Local governments and private railroad operators have recommended that a regionwide handbook on railroad maintenance and operational procedures be compiled to assist cities and rail carriers in clarifying separate and joint jurisdictional issues. This report provides analyses of current maintenance and railroad operational issues with recommendations supported by local governments, state agencies, the Federal Railroad Administration, and major rail carriers. Included are a summary of maintenance guidelines including crossing upgrade procedures and funding; jurisdictions of agencies on highway and railroad rights-of-way; recommendations on signals, pavement, drainage, signs, illumination, pavement markings, crossing material selection, visual obstructions, operating speed restrictions, and blocked crossings; an overview of legal considerations in Texas; and a listing of emergency and nonemergency contact phone numbers.

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I. INTRODUCTION

Railroad maintenance and operation procedures vary widely in the North Central Texas Region. In response to a request from local communities and railroad operators, this report was prepared to recommend guidelines which are agreeable to several interested parties including: local governments, the Railroad Commission of Texas (RCT), the Texas Department of Transportation (TxDOT), the Federal Railroad Administration (FRA), and major passenger and freight rail operators within the region. These recommendations are not enforceable by legislative action unless expressly stated in the report. Jurisdictional issues, either as separate or joint responsibilities among local, state, or federal agencies and affected railroad companies, are presented with uniform guidelines and recommendations to be considered by the 16-county North Central Texas Region as shown in Figure I-1. The specific railroad network within the North Central Texas Council of Governments (NCTCOG) Transportation Study Area is shown in Figure I-2.

Section II of this report provides a summary and recommendations for selected maintenance issues. Grade crossing upgrades using the TxDOT Priority Index (PI) and a survey of funding mechanisms are discussed. The TxDOT Railroad Grade Crossing Replanking Program is presented which describes how the state reviews crossing projects located on the State Highway System. The Highway-Rail Crossing Surface Ranking Index presents a subjective evaluation process for rating crossing conditions. Jurisdictions of responsible agencies are considered along with maintenance of track, signals, pavement, drainage, signs, pavement markings, fencing, selection of grade crossing materials, reflectorized tape on signs, crossing illumination, track inspections, visual obstructions at crossings, and temporary grade crossing closures for maintenance.

FIGURE I-1

MAP OF THE NORTH CENTRAL TEXAS REGION
(All Cities over 5,000)

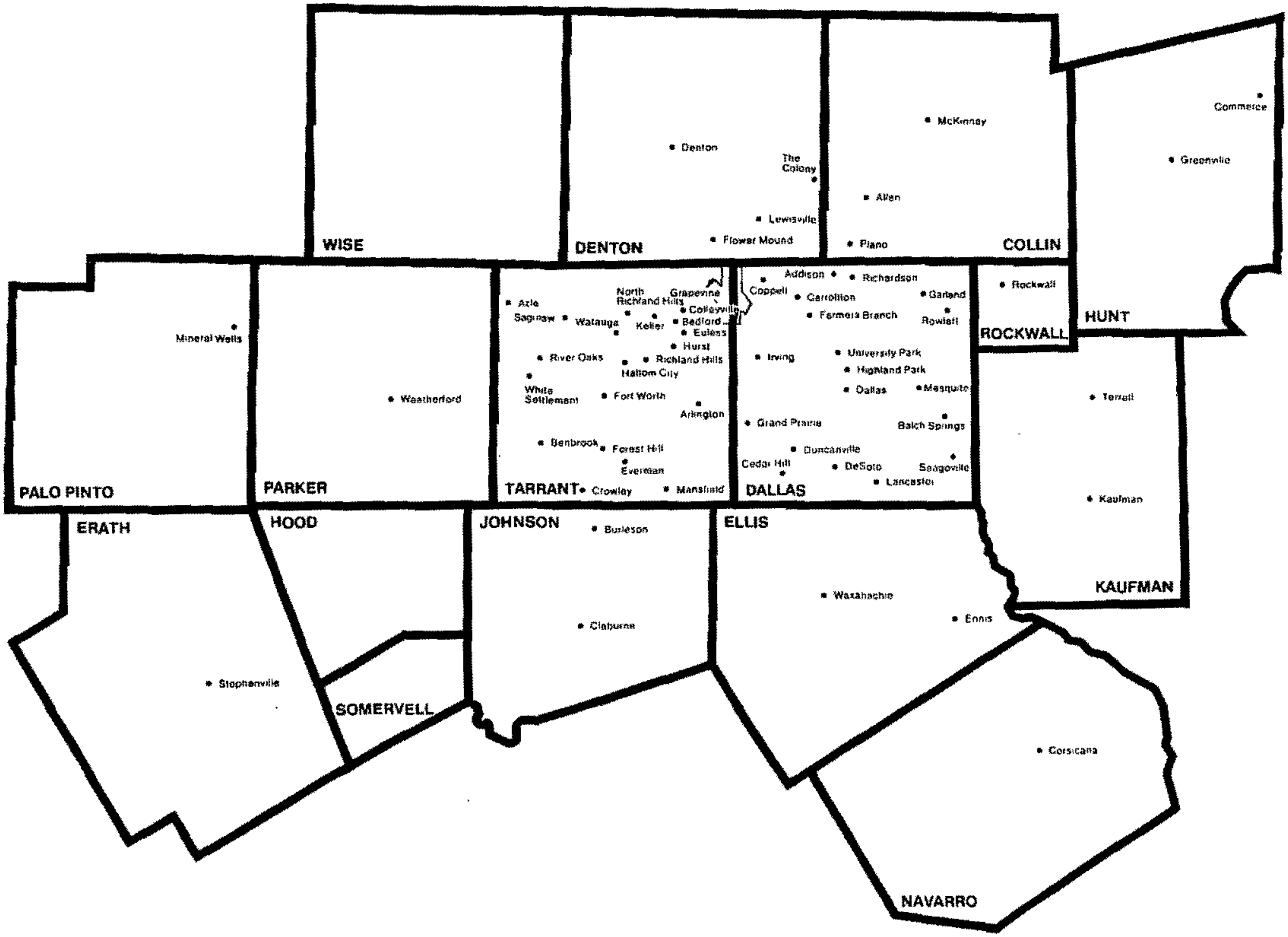
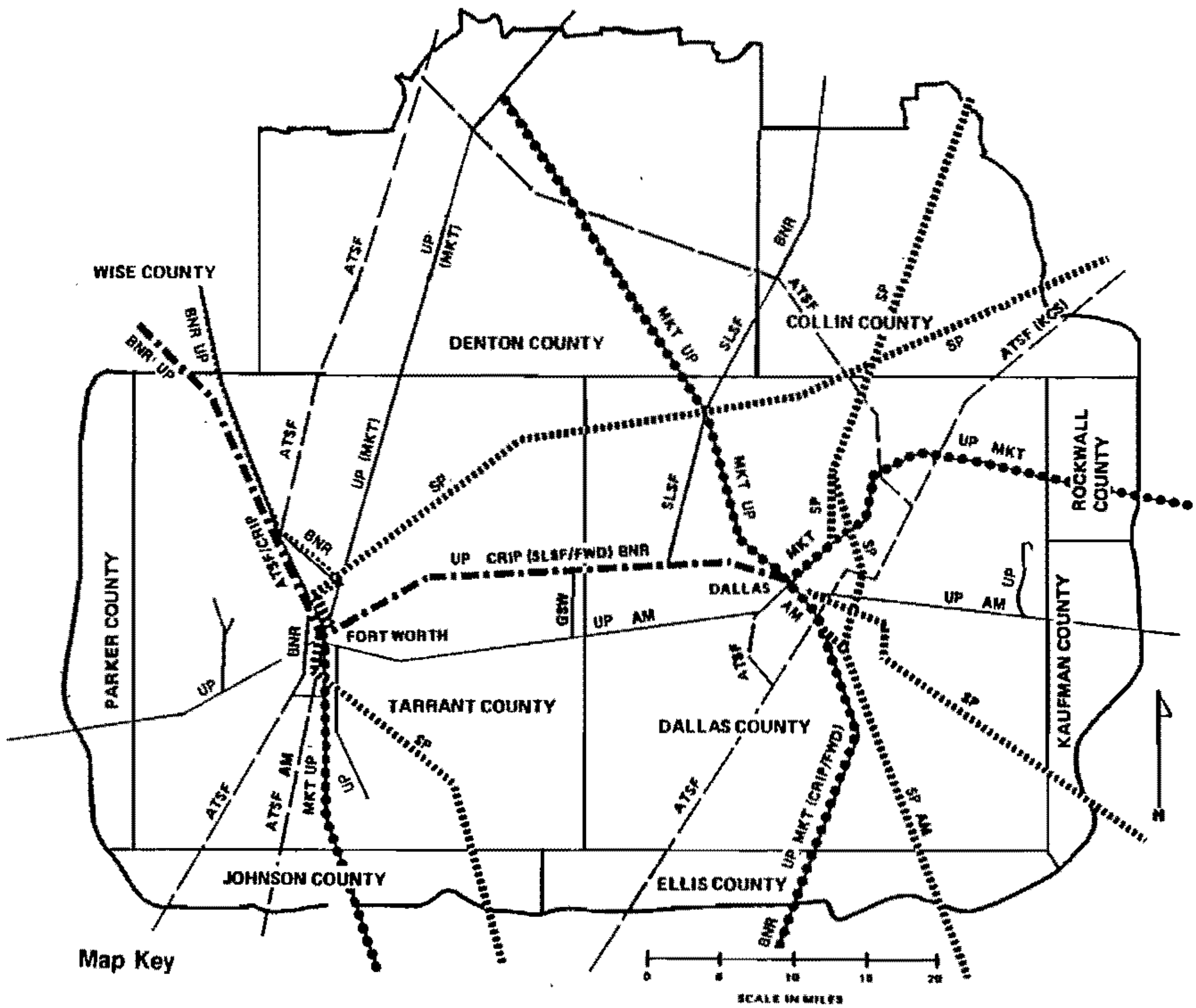


FIGURE I-2

RAIL NETWORK IN THE TRANSPORTATION STUDY AREA



Map Key

AM	Amtrak
ATSF	Atchison, Topeka & Santa Fe Railway
BNR	Burlington Northern Railroad Company
CRIP	Chicago, Rock Island & Pacific Railroad
FWD	Fort Worth & Denver Railway (Burlington Northern)
GSW	Great Southwestern Railroad
KCS	Kansas City Southern Railway
MKT	Missouri Kansas Texas Railroad
MP	Missouri Pacific Railroad
SLSF	St. Louis San Francisco Railway
SP	Southern Pacific Transportation Company
SSW	St. Louis Southwestern Railway
UP	Union Pacific Railroad Company

Source: Adapted from Peat, Marwick, Mitchell, and Company, Rail Planning Program for the North Central Texas Region, prepared for the North Central Texas Council of Governments (Arlington, Texas, January 1989) and NCTCOG Railroad Company Interviews conducted in March 1989.

Section III provides a summary of existing railroad and highway operational issues with recommendations for speed restrictions, size restrictions, blocked grade crossings, railroad noise related to existing land uses, motorist education, legal responsibilities of motorist, and police enforcement as well as contact numbers for city officials and rail carriers.

All references regarding cost estimates are expressed in 1989 dollars using the consumer price index. "Railroad operators" in this report refer to freight, passenger, and heavy rail commuter trains. "Active warning devices" refer to crossings with gates or flashers to warn of an approaching train. "Passive warning devices" refer to crossings with a crossbuck warning assembly.

This handbook is being prepared as the second phase of a NCTCOG Railroad Coordination Study. Phase One of this project addressed a railroad and roadway grade separation needs assessment benefit-cost analysis. Hazardous material transportation in railroad corridors will form the basis of a future study.

REGULATION AUTHORITY JURISDICTIONS

Nine agencies have jurisdiction over railroad operations and maintenance activities. These agencies' responsibilities overlap depending on the context of the situation. A selective list of agencies and their responsibilities of interest to local cities and railroad operating officials in the NCTCOG region is as follows:

Environmental Protection Agency (EPA) - Develops standards and procedures for environmental impact statements and assessments; develops noise policies for constant and repetitive noise sources and their effects on adjacent land uses and identifies future goals for noise reduction nationwide relative to public health and welfare; and developed Railroad Noise Emission Standards for rail carriers engaged in interstate commerce with compliance responsibility resting with the FRA.

Federal Railroad Administration (FRA) - Enforces the Code of Federal Regulations (CFR); enforces noise standards by testing moving, stationary, and switcher trains; specifies track classes including a reference to maximum railroad operating speeds; investigates complaints by the public regarding crossings; investigates selected train/vehicle crossing accidents usually where two or more fatalities occur; maintains the accident/incident reporting system; and is custodian of the U.S. Department of Transportation (DOT) American Association of Railroads (AAR) National Rail/Highway Crossing Inventory.

Federal Highway Administration (FHWA) - Administers federal funding for crossing safety improvements (railroad crossing upgrades) through the Surface Transportation Program (STP) under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) for all systems of roads and highways; publishes signs and pavement marking standards in the Manual on Uniform Traffic Control Devices (MUTCD); and conducts crossing research in coordination with the FRA.

Interstate Commerce Commission (ICC) - Generally deals with cost-effective and competitive rail transportation issues on an interstate level; has jurisdiction over the supply of railroad equipment; and requires environmental assessments of increased rail traffic of approximately 50 percent or greater or eight trains/day derived from mergers and new line construction which cause extra rail traffic.

National Highway Traffic Safety Administration (NHTSA) - Maintains the Fatal Accident Reporting System (FARS).

Department of Public Safety (DPS) - Enforces railroad-highway crossing safety laws and maintains railroad/highway accident data which is forwarded to the Texas Department of Transportation (TxDOT) and NHTSA; receives and passes to railroads reports of crossing signal problems made by the public using a toll-free 1-800 telephone number.

Railroad Commission of Texas (RCT) - Assists the FRA with the inspection of railroad equipment, operations and track; enforces state legislation regarding sight rectangle and clearance on bridges; has the authority to close crossings; and investigates complaints by the public regarding crossings.

Texas Department of Transportation (TxDOT) - Develops an annual list of recommended railroad-highway crossings for FHWA crossing safety improvement funds, administers the projects, and coordinates the on-site joint inspection of crossings for potential upgrading which includes a team of rail operators, cities, counties, school districts, and law enforcement officials to recommend the type of safety improvements.

City Law Enforcement - Enforces traffic and trespass laws; completes railroad/accident reports; and issues citations for railroad ordinance infractions if warranted.

Operation Lifesaver - Public information and education program that promotes crossing and trespasser safety programs to help prevent and reduce crashes, injuries, and fatalities and improve driver performance at public and private highway-rail grade crossings. Operation

Lifesaver involves the railroads, related federal, state, and local governments, business, railroad suppliers, labor, and other concerned safety professionals. Provides contact for Operation Lifesaver presentors program to schools, civic organizations, etc.

II. MAINTENANCE

The purpose of this chapter is to present the findings and recommendations of the Railroad Maintenance Work Group to the Railroad Coordination Task Force for consideration as a regional maintenance handbook for rail corridors in the Dallas-Fort Worth area. The Railroad Maintenance Work Group was formed in early 1989 with members from local cities, rail carriers, the Federal Railroad Administration (FRA), the Railroad Commission of Texas, and the Texas Department of Transportation (TxDOT). Their expertise plus current case law and civil statutes were utilized to develop this rail corridor maintenance and operations handbook.

The major issues of mutual interest addressed in this section are: the TxDOT Grade Crossing Priority Index (PI) and funding for crossing improvements, the TxDOT Railroad Grade Crossing Replanking Program, the Florida Highway Rail Crossing Surface Ranking Index, and a subsection on the jurisdictions of responsible agencies. The jurisdictions briefly discuss basic grade crossing elements which include: track maintenance, signal maintenance and traffic signal preemption, pavement alignment, drainage, advance signs and pavement markings, fencing, grade crossing materials, reflectorized tape on signs, illumination of crossings, track inspections, visual obstructions including vegetation control, temporary crossing closures, and the existing toll-free number in Texas for reporting grade crossing signal problems.

