INTERCONNECTION OF HIGHWAY-RAIL GRADE CROSSING WARNING SYSTEMS AND TRAFFIC CONTROL SIGNALS

NOVEMBER 2007

INTRODUCTION

Welcome to this seminar on Interconnection of Highway-Rail Grade Crossing Warning Systems and Highway Traffic Signals. Over the past eleven years, I have had the opportunity to present this seminar to persons from the Federal Railroad Administration, the Federal Highway Administration, Transport Canada, numerous state Departments of Transportation, city, county and state traffic engineering and signal departments as well as many railroads. Obviously, this is a highly specialized topic, one that receives very little attention in terms of available training. However, from the perspective of safety, it requires far more attention than it normally receives. Only when a catastrophic event occurs such as the Fox River Grove crash on October 25, 1995 does the need for training of this type become apparent.

Following the Fox River Grove crash, I was approached by the Oklahoma Department of Transportation in 1996, inquiring if I would have an interest in assisting them with understanding interconnection and preemption. This seminar is the ongoing continuation of that effort. My background includes over 33 years of active involvement in highway traffic signal and railroad signal applications, design and maintenance.

This workbook is a compilation of information, drawings, standards, recommended practices and “Rick’s Rules” to assist you in following along with the presentation and to provide a future reference as you need it. It has been developed to compliment the seminar and I strive to continually update it to reflect the most current information available.

Some sections have been reproduced from the Manual on Uniform Traffic Control Devices which exists in the public domain. Other sections from the AREMA Communication & Signal Manual of Recommended Practice and Institute of Transportation Engineers recommended practice for Preemption of Traffic Signals Near Railroad Grade Crossings are reproduced with permission to be used only for training and education. Use of these sections as work product requires the user to purchase a licensed copy from AREMA or ITE at their web sites listed below. It should also be noted that both publications are “living” documents which undergo continuing updates and revisions to address changing technology and practice. Therefore, the user should maintain current documents for use and reference.

Finally, I depend on you to provide me with feed back to assist in improving the content and presentation of this material. Please take a few minutes after the seminar to send me any comments or thoughts you may have to improve the quality or content of the seminar. If you would like, leave me your contact information if there is a specific thought or comment you want to discuss individually. If you need follow-up information or have a question my staff or I might be able to assist with, you can contact me from the information listed below.

Rick Campbell

INTRODUCTION

Additional information from standards and recommended practices used in this seminar may be obtained from the following:

MUTCD 2003 Edition Manual
Federal Highway Administration
http://mutcd.fhwa.dot.gov/

AREMA Communication & Signal Manual of Recommended Practices
American Railway Engineering and Maintenance-of-Way Association
http://www.arema.org

Preemption of Traffic Signals Near Railroad Crossings
Institute of Transportation Engineers
http://www.ite.org

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Fox River Grove, IL
October 25, 1995

Workbook Index

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TRAFFIC CONTROL SIGNALS

HISTORY OF TRAFFIC SIGNALS

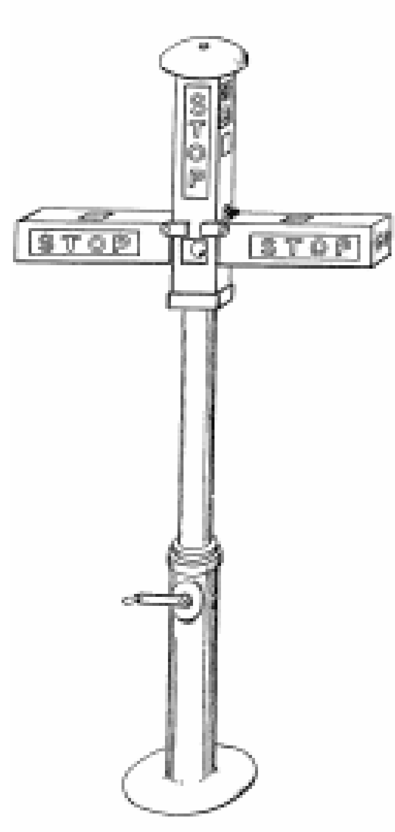
Even during the horse and buggy days, traffic in big cities was often heavy. Police officers had to be stationed full time directing traffic at busy intersections.