All handbook sections which quote costs are expressed in 1989 dollars. If costs were cited from references expressed in previous year dollars, the figures were adjusted using the consumer price index.

TEXAS PRIORITY INDEX FOR RAILROAD-HIGHWAY GRADE CROSSINGS

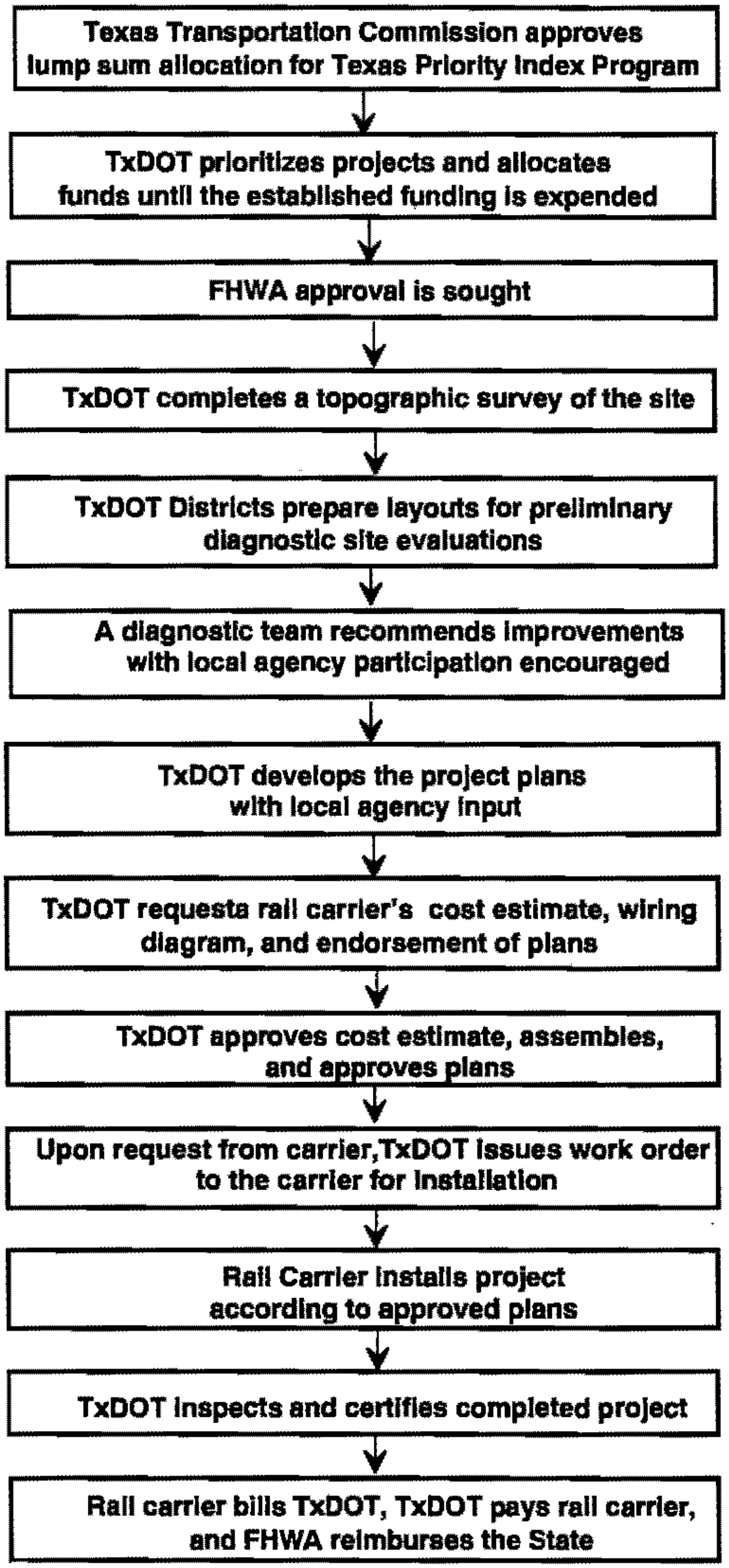
In Texas, federal funds have been available for crossing upgrades since the 1930s. The Federal Highway Administration (FHWA) and TxDOT manage the railroad-highway crossing safety improvement program under a federal oversight agreement to provide federal funds to Texas for highway-rail grade crossing safety improvements. This program, formerly funded under the Section 130 Rail-Highway Crossings program, is funded from part of the 10 percent of Surface Transportation Program (STP) funds set aside for safety. These funds have been apportioned by the ratio of the number of public crossings in the state to the total number of public crossings in the country as well as the state's population, area, and road mileage. FHWA provides 90 percent of the funding on all roadway systems for crossing improvements, with the state providing a 10 percent contribution. The Texas Transportation Commission annually approves funding of the state matching funds for the Rail-Highway Crossings program. The local governments' contribution is to provide any roadway approach or alignment improvements, utility or drainage adjustments, and vegetation trimming or removal.

Federal funds are primarily used to upgrade passively signed crossings to active warning signals. Other eligible safety improvements include advance warning signs, removal of visual obstructions, grade separation/bridge construction, improve roadway approaches, illumination, pavement markings, pavement rehabilitation, crossing surface material installation, signal preemption, drainage, and crossing closures or consolidations. Crossings located on the State Highway System are also eligible for other state funds for crossing surface improvements. Additional information on the TxDOT Replanking Program is provided in the next section.

TxDOT uses a selection process that prioritizes the Federal funded crossing safety projects by a priority index. The Texas Priority Index process is outlined in Figure II-1. Federal funds are

FIGURE II-1

TEXAS PRIORITY INDEX FUNDING PROCEDURE



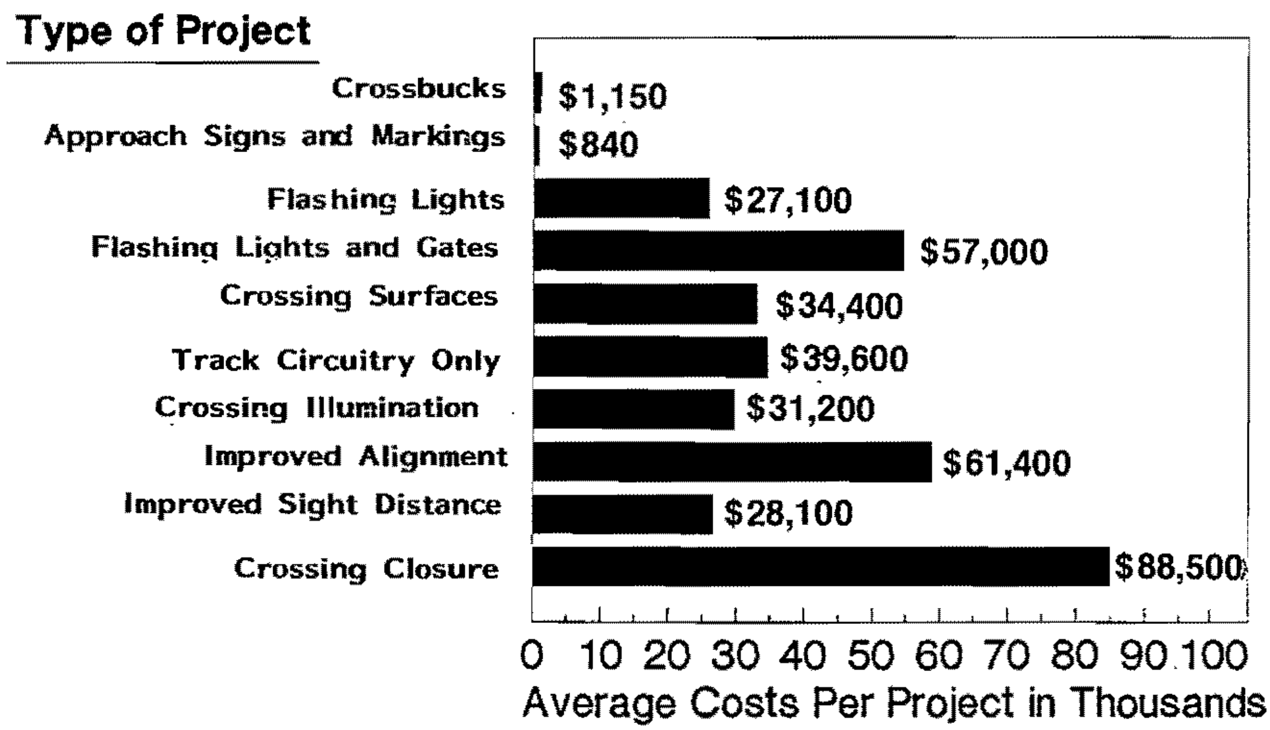
Source: North Central Texas Council of Governments allocated to the top ranked projects until the available funds are expended. The top ranked projects in each TxDOT district are then evaluated on site by a team of professionals with railroad and highway expertise. This diagnostic team is comprised of rail carriers, TxDOT officials, and local government officials. The diagnostic team considers the local conditions and alternatives and is then responsible for recommending the type of warning devices and other safety enhancements as required. First consideration is given to the necessity of the crossing in relation to adjacement crossings. Local authorities are encouraged to attend these evaluations. Their knowledge is especially helpful in presenting such significant factors on local conditions as a site's proximity to schools, hospitals, businesses, or residences, traffic patterns, type of vehicles using crossings, special conditions, etc. With the number of participants involved, installation typically occurs 18 months from initiation of the project.

The crossing safety improvement program does not preclude the FHWA, TxDOT, municipalities, and railroads from joining in railroad crossing projects outside the "window" of funding priorities if they so choose. Local governments should negotiate with the rail carriers to upgrade the crossing surface with higher quality, more durable materials such as rubber or concrete panels. Typical average costs for improvements are shown in Figure II-2.

TxDOT uses the most current data available to update their traffic counts and accident records; this insures that the projects receive an accurate priority ranking. Local authorities may forward their most recent average daily traffic (ADT) counts to TxDOT District Offices, or request that the TxDOT District Office perform a traffic count, to be included in the priority index formula. TxDOT analyzes a five-year period of accident statistics when determining accident trends at highway-rail grade crossings to quantify the hazard potential.

FIGURE II-2

NATIONAL AVERAGE OF GRADE CROSSING COSTS ($1989)



Source: Adapted from Richards and Associates, Highway and Rail Safety Newsletter (College Station, Texas, October 1988).

With over 13,000 public grade crossings in Texas and funds for approximately 200 projects per year; TxDOT developed the project selection procedure using a priority index (PI) formula. The Texas Grade Crossing Priority Index Program funded 227 projects in 1994 for $20 million and is estimated to fund 160 projects in 1995 for $15 million and 250 projects in 1996 for $25.9 million. The Texas PI uses a variation of the New Hampshire Index to prioritize grade crossings for potential upgrading. The potential for railroad-highway grade crossing accidents is primarily a function of the number and speed of trains traveling through the crossing, the volume of average daily traffic (ADT) utilizing the street facility, the existing traffic control device(s) in place, and the past five-year train involved accident history. The TxDOT Priority Index as of 1994 is as follows:

Texas Priority Index (PI) = $V * T * S_t * P_f * (.01) * A^{1.15}$

where: V = average daily traffic (vehicles/day)

T = number of trains per day

S_t = speed of trains (mph * 0.1)

P_f = protection factor of existing warning devices

- gates = 0.10
- cantilever flashers = 0.15
- mast flashers = 0.70
- crossbucks, wigwags, or bells = 1.00

A = number of train/vehicle accidents in previous five years to the 1.15 power
(if A=0 or A=1 the default is 1)

An example is provided using the following information where:

V = 5,000 vehicles per day,

T = 10 trains per day,

S_t = 30 mph * 0.10 = 3.0,

P_f = 0.70 (existing mast flashers), and

A = 0 accidents,

the following priority index will result:

$$PI = V * T * S_t * P_f * (.01) * A^{1.15}$$
$$= 5{,}000 * (10) * (3) * (0.70) * (.01) * (1) = 1{,}050$$

Given that the Texas PI cut off for project selection was 317 in 1987, 337 in 1988, and 269 in 1989, this example railroad-highway grade crossing would have ranked above the past minimum priority index thresholds for review and possible upgrade.

Several states employ other variations of the index by adding variables to augment the original equation. Optional safety factors added to this original equation by other states include: highway speed, crossing width, type of track, local population, volume of transit buses, number of school buses, number of tracks, crossing surface condition, proximity of nearby intersections, functional class of the road, vertical alignment, horizontal alignment (crossing angle), volume of trucks carrying hazardous material, average number of vehicle occupants. TxDOT uses this factor.

The Texas Transportation Institute (TTI), under a TxDOT contract, is working on a project to research, evaluate, and recommend revisions to the current Texas Priority Index for railroad-highway grade crossings. The 1994 TTI report is under review and evaluation by TxDOT to receive final acceptance. A list of some of the more significant potential factors that affect grade crossing safety is shown in Figure II-3. The revised formula may incorporate into the current list of factors the addition of sight distance modifications, approach factors, reaction factors, vertical alignment, number of school buses, transit buses, hazardous materials carriers, and other "special" vehicles.

FIGURE II-3

LIST OF FACTORS AFFECTING GRADE CROSSING SAFETY

Annual average daily traffic	Average daily train traffic each way
Existing protection at crossing	Sight distance
Rideability	Train speed
Accident history at the crossing	Vehicular (highway) speed
Type of vehicle using the crossing	Crossing angle
Type and number of tracks	Crossing width
Timetable train speed	Obstructions to vision (corner visibility)
Number of trucks	Length of railroad's rehabilitation cycle
Length of roadway rehabilitation cycle	Weather conditions
Surface type	Population
Transit traffic	School bus traffic
Surface condition	Functional class of highway
Vertical alignment	Horizontal alignment
Hazardous-material truck traffic	Number of passengers
Pedestrian traffic	

Source: Railroad-Highway Grade Crossing Handbook, Federal Highway Administration, (September 1986)

TXDOT RAILROAD GRADE CROSSING REPLANKING PROGRAM

The Railroad Grade Crossing Replanking Program has been established between the Texas Department of Transportation and the individual railroads to maintain grade crossings located on the state maintained highways. This system of review, developed through research conducted by the TTI, provides a uniform basis for identifying the current crossing conditions of all grade crossings on the State Highway System. Local agencies may find this a useful tool to apply to grade crossings under their jurisdiction to rank grade crossings for possible surface improvements. This methodology provides an assessment of a highway-rail crossings, but requires professional expertise and judgment in completing a subjective analysis of the site conditions.

The TxDOT District Railroad Project Coordinators perform a visual inspection of all grade crossings located on the State Highway System in their districts. The visual rating of the crossing considers the condition of the highway pavement, highway traffic volume, train traffic volume, railroad track condition and drainage factors. The railroad project coordinator assigns a numerical rating between 0 and 5 for the highway, rail, and drainage aspects of the crossing. The results of the highway-rail crossing inspections are submitted on the Railroad Grade Crossing Submission Forms for all candidate crossing projects to the TxDOT Traffic Operations Division, Railroad Section for review and prioritization. Figure II-4 shows the Railroad Grade Crossing Submission form.

All candidate crossings are prioritized based on an estimated cost per vehicle to repair or replace the crossing surface. The estimated cost is determined by multiplying the estimated or negotiated cost per track foot by the total track feet proposed for replanking. The average negotiated cost per track foot for asphalt, concrete panel, and rubber crossing materials are

FIGURE II-4

RAILROAD GRADE CROSSING SUBMISSION FORM

(Form must be completed and furnished to TRF-RR for each Crossing submitted for replacement on the 19__ Railroad Grade Crossing Replanking Program

DATE: ____________

DISTRICT No.: ____	Dist. Priority number: ____________
DOT No.: ____________	Name of Railroad: ____________
COUNTY: ____________	No. of trains per day: ____________
CONT-SEC: ____________	No. of tracks thru crossing: ____________
HIGHWAY: ____________	No. of tracks proposed for replanking: ____________
LOCATION: ____________ (city or nearest city or town)	Type of surfacing material **existing**: ____________
No. OF TRAVEL LANES: ________	Type of surfacing material **proposed**: ____________
ADT: ________	*Length of each crossing proposed for replanking: ____________

CONDITION OF CROSSING

Visually Rate Each Factor:

0 1 2 3 4 5
Excellent Condition — Poor Condition
VISUAL RATING SCALE

Each factor should be considered in assigning an overall rating for <u>each</u> category below.
Please check or make notes next to all problem factors in and around crossing.