The world's first traffic signal came into being before the automobile was in use, and traffic consisted only of pedestrians, buggies and wagons. Installed at an intersection in London in 1868, it was a revolving lantern with red and green signals. Red meant "stop" and green meant "caution." The lantern, illuminated by gas, was turned by means of a lever at its base so that the appropriate light faced traffic. On January 2, 1869, this crude traffic light exploded, injuring the policeman who was operating it.

And with the coming of automobiles, the situation got even worse. Police Officer William Potts of Detroit, Michigan, decided to do something about the problem. What he had in mind was figuring out a way to adapt railroad signals for street use. The railroads were already utilizing automatic controls. But railroad traffic traveled along parallel lines. Street traffic traveled at right angles. Potts used red, amber, and green railroad lights and about thirty-seven dollars worth of wire and electrical controls to make the world's first 4-way three color traffic light. It was installed in 1920 on the corner of Woodward and Michigan Avenues in Detroit. Within a year, Detroit had installed a total of fifteen of the new automatic lights.

Officer William Potts

At about the same time William Potts was implementing the electric traffic signal, Garrett Morgan of the United States realized the need to control the flow of traffic. Accidents were frequent. After witnessing a collision between an automobile and a horse-drawn carriage, Garrett Morgan took his turn at inventing a traffic signal. Other inventors had experimented with, marketed and even patented traffic signals, however, Garrett Morgan was one of the first to apply for and acquire a U.S. patent for an inexpensive to produce traffic signal. The patent was granted on November 20, 1923. Garrett Morgan later had the technology patented in Great Britain and Canada as well.



Garrett Morgan stated in his patent for the traffic signal, "This invention relates to traffic signals, and particularly to those which are adapted to be positioned adjacent the intersection of two or more streets and are manually operable for directing the flow of traffic... In addition, my invention contemplates the provision of a signal which may be readily and cheaply manufactured."

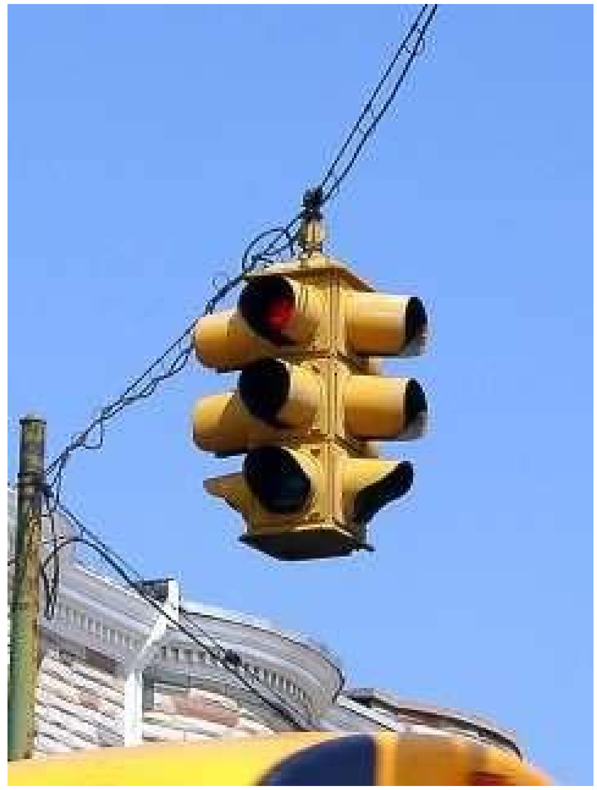
The Morgan traffic signal was a T-shaped pole unit that featured three positions: Stop, Go and an all-directional stop position. This “third position” halted traffic in all directions to allow pedestrians to cross streets more safely.