HIGHWAY: ____

1. Condition of Pavement
   a. Potholes
   b. Edge Ravelling
   c. Profile (high/low)
   d. Cross Section
2. Crossing Surface
   a. Roughness
   b. Deterioration
   c. Headerboards
   d. Hardware (missing/loose)
3. Traffic Behavior
   a. Speed Reduction
   b. Braking
   c. % of trucks to Cars (Est.)

RAILROAD: ____

1. Condition of Rail
   a. Superelevation (between tracks and/or highway)
   b. Flangeway (open/fouled)
   c. Rail height to xing (high/low)
2. Condition of Track
   a. Anchors, plates, spikes (loose/missing)
   b. Ties (rotten/loose/broken)
   c. Ballast (clean/fouled)
   d. Rail movement under loads (tracks pumping)
   e. Subgrade Stabilization

DRAINAGE: ____

1. Crossing Condition
   a. Fouled ballast - No. of feet out from xing?
   b. Standing water - No. of feet out from xing?
2. Crossing Area
   a. Grading Contour (into\away from xing)
   b. Culverts (existing, open\fouled)
   c. Subdrains (exposed, damaged, blocked, etc.)
   d. Adjacent Vegetation (blocking drainage)

*Panel lengths of crossing surface types: Rubber - 3' & 6' panels; Concrete - 10' panels; Timber - 8' panels (9' panels for SPT/SLSW).

provided in the Grade Crossing Materials section. The estimated cost per vehicle is then derived by dividing the estimated cost by the average daily traffic (ADT). The formula is provided below:

Estimated Cost per Vehicle = (Estimated Cost / Average Daily Traffic)

Estimated Cost = (Negotiated Cost per Track Foot) X Total Track Feet

Grade crossings with the lowest estimated cost per vehicle are given the highest priority ranking. The Replanking Program allocates the funds to the highest ranked crossings until the annual, funded apportionment representing approximately $3.5 million is obligated. This annual apportionment typically funds 140 crossing replanking projects. Grade crossings on roadways that are not maintained by the state are not eligible to receive funds through the Replanking Program.

HIGHWAY-RAIL CROSSING SURFACE RANKING INDEX

At present, no universally accepted procedure exists for cities to objectively evaluate the current condition of their highway-rail crossing surfaces. The predominant method used to subjectively determine the condition of the crossing surface is by physical inspection and by riding over it. Crossings that are rough and in need of repair should be called to the attention of the railroad company.

Since responsibility for the grade crossing is shared, both the local agencies and the railroads should be involved in the evaluation of the crossing surface and approaches. Site evaluations and other information such as safety needs and public complaint are important inputs used to assist in the decision-making process.

The Federal Highway Administration Railroad-Highway Grade Crossing Handbook makes reference to a procedure for ranking highway-rail intersections for crossing surface improvement. The procedure involves evaluating the crossing surface based on actually driving over the crossing and observing other drivers and vehicles as they traverse the crossing. The procedure, developed by the Florida Department of Transportation (FDOT), Office of Value Engineering, subjectively determines a crossing's rideability and observed condition in deciding whether the highway-rail crossing needs to be repaired or replaced.

The FDOT ranking index takes into account six basic elements: approaches, vehicle reaction, driver reaction, rail/pad condition, ADT, and percent trucks. The crossing surface index depends on professional judgment to subjectively determine the relative condition for the approaches, vehicle reaction, driver reaction, and rail/pad condition. These four elements are assigned a number of possible points, within a 100 point system, relative to their overall importance. Figure II-5 shows the characteristics, conditions, points, and weights in this index.

The condition of the characteristics weigh the possible points based on the severity of the judged condition of the element. The weighted points are summed for each crossing characteristic to obtain a total adjusted weight (T_W) for the surface condition. An example of a crossing evaluated as having severe cracking in the approach and leave areas, showing appreciable vehicle bouncing, with most drivers slowing and the rails having extensive movement with poor pad condition is rated below.

Characteristic	Condition	Weight		Points		Total
A. Approach & Leave	Severe	.20	X	10	=	2
B. Vehicle Reaction	Appreciable	.40	X	20	=	8
C. Driver Reaction	Most	.40	X	30	=	12
D. Rail /Pad	Extensive/Poor	.40	X	40	=	16
	Total Adjusted Weight (T_W):					**38**

FIGURE II-5

GRADE CROSSING SURFACE CHARACTERISTICS AND WEIGHTS

CHARACTERISTIC	CONDITION	POINTS	WEIGHT
A. Approach and Leave:	**Cracking and Patching**	**10**	
	Severe		0.20
	Extensive		0.40
	Moderate		0.70
	Minor		0.90
	None		1.00
B. Vehicle Reaction:	**Dipping and Bouncing**	**20**	
	Extreme		0.20
	Appreciable		0.40
	Noticeable		0.70
	Minor		0.90
	None		1.00
C. Driver Reaction:	**Slowing and Swerving**	**30**	
	All Drivers		0.20
	Most		0.40
	Some		0.70
	Few		0.90
	None		1.00
D. Rail and/or Pad:	**Movement and Condition**	**40**	
	Severe Very Poor		0.20
	Extensive Poor		0.40
	Moderate Fair		0.70
	Minor Good		0.90
	None New		1.00
	Total Points	**100**	

FIGURE II-6

ADT/PERCENT TRUCK QUOTIENT (Q)

AVERAGE DAILY TRAFFIC (ADT)	PERCENT TRUCKS			
	0-4%	**5-10%**	**11-15%**	**>15%**
< 5,000	1.00	0.97	0.95	0.93
5,000 - 14,999	0.95	0.94	0.91	0.90
15,000 - 24,999	0.90	0.89	0.88	0.86
25,000 - 34,999	0.85	0.83	0.81	0.80
35,000 - 44,999	0.80	0.78	0.78	0.75
> 45,000	0.75	0.74	0.73	0.70

Since the surface condition is directly related to the average daily traffic (ADT) and percentage of trucks, a quotient is used to further refine the total adjusted weight (T_W). A quotient, as shown in Figure II-6, is applied to the total adjusted weight (T_W). If the example crossing is in a rural area, where the ADT is almost always less than 5,000, but the percent of trucks is 15 percent or greater, the value, .93 Q, from Figure II-6 would be applied to the total adjusted weight (T_W).

T_WQ = crossing rate times the ADT/Truck Quotient

The crossing rate example would result in 38 X .93 = 35.3

The crossing rate is then compared with the grade chart shown in Figure II-7. The example crossing, which ranks well below the failure rating, would warrant total replacement. Depending on available funding, the responsible railroad maintenance engineer along with the TxDOT railroad coordinator must decide whether to repair or replace. Figure II-8 is an adapted version of the surface ranking form used by FDOT. It should be noted that category points, assigned weights and ADT/Truck Quotients are arbitrary, but they can be used to establish a prioritized list of crossings which need repair or replacement.

FIGURE II-7

GRADE CROSSING
SURFACE RATINGS

GRADE	POINTS
Excellent	90-100
Good	75-89
Fair	60-74
Poor	45-59
Failure	44 & below

FIGURE II-8

GRADE CROSSING SURFACE CONDITION RATING FORM

Location Identification	
Location	
Crossing Number	ADT
Railroad Company	Percent Trucks

A. Approach and Leave

10 X _____W = A _____

Weight (W)	Cracking & Patching
0.20	Severe
0.40	Extensive
0.70	Moderate
0.90	Minor
1.00	None

B. Vehicle Reaction

20 X _____W = B _____

Weight (W)	Dipping & Bouncing
0.20	Extreme
0.40	Appreciable
0.70	Noticeable
0.90	Minor
1.00	None

C. Driver Reaction

30 X _____W = C _____

Weight (W)	Slowing & Swerving
0.20	All Drivers
0.40	Most Drivers
0.70	Some Drivers
0.90	Few Drivers
1.00	No Drivers

D. Rail and/or Pad Movement Condition

40 X _____W = D _____

Weight (W)	Movement	Condition
0.20	Severe	Very Poor
0.40	Extensive	Poor
0.70	Moderate	Fair
0.90	Minor	Good
1.00	None	New

ADT / TRUCK QUOTIENT (Q)

Average Daily Traffic (ADT)	Percent Trucks			
	0–4%	5–10%	11–15%	> 15%
< 5,000	1.00	0.97	0.95	0.93
5,000 – 14,999	0.95	0.94	0.91	0.90
15,000 – 24,999	0.90	0.89	0.88	0.86
25,000 – 34,999	0.85	0.83	0.81	0.80
35,000 – 44,999	0.80	0.78	0.78	0.75
> 45,000	0.75	0.74	0.73	0.70

(A _____ + B _____ + C _____ + D _____) x Q _____ = _______ RATING

Source: U.S. Department of Transportation, Federal Railroad Administration, Highway-Railroad Grade Crossing Material Selection Handbook, Florida Department of Transportation, Bureau of Value Engineering, and University of Florida, Department of Civil Engineering, (Tallahassee, Florida 1984)

JURISDICTIONS OF RESPONSIBLE AGENCIES

Track, Signal, and Crossing Surface Maintenance

Within the State of Texas, cities, counties, TxDOT, and railroad operators assume both separate and joint maintenance responsibilities. Items such as the track and signals are always maintained by the rail operator. However, state civil statutes, site characteristics, and potential FHWA funding for crossing upgrades are further considerations in determining jointly funded improvements.

In Texas, the concept of railroad crossing maintenance occurs as one of the "enumerated powers" of home rule cities, according to Vernon's Annotated Texas Civil Statutes, Article 1175, Section 16. It requires that railroads be responsible for street improvements "between the rails and tracks of any such railway companies and for two feet on each side thereof." If the definition of "track," according to the FHWA publication entitled Railroad-Highway Grade Crossing Handbook, includes: "an assembly of rails, ties, and fastenings over which cars, locomotives, and trains are moved," then the railroad company's maintenance responsibility extends two feet beyond the ends of ties as shown in Figures II-9 and II-10. However, for practical purposes, the Railroad Maintenance Task Group concurs with the FHWA suggestion in the Railroad-Highway Grade Crossing Handbook, "the public agency having responsibility for the maintenance of roadway approaches generally terminates its maintenance responsibility for the roadway at the crossing surface." The Work Group makes the recommendation that local governments maintain pavement up to the crossing material located at the end of the ties. However, according to FHWA, the railroad operator shall maintain any vehicular, pedestrian, or bicycle crossings between the ends of the ties. All of these crossings should be physically separated for optimal traffic safety reasons.

FIGURE II-9

TYPICAL CROSS SECTION THRU TIMBER CROSSING

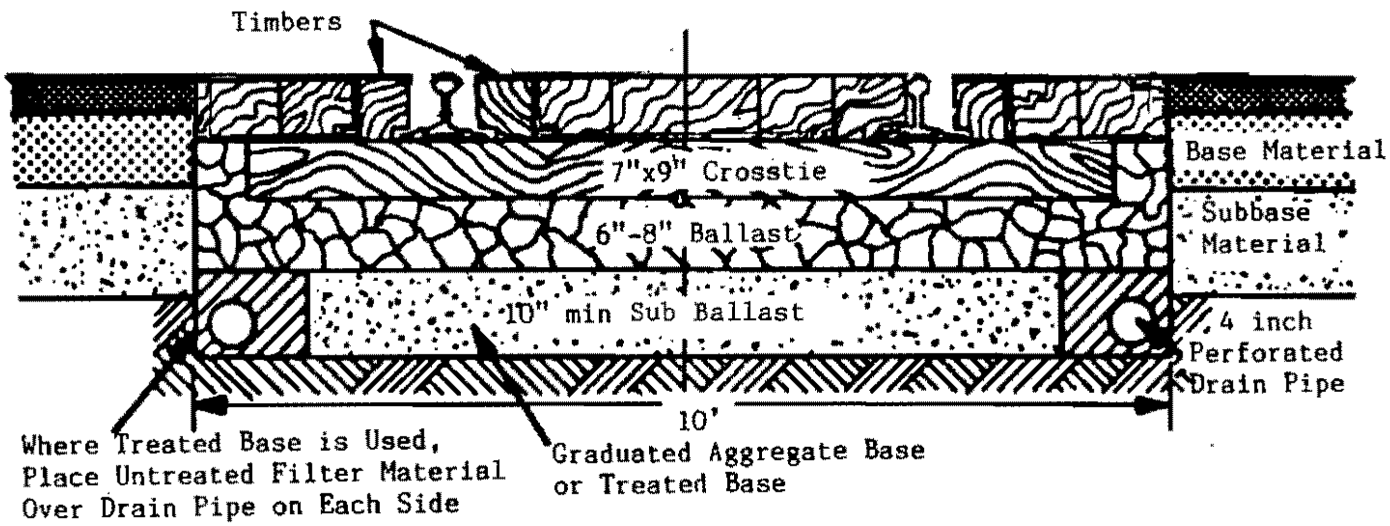
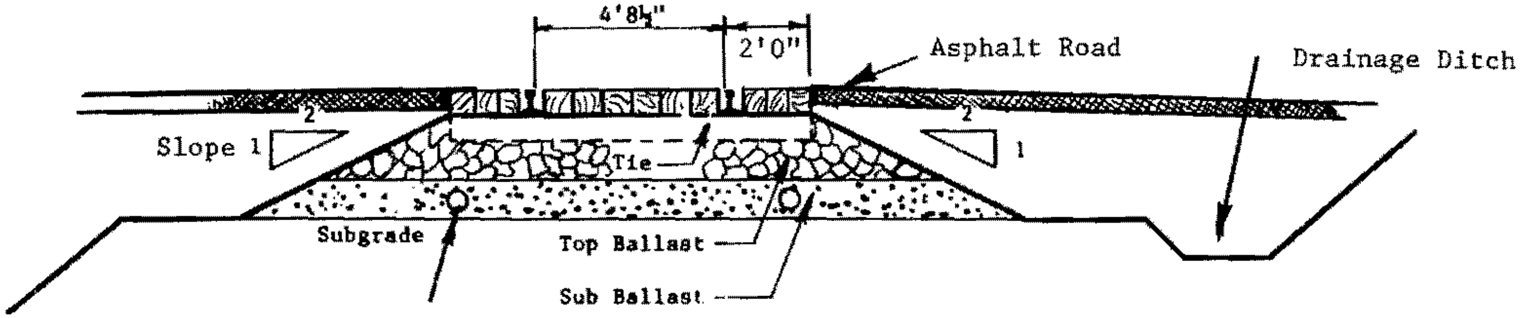


FIGURE II-10

ELEMENTS OF RAILROAD TRACK CROSS SECTION



Sources: FHWA, Railroad-Highway Grade Crossing Handbook, 2nd Edition, (Springfield, Virginia, September 1986).
Vernon's Annotated Texas Civil Statutes, Article 1175, Section 16.

Therefore, the railroad is responsible for the maintenance of the rails, ties, fastenings, ballast, initial upper ballast drainage pipe installation, crossbuck sign assembly, railroad signals, control boxes, and grade crossing surface materials which extend to the ends of the ties. In most cases, the local government will be responsible to reimburse the railroad for the cost differential for any crossing surface desired beyond the standard timber/asphalt surface.

Railroad Signal Maintenance and Traffic Signal Preemption

Signal maintenance at the crossing is the responsibility of the railroad carrier. However, TxDOT assists the railroad carrier by reimbursing the railroad a unit price for signal maintenance by the type of signal on state and federal highway systems, but not on city streets, county roads, or private crossings.