Garrett Morgan's hand-cranked semaphore-style traffic control signal was in use throughout North America until all manual traffic signals were replaced by the automatic red, yellow and green-light traffic signals currently used around the world. Morgan sold the rights to his traffic signal to the General Electric Corporation for $40,000. Shortly before his death in 1963, Garrett Morgan was awarded a citation for his traffic signal by the United States Government.

TYPE TIA–44
Automatic Isolated Traffic Signal Complete
Automatic Timing Switch is Installed in Base Casting

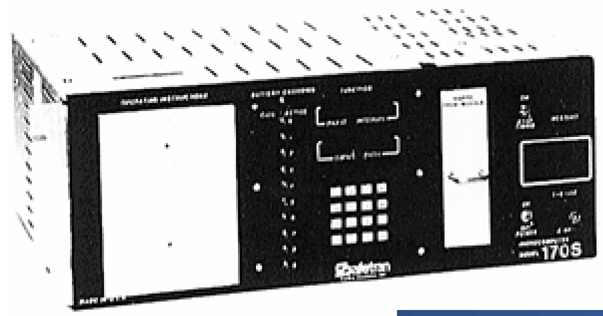
Crouse-Hinds Pedestal Type Isolated Traffic Signal
From Catalog 225, Printed April 15, 1930


NO
OUTLET




MEAT MARKET

TRAFFIC SIGNAL CONTROLLER UNITS



TYPE170

Controller Unit

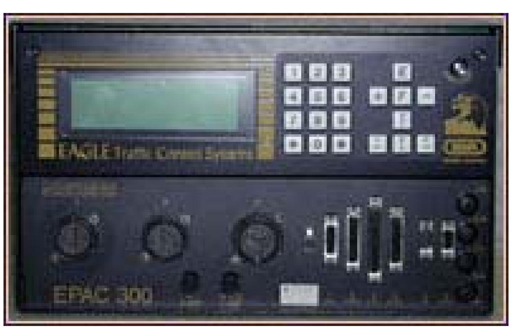
TYPE 2070

Controller Unit

TYPE 2070

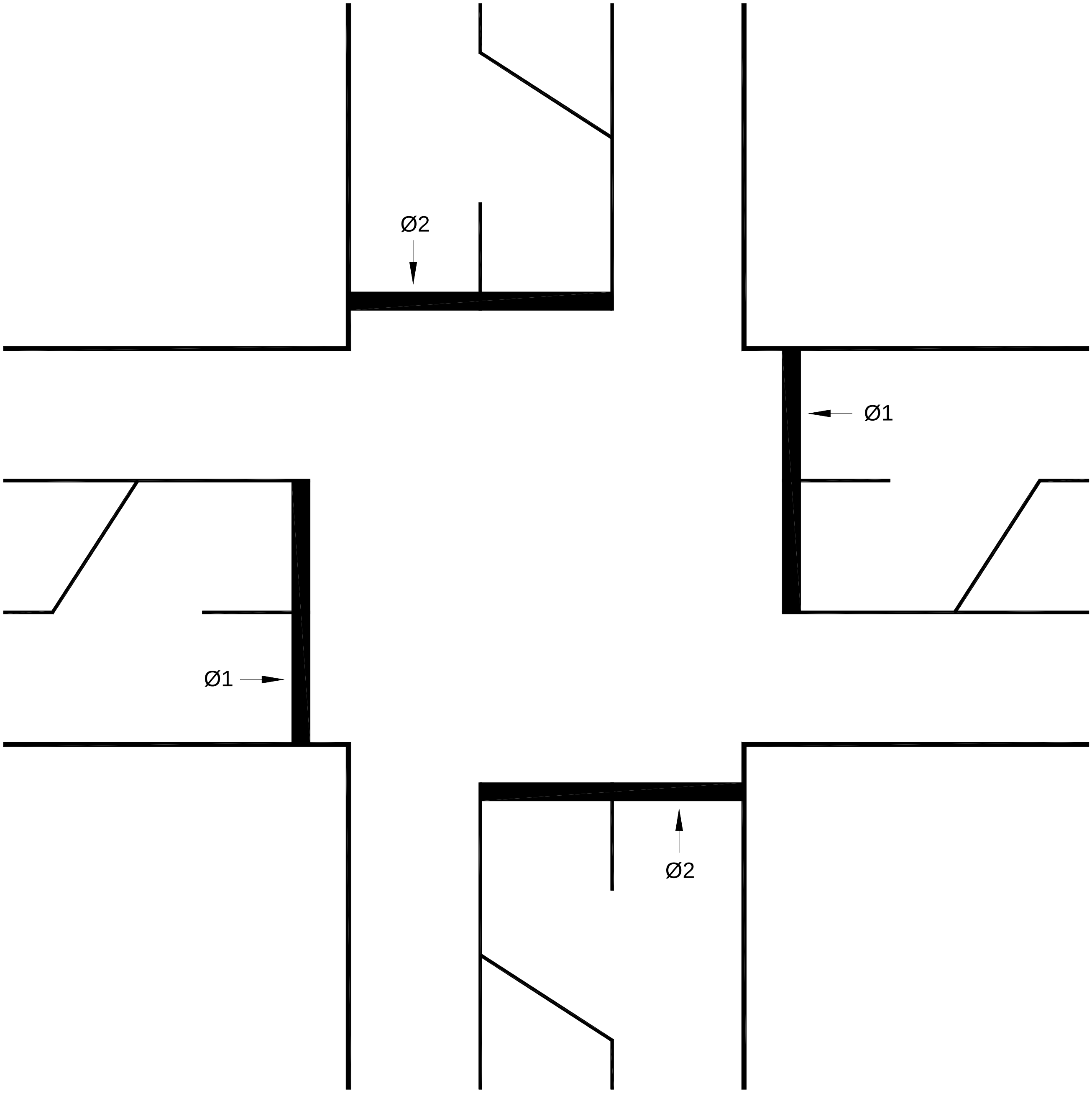
Controller Unit

(NEMA Adapter)



NEMA TS2

Controller Unit



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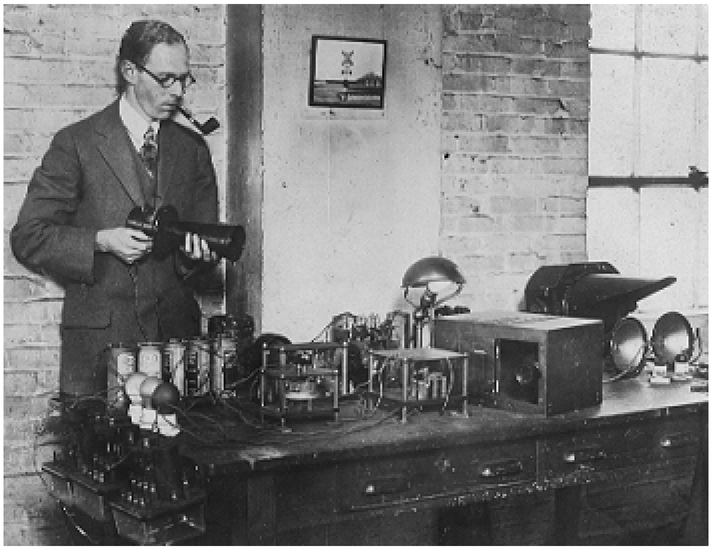
Traffic Actuated Signal Development