If a state or local public agency anticipates future signal preemption of traffic signals to clear the intersection at a grade crossing before a train approaches, the Railroad Maintenance Work Group recommends that the city should notify the railroad of the intent to use a circuit in the railroad signal control box. Automatic time crossing devices should be calibrated to the fastest train using the track. When train speed increases are planned, timing devices should be recalibrated to allow motorists adequate time to clear the crossing prior to the implementation of the new speeds.

At the time of installation, the critical cycle time to clear the intersection of vehicles should be supplied. However, if the critical cycle time exceeds 30 seconds, then a constant warning time device in the railroad control box is necessary and may be eligible for Rail-Highway Crossings program funding. As an example of cost, an upgrade to a control box in 1988 cost TxDOT $2,000, but the conversion of older signal controls on a direct current system could cost well over $100,000, especially in rural areas.

Pavement Alignment

Large grade changes in rail elevations would be a situation where the city may not be totally responsible for street approach grade changes. A schedule of cost sharing between the rail carrier and the local government or state agency responsible for the roadway is recommended by the Work Group.

The vertical slope of pavement approaching the crossing is recommended at a range of between 1 and 2 percent for 30 feet beyond the ends of ties, according to the American Railroad Engineering Association (AREA). Pavement sloping away from the track will also deter the necessity for installation of french drains by the local or state agency to deflect storm water away from the ballast to a storm water system or railroad ditch. Access to the railroad ditch would be through previous agreement with the railroad. The low vertical pavement slope would also assist faster acceleration of vehicles from a stop position across the tracks. It would prevent trucks or trailers with low undercarriages from becoming trapped on a severely humped pavement.

Horizontal alignment of the approach lanes is recommended to be as direct to the tracks as possible to assist motorists in viewing any approaching trains without contending with a potential "blind spot" situation. The width of the crossing surface should be sufficient to include all highway travel lanes and adjacent shoulders plus two feet, with the continuation of all traffic lanes across the tracks. Crossings that are inadequate in width should be called to the attention of the railroad company.

Drainage

Proper preparation of the track structure and good drainage of the subgrade are essential to good performance from any type of crossing surface. Excessive moisture in the soil can cause track settlement, accompanied by penetration of mud into the ballast section. Surface and subsurface drainage should be intercepted and discharged away from the crossing. Ideally, the roadway-railroad crossing should occur at a rise in topography to ensure drainage away from the ballast to prevent fouling of the ballast with "fines" from the subgrade. Accumulated "fines" would cause the ballast and track to "pump" from railroad loads, cause track instability, and increase the likelihood of a train derailment. However, if the pavement slopes toward the crossing the railroad will install a french drain, and the drain will remain its responsibility as being within the confines of the track.

Drainage is a maintenance consideration involving varying jurisdictions. Drainage structures and ballast are initially installed by railroads on their right-of-way. Bar ditches (or drainage ditches and culverts) are a joint responsibility which should have negotiated maintenance and improvements shared by parties benefiting from the infrastructure or whoever modifies the runoff pattern necessitating improvements. Approach pavement costs can be reduced within the local government right-of-way if the local government completes the subgrade preparation with four-inch perforated pipe and filter cloth, according to TxDOT. Use of a suitable filter fabric over the entire subgrade area under the crossing and for a sufficient distance beyond can be a significant aid in separation, filtration, water transport, and tensile reinforcement. It is recommended by the Work Group that any future drainage problems be the continued legal responsibility of the rail carrier for repairs.

Advance Signs and Pavement Markings

Standards for advance signs and pavement markings are found in the Texas Manual on Uniform Traffic Control Devices (MUTCD). The local agency, as previously recommended by the Work Group, should be the agency responsible for pavement extending to the crossing material at the edge of the ties, traffic controls on the approach, pavement markings, and all signs except the crossbuck and/or signal assembly. Figure II-11 depicts the typical railroad advance warning signs as specified by the Texas MUTCD. Figure II-12 shows the railroad crossing (crossbuck) sign, flashing light signal, and automatic gate typically used at grade crossings.

The crossbuck assembly consists of the crossbuck, a multitrack sign if appropriate, and the "exempt" sign if required. The exempt sign informs drivers of special vehicles, transit buses, school buses carrying children, or vehicles carrying hazardous materials that a stop is not required except when railroad equipment is approaching or occupying the crossing.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) legislation has added revisions to the Texas MUTCD to allow the use of STOP signs or YIELD signs at railroad crossings. When adequate sight distance cannot be maintained at a passive grade crossing, stop signs are an effective countermeasure. The signs can be posted at any highway-rail grade crossing without automatic traffic control devices with two or more trains crossing per day.

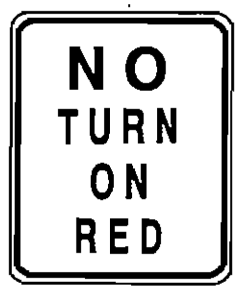
For other crossings with passive protection, STOP or YIELD signs may be used after need is established by a traffic engineering study. The study should take into consideration such factors as: volume and character of highway and train traffic, adequacy of stopping sight distance, crossing accident history, and need for active control devices. For all highway-rail grade crossings where STOP and YIELD signs are installed, STOP AHEAD or YIELD AHEAD advance warning signs shall also be installed.

As shown in the Highway & Rail Safety Newsletter of June 1993, a memorandum by the FHWA and the FRA Administrators to their Regional offices provides guidance on the selection of

<u>**FIGURE II-11**</u>

STANDARD PASSIVE ADVANCE WARNING SIGNS

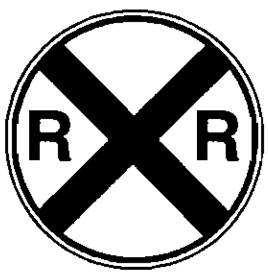
R8-8
24" x 30"



R10-11
24" x 30"

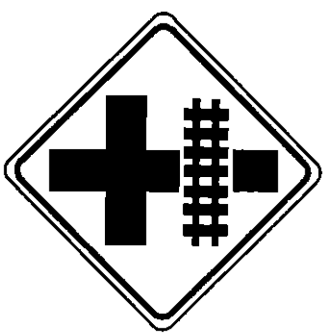
R15-3 White Background
W10-1a Yellow Background

R15-4
24" x 12"

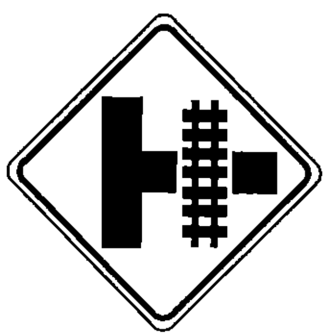


W10-1
36" Diameter

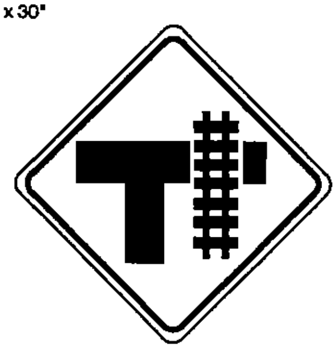
W10-5
30" x 30"



W10-2
30" x 30"



W10-3
30" x 30"

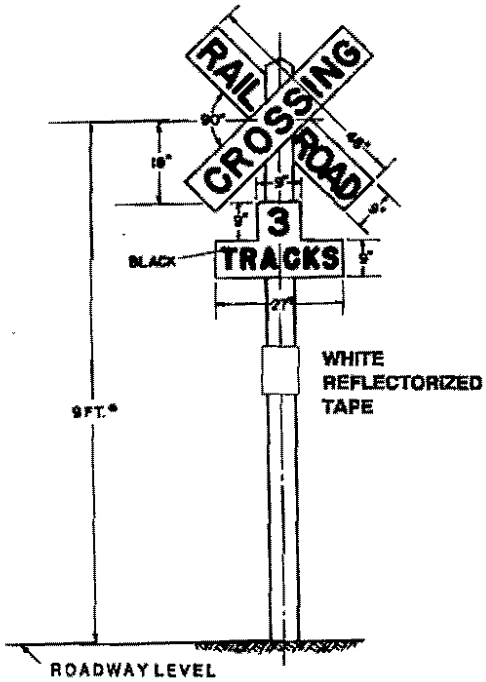


W10-4
30" x 30"

Source: Texas Department of Transportation, <u>Texas Manual on Uniform Traffic Control Devices</u>, (Austin, Texas: 1980).

FIGURE II-12

RAILROAD CROSSING (CROSSBUCK) SIGN AND FLASHING LIGHT SIGNAL AND AUTOMATIC GATE



Railroad Crossing (Crossbuck) Sign

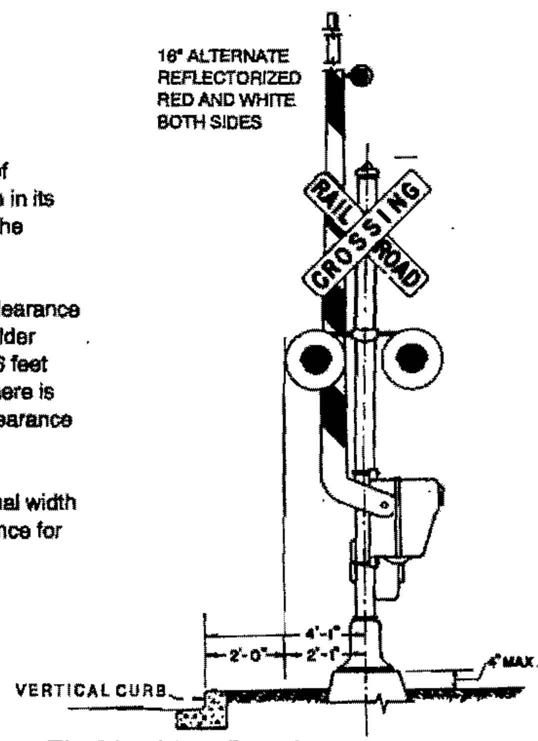
R15-1
48" x 9"
(Drilled for 90-degree mounting)

R15-2
9" x 9"
27" x 9"

Typical minimum clearance is 2 feet from face of vertical curb to closest part of signal or gate arm in its upright position for a distance of 17 feet above the crown of the roadway.

Where there is no curb, a minimum horizontal clearance of 2 feet from edge of a paved or surfaced shoulder shall be provided with a minimum clearance of 6 feet from the edge of the travelled roadway where there is no curb or shoulder. The minimum horizontal clearance shall be 6 feet from the edge of the roadway.

Where gates are located in the median, additional width may be required to provide the minimum clearance for the counterweight supports.



Flashing Light Signal and Automatic Gate

Source: Texas Department of Transportation, Texas Manual on Uniform Traffic Control Devices, (Austin, Texas: 1980).

highway-rail grade crossings for the installation of STOP and YIELD signs. Research by FHWA and FRA indicates that under pertinent circumstances STOP signs may be significantly more effective in preventing highway-rail collisions than crossbucks alone. However, both agencies recognize that other highway traffic safety concerns must be considered when determining proper signage at individual locations. Also, it has been shown that there is low motorist recognition and understanding of the crossbuck as a traffic control device alone and that supplementary signage at crossings not equipped with automated warning devices should be considered.

FHWA and FRA recommend that the following general factors be considered when reviewing a crossing for possible STOP or YIELD sign installation:

- Volume, type, and speed of highway traffic;
- Frequency, type, and speed of trains;
- Number of tracks;
- Intersection angles;
- Adequacy of stopping sight distance;
- Need for automated warning devices; and
- Crossing accident history.

The agencies recommend that the following specific factors be applied in determining first priority with respect to new STOP sign installations.

Fundamental indications: It is recommended that the following considerations be met in every case before a STOP sign is installed:

1. Local and/or State police and judicial officials will commit to a program of enforcement no less vigorous than would apply at a highway intersection equipped with STOP signs.

2. Installation of a STOP sign would not occasion a more dangerous situation (taking into consideration both the likelihood and severity of highway-rail collisions and other highway traffic risks) than would exist with a YIELD sign.

Positive indications: Any one of the following conditions indicate that use of STOP signs would tend to reduce risk of a highway-rail collision. It is recommended that the following considerations be weighed against the contra-indications below:

1. Maximum train speeds equal or exceed 30 mph (a factor highly correlated with highway-rail accident severity).
2. Highway traffic mix include buses, hazardous materials carriers and/or large (trash or earth moving) equipment.
3. Train movements are 10 or more per day, 5 or more days per week.
4. The rail line is used by passenger trains.
5. The rail line is regularly used to transport a significant quantity of hazardous materials.
6. The highway crosses two or more tracks, particularly where both tracks are main tracks or one track is a passing siding that is frequently used. If Federal-aid funds are used in a highway-rail grade crossing improvement project with multiple main line tracks, gates and flashing lights are required (23 CFR 646.214).
7. The angle of approach to the crossing is skewed.
8. The line of sight from an approaching highway vehicle to an approaching train is restricted such that approaching traffic is required to substantially reduce speed.

Contra-indications: Factors to be weighed in opposition to STOP signs:

1. The highway is other than secondary in character. Recommended maximum of 400 ADT in rural areas, and 1,500 ADT in urban areas. (If any of the positive indications apply to a

crossing with traffic counts in excess of these levels, strong consideration should be given to installation of automated warning devices).

2. The roadway is a steep ascending grade to or through the crossing, sight distance in both directions is unrestricted in relation to maximum closing speed, and the crossing is used by heavy vehicles. A crossing where there is insufficient time for any vehicle, proceeding from a complete stop, to safely traverse the crossing within the time allowed by maximum train speed, is an inherently unsafe crossing that should be closed.

Although STOP and YIELD signs are permissible traffic control devices within established conditions or warrants, proper use at grade crossings is critical to improving the motorist's understanding of the message that is displayed. As reported in the December 1994 issue of The Highway & Rail Safety Newsletter, a study of STOP signs in Alabama and Georgia by Archie Burnham reported that 82 percent of the drivers were confused of semi-confused by the STOP signs at railroad-highway grade crossings. Burnham found that of 862 vehicles 18 percent came to a full stop, 50 percent made a slow rolling stop, and 32 percent did not stop at all. Based upon these observations Burnham concluded that "one of the most widely recognized and often overlooked traffic safety axioms is the principle that over use provokes abuse. For a traffic control sign, signal, or pavement marking to be of value it must not be overused."

Regarding protection devices for signs and signals, FHWA revised the railroad-highway crossing guidelines. Guardrails are not recommended to shield warning device supports because a vehicle, if struck by a train, could strike the guardrail and be redirected towards the train. A circular metal beam guard fence is allowed to shield warning signals under appropriate circumstances.

Pavement markings refers to markings applied or attached to the surface of a roadway for the purpose of regulating, warning, or guiding traffic. The markings in advance of a grade crossing shall consist of an "X", the letters "RR", a no passing marking (2-lane roads), and certain transverse lines. Identical markings shall be placed in each approach lane on all paved approaches to grade crossings where grade crossing signals or automatic gates are located, and at all other grade crossings where the prevailing speed of highway traffic is 40 mph or greater.

Fencing

Fencing that encloses the railroad right-of-way may be used to restrict access. It can be an effective deterrent to indiscriminate use, according to FHWA, if placed on one side of the right-of-way with its height from four to eight feet. One of the three main objections to fencing is the cost which may be in excess of $100,000 per mile for chain link fencing, according to local rail carriers. Secondly, according to the FHWA Railroad-Highway Grade Crossing Handbook, it does not bar pedestrian entrances at crossings. Finally, maintenance costs would be another budget consideration for either party.

The absence of fencing at railroad rights-of-way would not implicate a city for potential tort liability. Therefore, the Task Force recommends that fencing in urban areas be considered a site-specific issue, studied and negotiated with the affected railroad operators and the local government.

Grade Crossing Materials

Several general guidelines are discussed in this section to assist a city in determining a crossing surface management process. These guidelines may help to define the most appropriate grade crossing surface for a specific site. The Railroad Maintenance Work Group concurs cities may request the railroads to upgrade the standard timber crossings. Asphalt and timber crossings are the most common surface materials and represent over 80 percent of all public crossing surfaces in Texas. It has been found that asphalt crossings and timber crossings have the shortest expected life span. Asphalt and timber crossings are specified for crossings with very low ADTs but may range up to 7,500 ADT without heavy truck traffic and still be cost effective.

The Florida Department of Transportation completed a materials selection handbook in 1984 to develop criteria for the selection of crossing surfaces. The expected life of each surface type was reduced proportional to an increase in ADT, percentage of trucks related to total traffic, multiple track spacing, and gross train tonnage. The annualized cost was then determined based on costs per linear foot and surface type as shown in Figure II-13. Listed below are several key factors, not specifically ranked in any order, that should be considered in determining an appropriate grade crossing surface:

- Highway Traffic/Functional Classification - The volume and capacity, vehicle type, and speed of the highway traffic affects the loading the crossing surface must suport
- Special Vehicles - Crossings used regularly by special vehicles, (e.g. school buses, transit buses, hazardous material carriers) should be given very careful consideration
- Railroad Traffic/Track Classification - The number of trains, train type and train speed as well as the weight and size of the rail affects the loading that the subgrade and supporting track will bear
- Expected Service Life of Crossing Surface - Dependent on adequate ballast tamping and butting onto the crossties with replacement of the weak crossties
- Accident History - Particularly accidents related to the condition of the surface
- Costs - Initial construction cost, replacement cost, and maintenance cost
- Engineering Judgment

FIGURE II-13

COMPARISON OF CROSSING MATERIAL COSTS & SERVICE LIFE
FLORIDA DEPARTMENT OF TRANSPORTATION

MATERIAL	EQUIVALENT ANNUAL COST* ($1989)	ESTIMATED SERVICE LIFE** (YEARS)	RANKING
RUBBER	2430	10-20	1
CONCRETE	2500	7-15	2
STEEL	3010	7-15	3
HD POLYETHYLENE	3310	5-10	4
TIMBER OR ASPHALT	2650	5-10	5

Source: Florida Department of Transportation, Bureau of Value Engineering, Highway-Railroad Grade Crossing Material Selection Handbook, (Tallahassee, Florida, 1984).

* Equivalent Annual Cost = (Installation + Maintenance - Salvage Value) / Calculated Service Life

**Primary high truck traffic or high vehicular volumes per lane would reduce service life

Assumptions:

- 7% Annual Interest Rate
- 5% Truck Traffic
- 15,000 Average Daily Traffic on roadways
- Under 3 million annual gross tonnage (eg: 2 unit coal trains: one loaded (11,000 tons/train in Texas) and one empty * 313 days (6 days/week)
- Costs converted to $1989 by utilizing the Consumer Price Index

The life of a crossing surface depends on the volume and weight of the highway and rail traffic. The highway traffic not only dictates the type of grade crossing surface to be installed, but obviously has a major influence on the life of the crossing. The deterioration of the riding quality of a crossing surface results in increased vehicle operating cost, hazards and inconvenience to highway traffic. Rail traffic also contributes to the deteriorating effect on the service life of the crossing in that it causes the need to repair or replace the highway-rail crossing surface. Railroad traffic damages the crossing surface through vibration or uplift in front of the wheels reducing the life by 5 to 50 percent depending on the surface type.

If cities maintain road facilities with traffic volumes greater than 5,000 ADT and prefer to upgrade the standard timber crossing provided by railroads, the Railroad Maintenance Work Group concurs that railroads will install the upgraded crossing materials if the local agency purchases the materials on a negotiated labor cost basis. On state maintained highways, TxDOT specifies timber surface materials for a crossing for vehicle traffic less than 2,000 ADT.

The two principal high-quality crossing materials used in Texas are the rubber or concrete panels. For railroad-highway crossings on the state maintained roads, TxDOT uses concrete or rubber panels for crossing materials for grade crossings with vehicle traffic greater than 2000 ADT. These materials provide a durable, smooth riding surface with a long-lasting surface life. Most railroads prefer full depth crossings without shims in main or branch line applications. Some railroads are adopting concrete panels as their standard-crossing surface material.

One of the principal "high-type" crossing surface materials is the rubber panel. This type of crossing surface consists of molded rubber panels usually steel-reinforced with a patterned, anti-skid surface. The panels can be removed or replaced for track maintenance. The rubber panels are made in versions that are either full-depth or shimmed to the correct surface height. Rubber was marginally preferred over concrete panels because of its lower annualized cost due to its high service life. Prices of crossings constructed in 1989 from 100 percent virgin rubber ranged from \$175-\$275 per track-foot, according to local city engineers. Further information concerning virgin rubber indicates it has the added advantage of being quiet in noise-sensitive areas. The Louisiana Department of Transportation and Development also had a high preference for rubber crossings according to the FHWA Highway-Railroad Grade Crossing Material Selection Handbook.

Currently, some railroads are installing prefabricated concrete panel crossings on all main lines and selected spur tracks. Some prefabricated concrete panel crossings in the Western states have lasted more than 15 years. Prices of crossing materials vary from \$90-\$175 per track-foot for prefabricated concrete. In a comparison with 100 percent virgin rubber, concrete proved to be more cost efficient in maintenance fees. The prefabricated concrete panels generally withstand normal rail maintenance better than rubber which is often damaged. Poured-in-place concrete is not recommended because it can cause track access problems for railroad companies during routine track maintenance operations.

The Work Group recommends that 100 percent virgin rubber or prefabricated concrete materials be utilized for crossings with more than 5,000 ADT or heavy truck traffic greater than 10 percent of the total traffic.

Reflectorized Tape and Illumination

The Texas House Bill (H.B.) 2681 of 1991 mandated that every grade crossing currently without active warning devices have 2" - 4" reflectorized tape installed on the support post and back of every single-sided crossbuck sign. This law requires TxDOT to be responsible for this portion of the crossbuck assembly. TxDOT representatives have the option of installing the material with their crews or supplying to local governments the reflectorized tape for local staff installation. Any replacement of crossbucks will be completed by the rail carrier with new double-sided reflectorized crossbuck signs. These will ultimately phase out single-sided crossbucks with reflectorized tape on back. Backing up the far-side crossbuck with another reflective crossbuck and reflectorized support post has two important advantages. First, it provides redundancy to assist drivers in detecting the crossing. Second, it will reflect vehicle headlights back through the gaps between the rail cars. The on-off effect creates a strobe light (flicker) similar to an active warning device.

If reflectorization has not reduced accidents, the Railroad Maintenance Work Group recommends the adoption of crossing illumination guidelines for crossings involving nighttime railroad operations or crossings with nighttime train-vehicle accidents as described in the FHWA Railroad-Highway Grade Crossing Handbook. According to the Handbook, crossing illumination may be effective under the following conditions:

- night time train operations
- low train speeds
- blockage of crossings for long periods at night
- accident history indicating that motorists often fail to detect trains or traffic control devices at night
- horizontal and/or vertical alignment of the highway approach which does not allow the vehicle headlight to fall on the train until the vehicle has passed the safe stopping distance
- long dark trains (e.g., unit coal trains)
- restricted sight distance or stopping distance in rural areas

- existing "humped" crossings where the large vertical grade change of the approach lanes can allow oncoming vehicle headlights to be visible under the train
- low ambient light levels

Recommendations for the placement and type of floodlights or luminaries are available in the FHWA Roadway Lighting Handbook. It is desirable to have at least two luminaries provided at the crossing, with one on each side of the track. Mounting height should be between 30 and 40 feet. Illumination should be a distinctive color and distribution so that it clearly distinguishes the crossing amongst other street lighting. In rural areas, some lighting should be directed down the track to light the sides of railroad cars.

Track Inspections

Railroad carriers are responsible for track inspections on a set schedule as outlined in the Code of Federal Regulations (CFR). These nationwide safety regulations are solely based on track conditions, track curvature, superelevation, and roadbed conditions with different standards for six classes of tracks. The FRA monitors the rail operators' compliance with these maintenance and operating standards and appears to have the sole legislative authority to fine railroads if noncompliance occurs, according to the Railroad Commission of Texas (RCT). This inspection procedure appears to have occurred based on the supremacy clause of the U.S. Constitution, which specifies when federal law conflicts with state or local law, the federal law must control. Thus, a local city's inspection of tracks appears to have no enforcement validity unless the RCT inspects the track on the city's behalf. A city's attempt at inspection has been found as a restriction on railroad operations and would be in violation of interstate commerce, a concept that Congress hoped to encourage in the Federal Railroad Safety Act of 1970. The Work Group recommends that track inspections, where necessary on behalf of local governments, be coordinated with FRA or RCT officials.

Visual Obstructions

The clearance of visual obstacles at railroad-highway grade crossings for each sight triangle of the crossing's four quadrants is recommended by the Work Group as outlined in revised Railroad Commission of Texas regulations. The RCT require vegetation control and permanent obstruction clearance for 250 feet as measured from the centerline of each crossing for public crossings equipped with crossbucks. When the railroad right-of-way is fenced, compliance would be deemed if the vegetation is controlled up to two feet from the fence. "Vegetation" includes grass, bushes, shrubbery, and trees having a diameter of six inches or less. "Public crossings" include an approach with at least one public roadway.

Obstructions also include trains, cars, or equipment standing closer than 250 feet from the centerline of any grade crossing equipped with passive warning devices. Railroad operators in violation of this rule are subject to fines unless a closer distance could not be avoided. Billboards and signs which are legally permitted by the state or a political subdivision are not necessarily permanent obstructions as long as they do not block the motorists' view of approaching trains, according to FHWA. Permanent buildings in existence prior to the effective date of this ruling are exempt from this requirement.

Railroad companies are responsible to bring their right-of-way vegetation into compliance. However, a variance may be applied for by rail carriers concerning nonconforming vegetation and permanent obstructions under the current RCT regulations. Clearing brush or weeds from a grade crossing provides adequate sight distance at a crossing and can also provide a better preview of the crossing for approaching drivers.

The Texas Department of Transportation sponsored a research report in 1994 through the Texas Transportation Institute to study the impact of sight distance as an additional variable to the Texas Priority Index for railroad-highway grade crossings. The report, by Fambro, Klaver, and Cooner, evaluated both sight distance as criterion for ranking railroad-highway grade crossings for improvement. In studying train involved accidents over a five year period, Fambro found that sight obstructions could have been a contributing factor nearly 50 percent of the time and that the majority of passive railroad-highway grade crossings have at least one sight obstruction. The research report recommends the use of a sight distance variable to help TxDOT engineers identify those crossings most in need of improvement. TxDOT will evaluate the findings of this report and may incorporate some or all of the recommendations into practice in the Texas Priority Index.

CROSSING RELOCATIONS, CONSOLIDATION OR CLOSURE

The Federal Railroad Administration has set a national goal to close 25 percent of the nation's highway-rail grade crossings by the year 2000. Texas, with almost 20,000 highway-rail grade crossings, has the highest number in the nation. Reducing the number of crossings through relocation or rerouting of the highway, or closure of the highway crossing represent "low cost" safety improvements. Crossing consolidation is desirable when there are many redundant crossings in a particular jurisdiction. Closure of a crossing may be required when the grade crossing is angled in such a way that the sight distance is restricted. Additionally, any restricted or obstructed sight distance that cannot be corrected for the motorist approaching a railroad grade crossing will warrant closure.

The number of crossings needed to carry highway traffic over a railroad in a community is influenced by many of the characteristics of the community itself. A study of highway traffic flow should be conducted to determine origin and destination points and needed highway capacity. Access issues must be studied to determine the impact on emergency vehicles, ambulances, fire trucks, and police. Thus, optimum routes over railroads can be determined. Highway operation over several crossings may be consolidated to move over a nearby crossing with flashing lights and gates or over a nearby grade separation. Alternative roates should be within a reasonable travel time and distance from a closed crossing. The alternate routes should have sufficient capacity to accommodate the diverted traffic safely and efficiently.

The 1986 Railroad-Highway Grade Crossing Handbook suggests that by using a systems approach several crossings in a community or rail corridor could be improved by the installation of traffic control devices while other crossings are closed. However, the various factors that should be considered to identify those crossings that should be closed are difficult to establish. Currently, there are no Federal restrictions or standards on how many or what types of crossings should be consolidated within a given area. The following criteria, taken from the 1994 FRA report Rail-Highway Crossing Safety Action Plan Support Proposals, have been found useful for selecting crossings for consolidation:

1. Consolidate crossings where there are more than four per mile in urban areas, and one per mile in rural areas and an alternate route is available.
2. Consolidate crossings which have fewer than 2,000 vehicles per day and more than two trains per day and an alternate route is available.
3. Eliminate crossings where the road crosses the tracks at a skewed angle or where the track is curved.

4. Link construction work with eliminations. This linkage will be especially important when upgrading rail corridors for high speed trains.
5. When improving one crossing (by grade separation or installation of automated warning devices), consider eliminating adjacent crossings and rerouting traffic from these crossings to the improved crossing.
6. For every new crossing built, consolidate traffic from two or three other crossings.
7. Eliminate complex crossings where it is difficult to provide adequate warning devices or which have severe operating problems (e.g., multiple tracks, extensive switching operations, long periods blocked, etc.).

The 1994 Highway-Railroad Grade Crossings: A Guide to Crossing Consolidation and Closure by the Federal Railroad Administration provides useful information agencies to assist them in grade crossing consolidation projects. The Guide addresses the issue of local opposition crossing closure. The Guide offers strategies to win local support based on actual crossing consolidation projects. Past experience shows that even when communities support crossing consolidation, they may oppose proposed changes in traffic patterns. In these cases, "trade-offs," such as upgrading other crossings in the area of the targeted closure, have been successful.

TEMPORARY CROSSING CLOSURES

It is recommended by the Railroad Maintenance Work Group that cities or counties be given five working days notice by the railroad operator for partial or full street closures due to maintenance or rehabilitation of the railroad crossing unless an emergency situation prevails. This notice will allow local governments to coordinate detour routes if warranted. It is also the recommendation of this Work Group that any work area traffic control be coordinated between the local government and the railroad.

BICYCLE CROSSINGS

Bicycle paths across railroad tracks present several special problems. There are some relatively simple and cost-effective treatments available for the problems cyclists encounter at railroad grade crossings. The reduction of lane width at a crossing can affect passage of bicycles across the tracks. The 1986 Railroad-Highway Grade Crossing Handbook specifies that the crossing should be sufficient to extend at least one foot beyond the edge of the highway pavement, including any paved shoulders on the highway approaches to the crossing.

Also, depending on the crossing angle (the skew of the tracks in comparison with the bikeway or traveled lane) and the condition of the tracks, a cyclist may lose control of the vehicle if a wheel becomes trapped or violently redirected in the flangeway. The surface materials and the flangeway depth and width must be examined to determine if the crossing is safe for the cycling public. The more the crossing deviates from the ideal 90-degree crossing, the greater the potential for a cycle wheel to be trapped or violently redirected in the flangeway. If the crossing angle is less than 45 degrees, engineers should consider widening the bikeway to allow sufficient width to cross the tracks at a safer angle. Maintenance personnel should preserve the crossing surface to be as smooth and level as possible in order to provide for the safest passage for the cyclists.

Another potential problem exists in the communication of an approaching train to the cyclists at actively controlled railroad-highway grade crossings that use flashing lights. The Handbook recommends the use of a crossing bell to supplement other active traffic devices to help alleviate the detection problem sometimes encountered by cyclists. The Handbook goes on to say that other than smooth surface treatments, there are no special controls for these special vehicles.

However, if a bicycle trail crosses tracks at-grade, the bicyclist should be warned of this with suitable markings and signs.

AMERICANS WITH DISABILITIES ACT

The Americans with Disabilities Act (ADA) establishes accessibility standards for new construction and alterations of state and local government facilities covered by the ADA. One small part of the Interim Final Rule published by the Architectural and Transportation Barriers Compliance Board relates to railroads. Section 14.2.1 of the Accessibility Guidelines for Buildings and Facilities sets out minimum requirements for new construction of public sidewalks. Among other things, the interim rul specifies: "Where public sidewalks cross rail systems at grade, the surface of the continuous passage shall be level and flush with the rail top at the outer edge and between the rails. The horizontal gap on the inner edge of each rail shall be the minimum necessary to allow passage of wheel flanges and shall not exceed 2 1/2 inches maximum." The effective date of this rule was December 20, 1994.