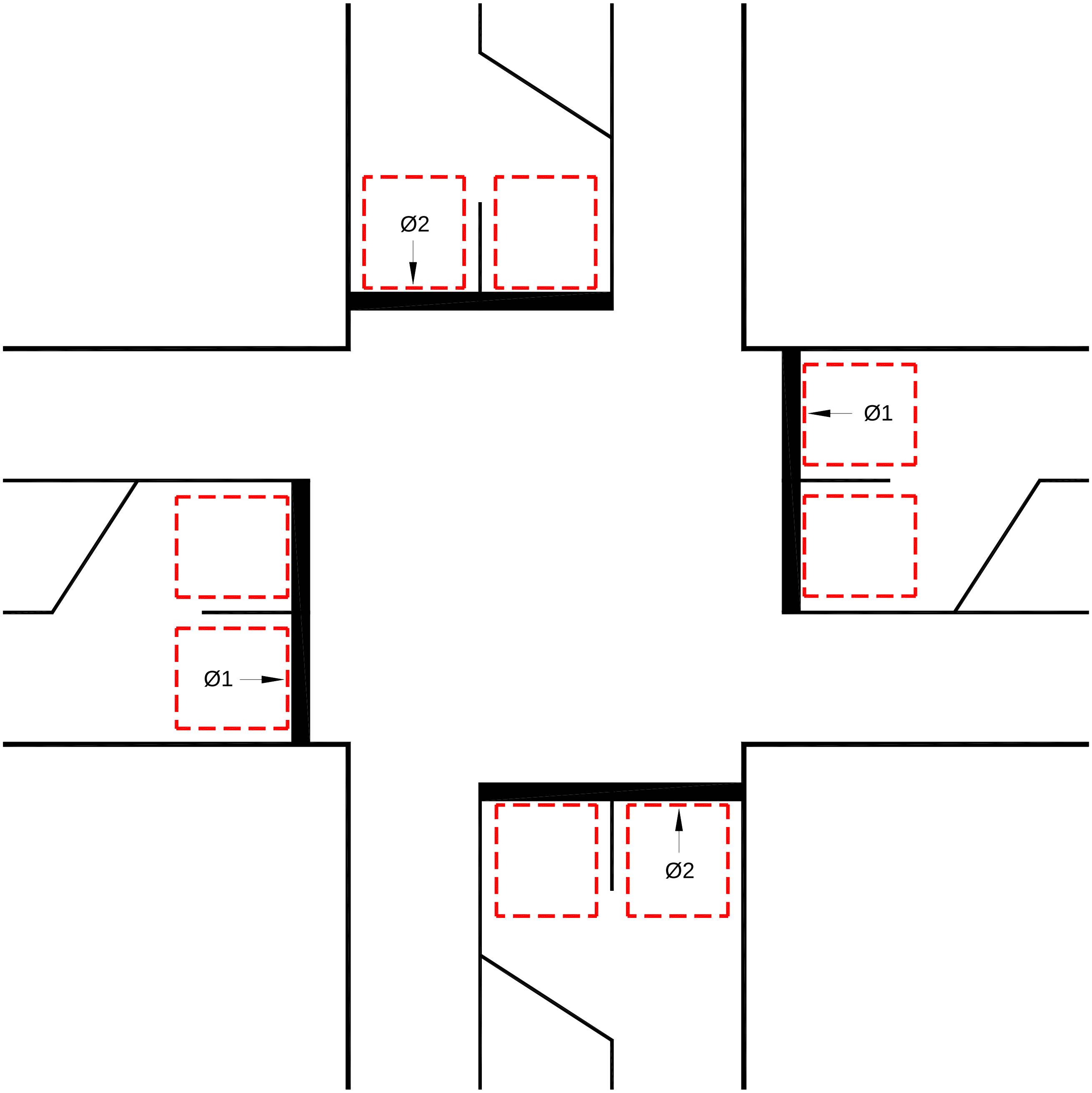
Charles Adler, Jr. holding horn for traffic signal, n.d.
Charles Adler, Jr. Collection, ca. 1920-1980

"To Obtain Signal - Stop Blow Horn,"
traffic-actuated signal light,
Charles Adler, Jr. Collection,
ca. 1920-1980

Traffic-actuated (by the sound of a car horn) signal light
Charles Adler, Jr. Collection, ca. 1920-1980

"Charles Adler, Jr. demonstrating the operation of the signal by the passage of a car over the sound detector"

Note - Adler is actually pointing to a “Pressure Pad” vehicle detector, not a sound detector as indicated by the text.