TOLL-FREE NUMBER IN TEXAS FOR REPORTING CROSSING SIGNAL PROBLEMS

The Texas Department of Public Safety (DPS) conducts a crossing signal reporting procedure for the public in Texas. The provision of a toll-free number permits any person to report any problem or malfunction with a railroad-highway signalized grade crossing on the state or federal highway system. Analysis of logged calls by the Railroad Commission of Texas and the DPS has primarily indicated problems with improper signal operation, excessive crossing delays for motorists, and poor crossing conditions.

Every signalized railroad-highway grade crossing has a sign showing both an identification number and toll-free telephone number for reporting safety problems. Figure II-11 shows the standard malfunction warning sign which is designated under the MUTCD as the R15-4 sign. The identification number is a unique, six-digit code number that identifies its' location and which railroad has maintenance responsibility. The DPS crossing safety telephone number is 1-800-772-7677 and is attached to metal signal posts at the crossings. When the public is reporting a problem, the U.S. Department of Transportation (DOT) crossing number, together with any alphabetic characters, should be given to the answering DPS dispatcher.

Cities can participate in this DPS signage program for signalized crossings. The typical cost of these signs is approximately $15 with railroads offering to install these signs or supervise their installation on existing railroad signal posts if the city is willing to pay for the materials. The RCT has confirmed that funding and installation are available from TxDOT District offices for any public rail-highway crossing with railroad signals. The local jurisdiction having road authority should contact the appropriate TxDOT District office and railroad company to arrange for funding and installation of the signs.

The Railroad Maintenance Work Group recommends that where local funds permit, city governments at their discretion arrange for U.S. DOT inventory number signs or stencils to be placed on signal posts at grade crossings. The signs' manufacturing costs would be absorbed by the city and installation arranged through the railroad operator.

III. OPERATIONS

Railroad operations include items of mutual concern for local government officials, the general public, and the railroad operators. The issues can be summarized into economic, safety, and environmental considerations. For the North Central Texas area, local governments and railroad representatives have identified seven major issues as follows:

- speed restrictions
- size restrictions
- blocked crossings
- railroad noise related to adjacent land uses
- motorist education
- responsibilities of motorists at grade crossings
- police enforcement at activated warning device grade crossings

Recommendations for these selected items are presented by the Railroad Operations Work Group to the Railroad Coordination Task Force for inclusion as regional operation guidelines for rail corridors.

SPEED RESTRICTIONS

Historical Development

Historically, railroads came to the centers of existing communities because the communities wanted them to enter and provide transportation between them and the rest of the country. In sparsely populated areas, cities were built up around railroads. In today's environment, especially with high vehicular traffic, conflicts have arisen over the railroads' location in urbanized areas.

From the community and motorists' viewpoint, the railroad is currently a dividing force providing safety hazards, vehicular delays, congestion, potential emergency vehicle response time delays, and blocked street crossings. The resulting frustration encourages impatient motorists to run through closed automatic gates when trains are in dangerous proximity. Thus, some communities have imposed railroad speed restrictions in the interest of public safety.

From the rail carriers' perspective, arbitrary speed restrictions are undesirable because of the delays and fuel costs incurred for trains slowing to pass through the community. It makes the railroads less competitive because lower train speeds and higher costs enable the airline and trucking industry to attract a larger percentage of the transportation market. However, the prevalent central city location still proves advantageous for the railroads. The rail corridors can also provide easements for utility companies and fiber-optic communication services to enter the central cities.

Historically, municipal speed restrictions for railroads did not occur in great numbers until the late 1890s when the number of crossings and number of rail/motor vehicle accidents increased because of the conflicting surface transportation modes. Initially, many states and cities demanded that the railroads, who were responsible for the crossings, take immediate action to eliminate hazardous crossings. Numerous laws, ordinances, and regulations were adopted to enforce these community demands, but there was neither regulation uniformity, a division of responsibilities, nor an allocation of costs.

Existing Railroad Operating Speeds

Existing railroad operating speeds in the Dallas-Fort Worth region are governed by the FRA track class standards, maintenance standards, and individual railroad operating policies which may adopt existing city railroad ordinances. A summary of city railroad ordinances for Dallas, Fort Worth, Arlington, Grand Prairie, Irving, Garland, and Farmers Branch are shown in Figure III-1. Tabulated FRA track classes and related maximum allowable operating speeds are shown in Figure III-2. Several city ordinances illustrate the diversity between their allowable train operating speeds and the FRA maximum allowable operating speeds in the Dallas-Fort Worth region. For instance, the Dallas ordinance allows crossings with passive warning devices to have limited speeds of 10-25 mph while Farmers Branch allows 40 mph citywide.

Federal Court Judgments

In order to give some legal context to the differences in current railroad operating speeds, a review of case law is appropriate. In 1893 the U.S. Supreme Court, in the precedent-setting case of New York and Northeastern Railway vs. Town of Bristol, upheld the constitutionality of a Connecticut statute that required railroads to pay 75 percent of the costs to improve or eliminate crossings where the highway was in existence before the railroad. In addition, if the road was constructed after the railroad, the railroad was still required to pay 50 percent of such costs. This so-called "Senior-Junior" principle was followed by the courts in several other states to determine the railroads' responsibilities.

Until 1935, the U.S. Supreme Court adhered to the position that a railroad company should allocate a portion or all of the expense for the construction, maintenance, rehabilitation, or elimination of public railroad-highway grade crossings. This was partially due to the dominance and financial status of the railroads during the first three decades of this century. However, funds from federal industrial recovery acts provided monies for separation of the railroad-highway grade crossings and installation of rail crossing traffic control devices. By this time, the public attitude

FIGURE III-1

COMMUNITY-IMPOSED SPEED RESTRICTIONS IN THE NORTH CENTRAL TEXAS REGION

MAXIMUM SPEED LIMITS

COMMUNITY	GENERAL CITY LIMITS	CROSSBUCK OR FLASHER CROSSING PROTECTION	GATE-PROTECTED CROSSING PROTECTION	SPECIFIED CITY DISTRICTS	SPUR OR SWITCH TRACKS
Dallas	10 - 110**	10 - 25	40 - 110**	---	10(C) 25(F)
Fort Worth	40	20	40	20	---
Arlington*	40	20	40	---	---
Grand Prairie	30	30	30	30	30
Irving	30	---	---	---	---
Garland	30	30	30	---	---
Farmers Branch	40	40	40	---	---

* Draft ordinance
**FRA Class 6 operating limit, with gates or grade separation.

(C) Crossbuck
(F) Flashers

Source: North Central Texas Council of Governments, Transportation Department Local Railroad Ordinance Survey (Arlington, Texas, January 1989).

FIGURE III-2

1988 CURRENT CLASS OF TRACK AND OPERATING SPEED LIMITS OF THE FEDERAL RAILROAD ADMINISTRATION

	ALLOWABLE OPERATING SPEEDS (miles per hour)	
TRACK	**FREIGHT**	**PASSENGER**
Class 1	10	15
Class 2	25	30
Class 3	40	60
Class 4	60	80
Class 5	80	90
Class 6	110	110

Source: United States Government, Code of Federal Regulations (CFR), Title 49, Part 213.9 except as provided in para (b) and (c) of this section and 213.57, 213.59, 213.113(a), and 213.137(b) and (c), Federal Railroad Administration, (Washington, DC, October 1, 1988).

shifted, and the U.S. Supreme Court's decision, according to the Railroad-Highway Grade Crossing Handbook, reflected:

> The railroad has ceased to be the prime instrument of danger and the main cause of accidents. It is the railroad which now requires protection from dangers incident to motor transportation.

Precedence of Federal Railroad Administration Track Classification

The enactment by Congress of the Federal Railroad Safety Act of 1970 was intended to provide uniform, nationwide railroad safety standards. Authority for individual states to further regulate railroads was given only under special circumstances. Congress sought to eliminate the undue burden on interstate commerce and railroads by limiting state and local administrative and judicial systems in several areas affecting rail operations. Pursuant to the Act, the FRA adopted train operating speeds in conjunction with the adoption of track, roadbed, and signal standards. The FRA established train speeds between 10 and 110 mph as summarized in Figure III-1. In Baltimore and Ohio Railroad Company vs. the City of Piqua, Ohio, a federal court in 1986 held that a city's attempt to establish railroad operating speeds below FRA standards was preempted by federal law and therefore invalid. Railroads are willing to cooperate with different levels of government to institute safe and practical train speeds, motor vehicle speeds, traffic control devices, and adequate sight distances to reduce railroad and highway crossing hazards.

Amtrak has worked with local governments on a railroad corridor upgrade program to raise operating speeds of the FRA Class 4 main line between Dallas and Houston. Selected crossings are being upgraded by standard federal rail-highway crossing safety improvement matching funds. They have been successful in revising operating speeds in conjunction with the counties of Dallas and Carson, plus the cities of Ennis, Wilmer, Palmer, Hutchins, and Houston. Houston currently has passenger train operating speeds of between 30 and 60 mph.

State Intervention for Local Crossing Hazards

Allowance was made for state intervention on behalf of cities such that, "A state may adopt or continue to enforce an additional or more stringent law, rule, regulation, order, or standard relating to railroad safety when necessary to eliminate or reduce an essentially local safety hazard, when not incompatible with any federal law, nor creating an undue burden on interstate commerce." This judgment was made in the precedent-setting case of Sisk vs. National Railroad Passenger Corporation (Amtrak), 647 Federal Supplement 861 (Federal District Court, Kansas, 1986).

The case further argued that the supremacy clause in the United States Constitution established that when federal law conflicts with state or local law, the federal law must control. However, Congress did allow the states to act on behalf of cities concerning local railroad hazards to reduce train operating speeds due to, for example, problems with sight distance, road geometry, proximity of school children, school bus routes, or emergency vehicle routes. The RCT supports this judicial position of state intervention on behalf of local cities at unprotected crossings and is recommending that modifications to railroad speed limits be achieved on a site-specific basis in conjunction with the Commission and the affected rail operator.

Harmonic Oscillation

Documentation from the Texas Transportation Institute (TTI), entitled A General Overview of Railroad Safety in Texas, states that for railroad operating speeds between 12 and 25 mph, harmonic oscillation or car rocking can occur with a potential for derailment, particularly along extended portions of track at a lower speed range. Consideration should be given to this problem, according to the Work Group, before any new railroad speeds below 25 mph are adopted.

Accident Data

The national office of the FRA in Washington, D.C. publishes accident statistics annually. Those statistics and others utilized in accident analysis according to the FHWA, should be surveyed over a minimum three- to five-year period to determine trends, such as those necessary in before-and-after crossing improvement studies. TxDOT analyze a five-year period of train-involved accident statistics reported to the Texas Department of Public Safety when determining which crossings are eligible for site diagnostics and FHWA crossing safety upgrade funds.

Analyzing the Texas region in particular, grade crossing accidents between 1980 and 1988 are categorized by train-involved and nontrain-involved accidents occurring at crossings with active (automatic gates or flashers) and passive (crossbuck) warning devices. Figure III-3 illustrates the total number and percentage of Texas railroad accidents. Over 40 percent of the crossing accidents occur at active warning devices and are nontrain-involved collisions. This indicates that drivers are confused over what the railroad signs and signals really mean, especially for the younger and older adult population, according to TTI. In detail, 3904 or 58 percent of total train-involved accidents occur at active warning device crossings. The data also suggests that fatality rates are correlated to age groups, not only of young adults from 15 to 29 years but older adults of 75 years of age or higher. Both have significantly higher fatality rates compared to the general population, as shown in Figure III-4. Currently, no "train miles of travel" data are available from the national FRA database to normalize accident rates as a function of train speeds.

Recommendations

Federal court cases indicate FRA track standards supersede other speed restrictions set by a state or city. The exception would be for site-specific local factors such as obstructed sight

FIGURE III-3

TEXAS GRADE CROSSING ACCIDENTS

TRAIN-INVOLVED AND NONTRAIN-INVOLVED (1980-1988)

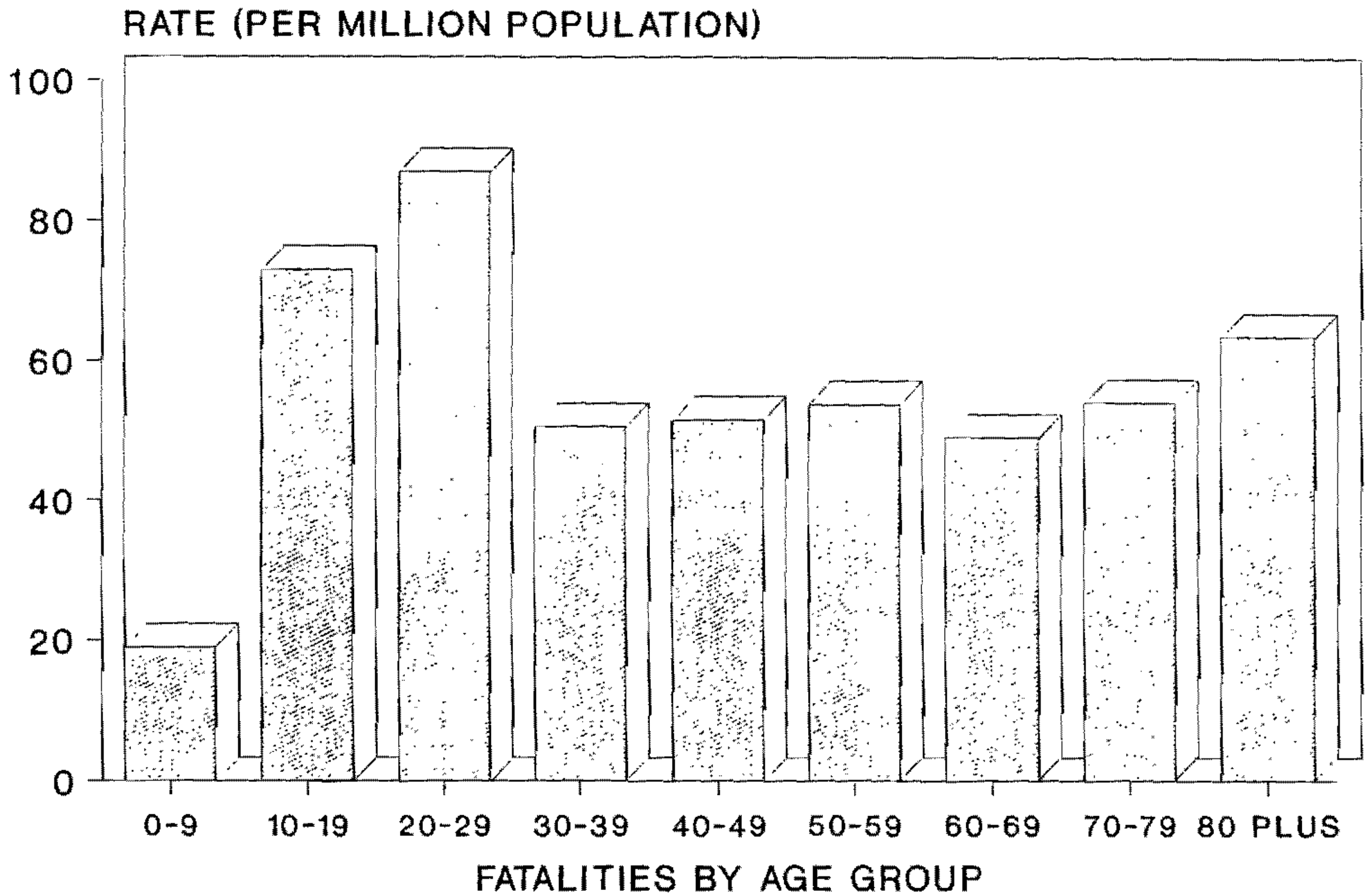
ATTRIBUTE	ACTIVE WARNING DEVICE [1]	PASSIVE WARNING DEVICE [2]	TOTAL ACCIDENTS
TRAIN-INVOLVED: ACCIDENTS	3904	2795	6699
PERCENT	(58.3%)	(41.7%)	(100%)
NONTRAIN-INVOLVED: ACCIDENTS	5563	1613	7176
PERCENT	(77.5%)	(22.5%)	(100%)
TOTAL ACCIDENTS:	9467	4408	13875

1 GATES OR FLASHERS
2 CROSSBUCKS

Source: Federal Highway Administration, A Training Course for the: Railroad Highway Grade Crossing Handbook--Participants Notebook.

FIGURE III-4

CROSSING FATALITY RATES BY AGE
1977 - 1988 VEHICLE OCCUPANTS



Source: Adapted from Federal Highway Administration, A Training Course for the: Railroad Highway Grade Crossing Handbook--Participants Notebook.

distances or schools in close proximity to rail corridors. At that point, the state on behalf of the city can institute more stringent railroad operating speed standards if warranted.

The Railroad Commission of Texas recommends that communities and railroads try to resolve the grade crossing problem and then only consider speed restrictions on a corridor-wide basis. If a certain grade crossing problem continues, then railroads may adopt railroad speed restrictions mutually agreed upon during negotiation with railroad operators on a limited site-specific basis.

Harmonic oscillation between 12 and 25 mph is also a technical issue to consider when seeking railroad speed limits. The rocking of trains which may occur at that speed range can derail trains, especially over extended portions of track.

Reconsidering accident data which indicates that rail accidents at grade crossings occur more with younger and older members of the adult population, education targeted at these age groups may be very cost effective.

Considering these four factors, the Work Group recommends that:

- any existing city train speed ordinances be repealed, and
- railroads make available FRA track classifications for its tracks.

SIZE RESTRICTIONS

According to the judgment in the law case of <u>Southern Pacific Company vs. State of Arizona</u> (325, U.S. 761) in the Federal Supreme Court in 1945, any attempt by a state (and therefore any lesser governmental entity) to limit the length of trains is an unconstitutional burden on interstate commerce. The express policy of Congress was to promote an "economical national railroad system." The Task Force therefore considers that train size restrictions in local ordinances appear legally unenforceable and recommends procedures to shorten train lengths relative to blocked crossings be discussed with the railroads. FHWA railroad-highway crossing safety funds could be employed for grade-separated structures in this situation, and certain rail carriers will offer to provide funding given the accident and derailment history of the crossing.

BLOCKED CROSSINGS

A number of cities within their railroad ordinances have a law which disallows the blocking of grade crossings for more than five consecutive minutes by a standing train. This is based on Article 6701d-5 from Vernon's Annotated Texas Civil Statutes which states:

> "An officer, agent, servant, or receiver of any railway corporation who willfully obstructs for more than five minutes at any one time any street, railway crossing, or public highway by permitting their train to stand on or across such a crossing shall be fined not less than five nor more than one hundred dollars."

This law was made effective in 1921 during the 37th Texas Legislative session. Given the number of tracks and switches in urban areas which could potentially be blocked, jurisprudence would apparently determine whether a "willful" blockage of a crossing occurred. "Considering that urban areas with two grade crossings per mile are not unusual and train lengths can range from 5,000 to 7,000 feet, then potentially three grade crossings could be blocked from a single train."

Track circuitry involving either motion detector track circuits or constant warning-time devices can improve motorist crossing delays. When trains approach crossings at variable speeds or have significant switching movements, the constant warning time device uses an electronic system to ensure a 20- to 25-second warning device activation time regardless of the train speed on the approach. If the train stops before the crossing, the signal is deactivated. The cost of a constant warning time device ranges from $11,500 to $14,000 plus from $9,000 to $11,000 extra to install it compared to a motion detector. Motion detector track circuits utilize audio frequencies to detect when a train stops on the approach or moves away from a crossing. The crossing warning system is then deactivated if the train is within normal approach limits.

Grade crossing accident research reported in the November 1989 issue of Highway and Rail Safety Newsletter by the Canadian Institute of Guided Ground Transport indicated that critical incidents result from the following conditions at the crossing:

- unduly long warning times
- long occupancy times of the crossing by some trains
- false alarms due to a signal malfunction or a signal placed in a fail safe status

The researchers considered those events as precursors to the tendency of drivers to deliberately violate the signals. Their analysis of video recordings indicated 25 percent to 33 percent of drivers were not aware that they are approaching a crossing. Other drivers incurred an "unobeyable signal problem" where the signals flash and the driver was unable to stop the vehicle in a safe and comfortable manner. Finally, approximately 60 percent of the drivers had a speed variance approaching the crossing where motorists either increased or decreased their speed thus increasing the incidence of collisions at crossings involving no train: either rear-end or front-end collisions with other vehicles resulted.

The researchers concluded that for safety purposes at crossings, the drivers' decision to disobey the signal will be smaller if warning times are kept short including the time that moving trains occupy the crossing (that is when trains are short and move fast). They concluded efforts toward risk control, short of grade separation, should include:

- increasing crossing conspicuity,

- reducing occurrence of unobeyable signals,
- improving smoothness of crossing surfaces,
- eliminating false alarms and excessively long warning periods, and
- reducing total duration of signal activation.

Warrants and guidelines for these predictors have currently not been developed.

The University of Tennessee Transportation Center has found that experimental four-quadrant gate systems reduce the number of gate violations to almost zero. With the two-quadrant gate system, one or more motor vehicles drove around closed gates during 84 out of 100 train arrivals. The experimental four-quadrant gates are not contained in the Texas MUTCD, although the regular gate locations with a center median prevents motorists from driving around activated gates. The experimental four-quadrant gate system reduced 260 motorists per 100 trains from driving around gates to zero. The gates also reduced vehicles crossing between 10 to 20 seconds from train arrival to zero. During the testing period, no motorist was trapped on the tracks, emergency vehicle operation was not impaired, no unreasonable delays were created for the motorist, no public complaints were received, and retrofitting crossings with two extra gates was not difficult.

Researchers at the University of Tennessee recommend the following crossings for four quadrant gates:

- crossings on four-lane undivided roads
- multitrack crossings where the distance between tracks is greater than the length of a motor vehicle
- crossings without constant warning time devices where train times are long and variable

- crossings where there are hazardous materials trucks, transit buses, school buses, or high-speed trains
- crossings with consistent gate arm violations or continuing accidents

Appraising the likelihood of this occurrence, the Railroad Ordinance Work Group has recommended the following:

- as mentioned earlier, blocked crossings be analyzed from a corridor perspective
- motion detectors or constant warning-time track circuits be utilized as appropriate for crossings with heavy switching operations or variable train speeds to minimize warning device activation time
- guidelines for grade separations, described in the Highway-Railroad Grade Crossing Handbook be adopted with encouragement of city initiatives to secure FHWA crossing safety improvement funds and matching funds from railroads

RAILROAD NOISE RELATING TO ADJACENT LAND USES

The FRA regulates train noise by standards published in the CFR. For example, locomotives manufactured prior to 1981 can have allowable "A-weighted" noise decibel levels of 96 dBA maximum when trains are in motion (fast). Locomotives manufactured after December 1980 can have allowable noise levels of 90 dBA maximum when trains are in motion (fast).

Additional noise regulations for switcher locomotives manufactured on or before December 31, 1979, which operate in yards, are also available in the CFR. When stationary locomotive noise exceeds the receiving property limit of 65 dBA as shown in Appendix B, the locomotives are considered in noncompliance. This situation will trigger a 30-meter or less noise level test on receiving properties. Overall, FRA enforcement efforts focus on abatement procedures that will achieve a reduction of receiving property noise levels to less than 65 dBA.

The ICC also has involvement with railroad noise control as a part of its environmental impact process. If a railroad project involves either new rail line construction, a discontinuance of passenger trains, or certain rail mergers causing heavier train traffic (usually 50 percent greater train traffic or eight trains per day) on new, existing, or adjacent lines, the ICC's noise rules would apply as written in 49 CFR, Part 1105. Again, the preliminary investigation would need to find environmentally significant decibel changes, as defined in 40 CFR 1508.27 for the L_{dn} measure = 65 dBA for moving trains.

An example of noise contours indicates that one loaded and one empty coal unit train (over 100 cars totaling 11,000 tons maximum) per day transporting approximately four million tons of coal annually during daylight hours would have an L_{dn} of 65 dB with a contour commonly extending approximately 50 feet from the centerline of the track. Under a 12 million ton per year scenario, six trains (three loaded and three empty) would increase the L_{dn} of 65 dBA contour line to 190 feet from the track centerline. This indicates that the L_{dn} of 65 dBA is a fair measure for noise intrusion into sensitive land-use areas depending on the extent of residential dwelling units and other affected facilities such as libraries, hospitals, nursing homes, and schools. The Work Group recommends that railroad noise of moving trains over 65 dBA next to residential property be the trigger for further noise measurements as defined in the CFR and resolved by FRA procedures.

MOTORIST EDUCATION

Grade Crossing Safety Facts

Texas has recognized the importance of educating motorists of the potential hazards at highway-rail grade crossings by enacting legislation to include grade crossing safety training in all defensive driving classes taught in Texas. In 1993 Texas had nearly 7 percent of the total national public and private grade crossings with over 10 percent of the nation's grade crossing accidents and 12 percent of the nation's fatalities at grade crossings, meaning that a disproportionate number of accidents occur in Texas. Details about Texas train/vehicle accidents in 1993 indicate:

- 52 percent occurred at signalized crossings,
- 54 percent happened during daylight hours,
- 61 percent involved train speeds of less than 29 mph,
- 52 percent happened where the driver's view was unobstructed,
- 66 percent occurred in clear weather, and
- 25 percent involved vehicles running into trains.

A 1982 study by Berg, knoblach, and Hucke proposed that the occurrence of a vehicle-train accident was the result of a recognition, decision, or action error. The findings of the study, as summarized by Fambro, Klaver, and Cooner in 1994, revealed that about 80 percent of the accidents investigated at crossings with crossbucks involved errors of driver recognition and about 23 percent involved late recognition of a train that was already in the crossing. The study identified the principal contributing factors to vehicle-train accidents at crossings as the lack of quadrant sight distance and low driver expectancy of train presence. Further, the study revealed that nearly 38 percent of the accidents investigated at crossings with flashing lights involved driver recognition errors. Of these accidents the study showed that 81 percent of the drivers did not detect the signal when they were on the approach. Apparently, motorists who are involved in grade crossing accidents often do not exercise proper caution and do not observe motor vehicle laws and will attempt to "run through" crossings even when the crossing gates are activated.

Local governments should note that Amtrak requires the assignment of signal department employees to investigate all reported signal malfunctions and the assignment of Amtrak police to be at the crossing until required inspections and repairs are completed on the signals.

Operation Lifesaver

A national nonprofit program called "Operation Lifesaver" is an active, continuous public information and education program to help prevent and reduce crashes, injuries, and fatalities and improve driver performance at highway-rail grade crossings. Operation Lifesaver is needed because many drivers do not cross railroad tracks often enough to be familiar with the warning devices designed for their safety. Driver inattention and impatience are the most common factors contributing to motor vehicle/train collisions at highway-rail grade crossings. The majority of 486 collisions in 1993 in Texas occurred during clear weather at crossings with active warning signals during daylight hours by trains going less than 29 miles per hour.

Operation Lifesaver reminds you to Look, Listen, and Live when approaching highway-rail grade crossings. Program emphasis is on the three E's:

- Enforcement of existing laws governing highway-rail grade crossings.
- Engineering highway-rail grade crossings to provide the greatest safety by working with communities in their efforts to provide additional warning devices.
- Education of the driving public about the inherent dangers at highway-rail grade crossings.

To enhance highway-rail grade crossing safety, Operation Lifesaver endorses the concept of reducing the number of crossings through elimination, consolidation, grade separation and restricting the number of new crossings.

Operation Lifesaver offers films, information, and speakers upon request to schools, civic groups, shopping malls, the media, governments, corporate driver training courses, fleet vehicle drivers, and others. If cities or counties are interested in improving their local grade crossing safety, this Work Group recommends that they contact the Texas Safety Association, a nonprofit organization which helps coordinate grade crossing safety education in Texas. Their Austin telephone number is 512/343-6525. The Operation Lifesaver Coordinator for Texas may be reached at the above number or fax 512/343-0746. The National Support Center for Operation Lifesaver, Incorporated may be reached toll free at 1-800-537-6224.

Legal Responsibilities of Motorists at Grade Crossings

Drivers are subject to fines by law enforcement officers at the Department of Public Safety (DPS) for violating laws stated in Article XI, Section 86 of Uniform Act in the Texas Motor Vehicle Laws regarding grade crossings. The Act states:

> whenever any person driving a vehicle approaches a railroad grade crossing, the driver of the such vehicle shall stop within fifty (50) feet but not less than fifteen (15) feet from the nearest rail of such railroad and shall not proceed until he can do so safely when:
>
> - a clearly visible electric or mechanical signal device gives warning of the immediate approach of a train,
> - a crossing gate is lowered or when a human flagman gives or continues to give a signal of the approach or passage of a train,
> - a railroad engine approaching within approximately 1500 feet of the highway crossing emits a signal audible from such distance and such engine by reason of its speed or nearness to such crossing is an immediate hazard, or
> - an approaching train is plainly visible and is in hazardous proximity to such crossing.

Drivers must stop by law for flashing lights, bells, or gates. If for some reason the lights are flashing and no train is in sight, the driver should stop and look both ways, and then proceed when they are sure the track(s) are clear.

Police Enforcement at Activated Warning Device Grade Crossings

Law enforcement officials are being urged to write citations for any motorist or pedestrian who disregards activated grade crossing warning devices. Operation Lifesaver has a program that invites law enforcement officiers to ride on locomotives in order to witness first hand what train engineers see everyday at highway-rail grade crossings where the motorists commonly fail to stop and remain behind activated warning devices such as gates or flashers. Enforcement of existing laws governing highway-rail grade crossings pertains to driving past flashing signals, driving around automatic gates and flashers, failure to obey yield or stop signs, failure for special vehicles to stop, and failure to yield right-of-way to a train at a passively controlled highway-rail grade crossing.

Upon receipt of a railroad crossing warning system malfunction, the railroad shall take appropriate action as required by 49 C.F.R. Part 234. Until repair or correction of the warning system is completed, the railroad having maintenance responsibility for the warning system shall promptly initiate efforts to provide alternative means of warning highway traffic and railroad employees at the subject crossing. The railroad must notify the law enforcement agency having jurisdiction over the crossing that is capable of responding and controlling vehicular traffic at the crossing. In many cases, the law enforcement agency is the first to know of a warning system malfunction through public reports before the railroad company.

The FRA has established regulations for warning system malfunctions at railroad-highway grade crossings. If at least one uniformed law enforcement officer provides warning to highway traffic at the crossing, trains may proceed through the crossing at normal speed. If an appropriately equipped flagger or crewmember of the train is available to flag highway traffic to a stop, the train may proceed through the crossing. The regulations specify that a train may proceed at normal speed if there is a flagger for each direction of highway traffic or may proceed with caution through the crossing at a speed not exceeding 15 miles per hour if there is only one flagger or train crewmember to stop highway traffic. Normal speed may be resumed after the train has passed through the crossing. However, the train may not pass if there is no law enforcement officer or flagger or train crewmember available to stop highway traffic.

APPENDIX A

CONTACT NUMBERS FOR CITY OFFICIALS AND RAIL CARRIERS

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CONTACT NUMBERS FOR CITY OFFICIALS AND RAIL CARRIERS

Cities:

Arlington - Senior Traffic Engineer - 817/459-6371

Bedford - (no railroads within city limits)

Burleson - Director of Public Works - 817/295-1113

Carrollton - Director of Traffic and Transportation - 214/466-3050

Dallas - Director of Transportation - 214/670-4026

Denton - Emergency Management Coordinator - 817/473-1104

Euless - Emergency Management Coordinator - 817/685-1573

Farmers Branch - City Engineer - 214/247-3131

Fort Worth - City Traffic Engineer - 817/870-8055

Garland - Director of Traffic and Transportation - 214/205-2432

Grand Prairie - Assistant Director of Public Works - 214/660-8131

Greenville - Street Superintendent - 214/457-3153

Hurst - Traffic Engineer - 817/281-6160 x222

Irving - Director of Traffic and Transportation - 214/721-2646

Kaufman - (no railroads within city limits)

Mansfield - Fire Chief - 817/473-1104

Mesquite - Fire Marshal - 214/216-6267
- City Engineer - 214/216-6214

Mineral Wells - City Manager - 817/328-1211

North Richland Hills - Deputy Emergency Management Coordinator - 817/281-8393

Plano - Fire Chief - 214/578-7148

Richardson - Traffic Engineer - 214/238-4230

Rockwall - City Engineer - 214/771-1111

CONTACT NUMBERS FOR CITY OFFICIALS AND RAIL CARRIERS (Cont'd)

Stephenville - City Administrator - 817/965-7887

Waxahachie - (no contact available)

Weatherford - Fire Chief - 817/594-5541

FRA - 817/334-3601 - Leon Sapp

Railroad Commission - 512/463-7116

Amtrak

Local Operations - Transportation Manager - (Fort Worth) 817/334-0268

24-Hour Emergencies - (Mid-West Operations - Chicago) 1-800-543-2409

Atchison, Topeka, and Santa Fe Railway Company

Emergencies - Chief Dispatcher - (Euless) 817/868-3211

Maintenance - Asst. Supt. Maintenance - (Euless) 817/868-3091

Signals - General Supervisor of Signals - (Euless) 817/868-3054

Crossing Upgrades - Asst. Supt. Maintenance - (Euless) 817/868-3091

Burlington Northern Railroad Company

Emergencies - Chief Dispatcher - (Springfield, MI) 417/864-2121

Track Maintenance - Superintendent of Engineering and Maintenance - (Fort Worth) 817/581-2450

Signals - Supervisor of Control Systems - (Fort Worth) 817/581-2454

Local Operations - Operations Terminal Superintendent - (Fort Worth) 817/878-7231

Crossing Upgrades - Engineer of Public Works - (Fort Worth) 817/581-2460

CONTACT NUMBERS FOR CITY OFFICIALS AND RAIL CARRIERS (Cont'd)

Cottonbelt Railroad Company

Emergencies - Chief Dispatcher - (Pine Bluff, AK) 501/541-1600

Local Office - (Carrollton) 214/434-7999 (answered 24 hours, except 8 a.m. - 4 p.m. Sunday) or 214/242-5320 during regular business hours

Track Maintenance - Roadmaster - (Mt. Pleasant, TX) 214/572-3301

Signals - Trainmaster - (Carrollton) 214/372-7465

Local Operations - Trainmaster - (Carrollton) 214/372-7465

Crossing Upgrades - Trainmaster - (Carrollton) 214/372-7465

Dallas Area Rapid Transit

Emergencies - Jack Campbell, DART Control Center - 214/828-6779

DART Transit Police Dispatcher - 214/828-8500

Missouri-Kansas-Texas Railroad Company

(see Union-Pacific which encompasses this old Missouri-Pacific line)

Operation Lifesaver

Phone - 512/343-6525
Fax - 512/343-0746

Southern Pacific Transportation Company

Emergencies - Chief Dispatcher - (Houston) 713/223-6262

Maintenance - Roadmaster - (Dallas) 214/372-4401

Local Operations - Area Engineer - (Dallas) 214/372-7553

Signals - Supervisor of Signals - (Dallas) 214/372-7457

Crossing Upgrades - Area Engineer - (Dallas) 214/372-7553

CONTACT NUMBERS FOR CITY OFFICIALS AND RAIL CARRIERS (Cont'd)

Union Pacific Railroad Company

Emergencies - Chief Dispatcher - (Houston) 713/350-7581

Local Operations and Signals - Superintendent of Operations

- (serving Dallas, Fort Worth, Greenville, Mesquite, Chico, and Waxahachie lines) 817/878-4540 (7 a.m. - 5:30 p.m.)

- (serving Denton County northward) 817/878-4550 (7 a.m. - 5:30 p.m.)

- (serving State Highway 80 East) 214/236-2951 (7 a.m. - 5:30 p.m.)
- (serving south line to Houston) 713/350-7660 (7 a.m. - 5:30 p.m.)

24-Hour Local Operations - Manager of Train Operations

- (serving U.P. Dallas, Fort Worth, Greenville, Mesquite, Chico, and Waxahachie lines) 817/878-4546

- (serving old MKT system) 214/651-6792

Track Maintenance - Manager of Engineering Maintenance

- (serving Parker County westward) 817/878-4618

Track Maintenance - Manager of Engineering Maintenance

- (serving Dallas, Fort Worth, Greenville, Mesquite, Chico, and Waxahachie lines) 817/878-4614

- (serving Denton County northward) 817/387-6213

- (serving Rockwall County eastward) 214/236-2971

Crossing Upgrades - Manager of Public Projects -

- (serving all North Central Texas areas) 214/463-6525 (Denison)

APPENDIX B

FRA LOCOMOTIVE NOISE ENFORSEMENT POLICY

APPENDIX B

FRA LOCOMOTIVE NOISE ENFORCEMENT POLICY

Paragraph and section	Noise source	Noise standard—A weighted sound level in dB	Noise measure [1]	Measurement location
	All Locomotives Manufactured on or Before 31 December 1979			
201.11(a)	Stationary, Idle Throttle Setting	73	L_{max} (slow)	30 m (100 ft)
201.11(a)	Stationary, All Other Throttle Settings	93	do	Do.
201.12(a)	Moving	96	L_{max} (fast)	Do.
	All Locomotives Manufactured After 31 December 1979			
201.11(b)	Stationary, Idle Throttle Setting	70	L_{max} (slow)	Do.
201.11(b)	Stationary, All Other Throttle Settings	87	do	Do.
201.12(b)	Moving	90	L_{max} (fast)	Do.
201.11(c) and 201.12(c).	*Additional Requirement for Switcher Locomotives Manufactured on or Before 31 December 1979 Operating in Yards Where Stationary Switcher and other Locomotive Noise Exceeds the Receiving Property Limit of.*	65	L_{90} (fast) [2]	Receiving property
201.11(c)	Stationary, Idle Throttle Setting	70	L_{max} (slow)	30 m (100 ft)
201.11(c)	Stationary, All Other Throttle Settings	87	do	Do.
201.12(c)	Moving	90	L_{max} (fast)	Do.
	Rail Cars			
201.13(1)	Moving at Speeds of 45 mph or Less	88	do	Do.
201.13(2)	Moving at Speeds Greater than 45 mph	93	do	Do.
	Other Yard Equipment and Facilities			
201.14	Retarders	83	$L_{adj\ ave\ max}$ (fast)	Receiving property
201.15	Car-Coupling Operations	92	do	Do.
201.16	*Locomotive Load Cell Test Stands, Where the Noise from Locomotive Load Cell Operations Exceeds the Receiving Property Limits of.*	65	L_{90} (fast) [2]	Do.
201.16(a)	Primary Standard	78	L_{max} (slow)	30 m (100 ft).
201.16(b)	Secondary Standard If 30-m Measurement Not Feasible.	65	L_{90} (fast)	Receiving property located more than 120 m from Load Cell.

[1] L_{max}=Maximum sound level; L_{90}=Statistical sound level exceeded 90% of the time; $L_{adj\ ave\ max}$=Adjusted average maximum sound level.

[2] L_{90} must be validated by determining that L_{10}–L_{90} is less than or equal to 4dB (A).

[48 FR 56758, Dec. 23, 1983; 49 FR 1521, Jan. 12, 1984]

APPENDIX B—SWITCHER LOCOMOTIVE ENFORCEMENT POLICY

The EPA standards require that the noise emissions from all switcher locomotives in a particular facility be less than prescribed levels measured at 30 meters, under all operating modes. This requirement is deemed to be met unless "receiving property" noise due to switcher locomotives exceeds 65 dB(A), when measured in accordance with Subpart C of 40 CFR Part 201. The 65 dB(A) receiving property standard is the "trigger" for requiring the 30-meter test of switcher locomotives.

The purpose underlying FRA's enforcement of the noise standards is to reduce the impact of rail operations noise on receiving properties. In some instances, measures other than the 30-meter test approach may more effectively reduce the noise levels at receiving properties; therefore, FRA enforcement efforts will focus on abatement procedures that will achieve a reduction of receiving property noise levels to less than 65 dB(A).

For example, a parked, idling locomotive, even if equipped with exhaust silencing that meets the stationary locomotive standard (30-meter test), may cause the receiving property standard to be exceeded if located on trackage adjacent to the receiving property. In that case, application of the 30-meter test to other switcher locomotives at the facility may not serve to reduce the receiving property noise level. On the other hand, operational changes by the railroad could significantly reduce receiving property noise levels. In such case, FRA would consider retesting after abatement measures have been taken. If the receiving property noise level is below the trigger and the abatement action is adopted, FRA would not make a 30-meter test of the switcher locomotives at the facility.

Source: United States Government, Code of Federal Regulations (CFR), Title 49, part 213.9 except as provided in para (b) and (c) of this section and 213.57, 213.59, 213.113 (a), and 213.137 (b) and (c), Federal Railroad Administration (Washington, D.C., October 1, 1988).

APPENDIX C

GLOSSARY

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GLOSSARY

"A-Weighted" Noise Levels (dBA) - The weighting of sound which de-emphasizes lower and higher frequencies that are beyond the average human hearing range.

Accident Rate - 1) The number of accidents, fatalities, or injuries divided by a measure of vehicle activity to provide a means of comparing accident trends through time. 2) The number of accidents per crossing per year.

Ballast - Gravel, broken stone, or slag placed between and under the ties of a railroad to give stability, provide drainage, and distribute loads.

Bar Ditch - Can be used as a drainage channel that carries water runoff from the track structure and adjacent land; forms part of the regional storm water and storm sewer system.

Benefit-Cost Ratio - The economic value of the reduction in fatalities, injuries, and property damage divided by the cost of the accident reducing measure.

Branch Line - A secondary line of railroad usually handling light volumes of traffic.

Case Law - Law established by judicial decisions in particular cases, instead of by legislative action.

Civil Statute - An enactment made by a legislature for its citizens and expressed as a formal document.

Constant Warning Time Track Circuit - Warning devices that will sense train speed in approach section of crossings equipped with gates or flashers and select appropriate warning time.

Crosstie - The wooden or concrete support upon which track rails rest and which holds them to gauge and transfers their load through the ballast to the subgrade.

Main Line - The principle line or lines of a railway.

Decibels (dB) - The unit of measurement for sound intensity, with zero dB corresponding roughly to the threshold of hearing.

Exempt Sign - Informs drivers of vehicles for hire, school buses carrying children, or vehicles carrying hazardous or flammable materials that a stop is not required except when railroad equipment is approaching or occupying the crossing, or the driver's view of the sign is blocked.

Fines - Minute particles of rock resulting from pulverized ballast or other rock aggregate.

French Drain - A drainage trench filled to ground level with fragments of brick or rock.

Grade Separation - A crossing of two highways, or a highway and a railroad, at different levels.

Green Board - A permanent railroad sign which instructs an engineer to resume normal speed of the train.

Harmonic Oscillation - The rocking motion of a train at speeds of 12-25 mph hour due to loads on staggered rail joints occurring over extended distances.

Horizontal Alignment - The angle of a roadway as it intersects another road or rail line; 90-degree intersections are optimal for adequate sight triangles.

L_{dn} Noise Level - The average noise level of both day and night hours where the night level between 10 p.m. and 7 a.m. is weighted an additional ten decibels (dB) to account for the increased effect of noise perceived during these hours.

Line-Haul - The movement of freight over the tracks of a railroad from one town or city to another town or city.

Main Track - A track extending through yards and between stations, upon which trains are operated by timetable, train order or both, or the use of which is governed by block signals or by centralized traffic control.

Motion Detector Track Circuit - Detects train movement with an audio frequency whereby if a train stops on approach or moves away from a crossing, the crossing warning system will be deactivated; often used for switching moves within normal approach limits.

Normalize - In statistics to create a normal bell-shaped curve showing a distribution of probability of a given event relative to an independent variable.

Precedent - An adjudged case or judicial decision that furnishes a rule or model for deciding a subsequent case that presents the same or similar legal problems.

Priority Index - A mathematical equation used in Texas to rank the hazard of an existing railroad grade crossing; it assists in the TxDOT determination of potential matching funding from FHWA Surface Transportation Program safety monies to be passed through to local authorities.

Pumping - The effect of poor drainage in the sub-ballast which causes mud to form, fouls the ballast, and allows the track to move vertically under heavy loads.

Railroad Line Miles - The aggregate length of road of line-haul railroads. It excludes yard tracks, sidings, and parallel lines. Jointly-used track is counted only once.

Railroad Track Miles - Total miles of railroad track including multiple main tracks, yard tracks and sidings, owned by both line-haul and switching and terminal companies.

Railroad/Highway Grade Crossing - The general area where a highway and a railroad cross at the same elevation and includes the railroad right-of-way, roadway right-of-way, and roadside signs and facilities.

Pedestrian Crossing - A railroad- highway grade crossing that is used by pedestrians only.

Private Crossing - A railroad- highway grade crossing that includes a privately owned roadway utilized only by the owner's licensees and invitees.

Public Crossing - A railroad- highway grade crossing that includes a roadway under the jurisdiction of, and maintained by, a public authority on at least one side of the track.

Senior-Junior Principle - A concept where a division of responsibility occurs between two parties depending on who or which was in existence first.

Tort Liability - Any private or civil wrong by act or omission, such as an accident which occurs from a person's negligence.

Track - An assembly of rails, ties, and fastenings over which cars, locomotives, and trains are moved.

Double or Multiple - Two or more main tracks over which trains may travel in both directions.

Single - 1) The main track on a roadbed having one main track upon which trains are operated in both directions. 2) In multiple track territory, the process of running all trains, regardless of direction on one track while the other track is temporarily out of service.

Traffic Control Device - A sign, signal, marking, or other device placed on or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide traffic.

Traffic Control Device (Active) - Those traffic control devices activated by the approach or presence of a train, such as flashing light signals, automatic gates, and similar devices as well as manually operated devices and crossing watchmen, all of which display to motorists positive warning of the approach or presence of a train.

Traffic Control Device (Passive) - Those types of traffic control devices, including signs, markings, and other devices, located at or in advance of grade crossings to indicate the presence of a crossing but which do not change aspect upon the approach or presence of a train.

Traffic Markings - All lines, patterns, words, colors, or other devices, except signs, set into the surface of, applied upon, or attached to the pavement or curbing or to the objects within or adjacent to the roadway, officially placed for the purpose of regulating, warning, or guiding traffic.

Train Miles of Travel - The total amount of distance each train travels in a given year.

Vertical Alignment - The vertical slope of pavement or other material to allow for drainage.

Wigwags - An early active warning device which operates with a red symbol swinging on a fulcrum.

APPENDIX D

LIST OF ACRONYMS

APPENDIX D

LIST OF ACRONYMS

AAR	- American Association of Railroads
ADT	- Average Daily Traffic (vehicular)
AREA	- American Railroad Engineering Association
CFR	- Code of Federal Regulations
DOT	- Department of Transportation
DPS	- Department of Public Safety
EPA	- Environmental Protection Agency
FARS	- Fatal Accident Reporting System
FHWA	- Federal Highway Administration
FRA	- Federal Railroad Administration
ICC	- Interstate Commerce Commission
NCTCOG	- North Central Texas Council of Governments
NHTSA	- National Highway Traffic Safety Administration
PI	- Priority Index
RCT	- Railroad Commission of Texas
TxDOT	- Texas Department of Transportation
TTI	- Texas Transportation Institute

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