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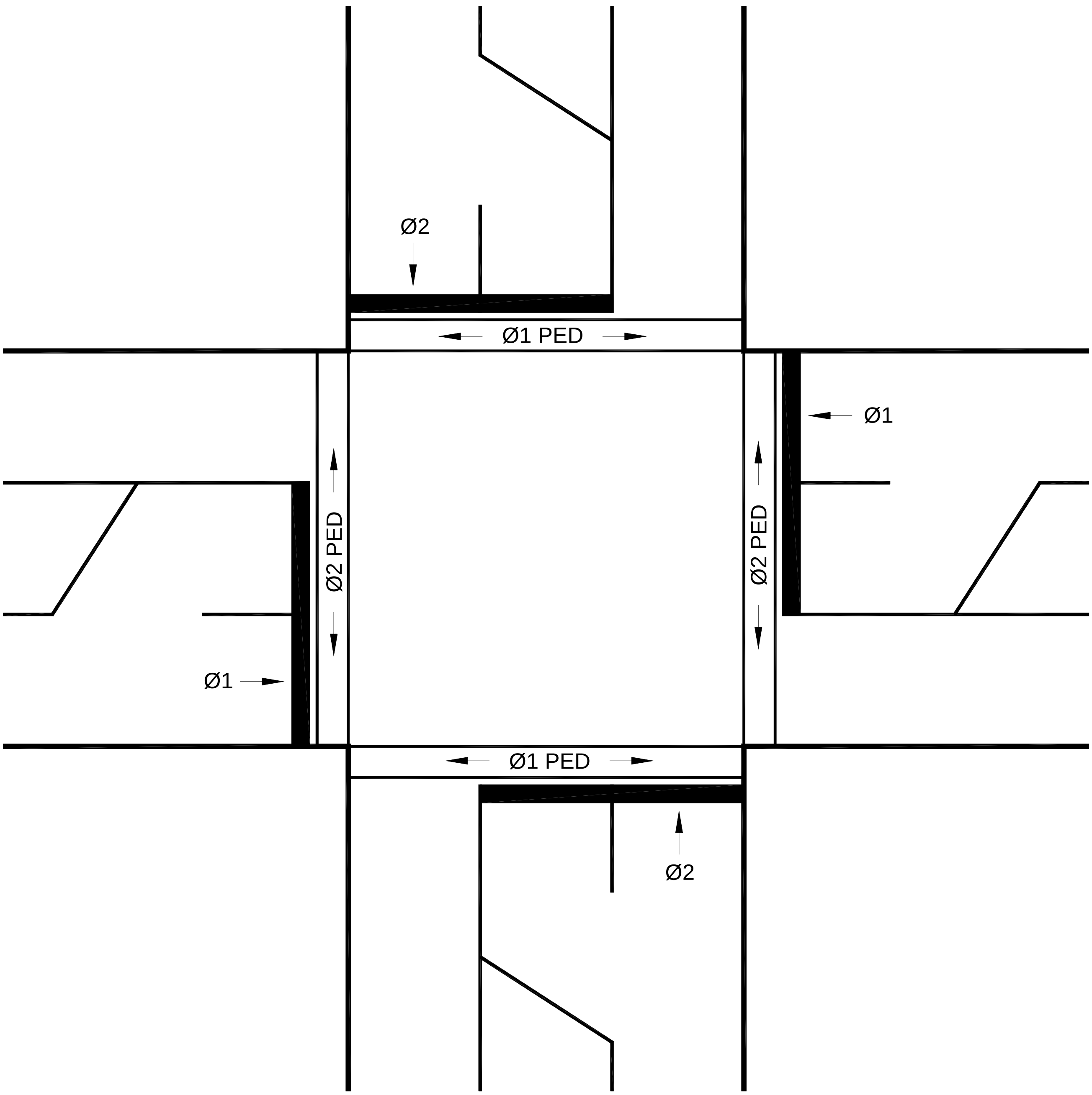

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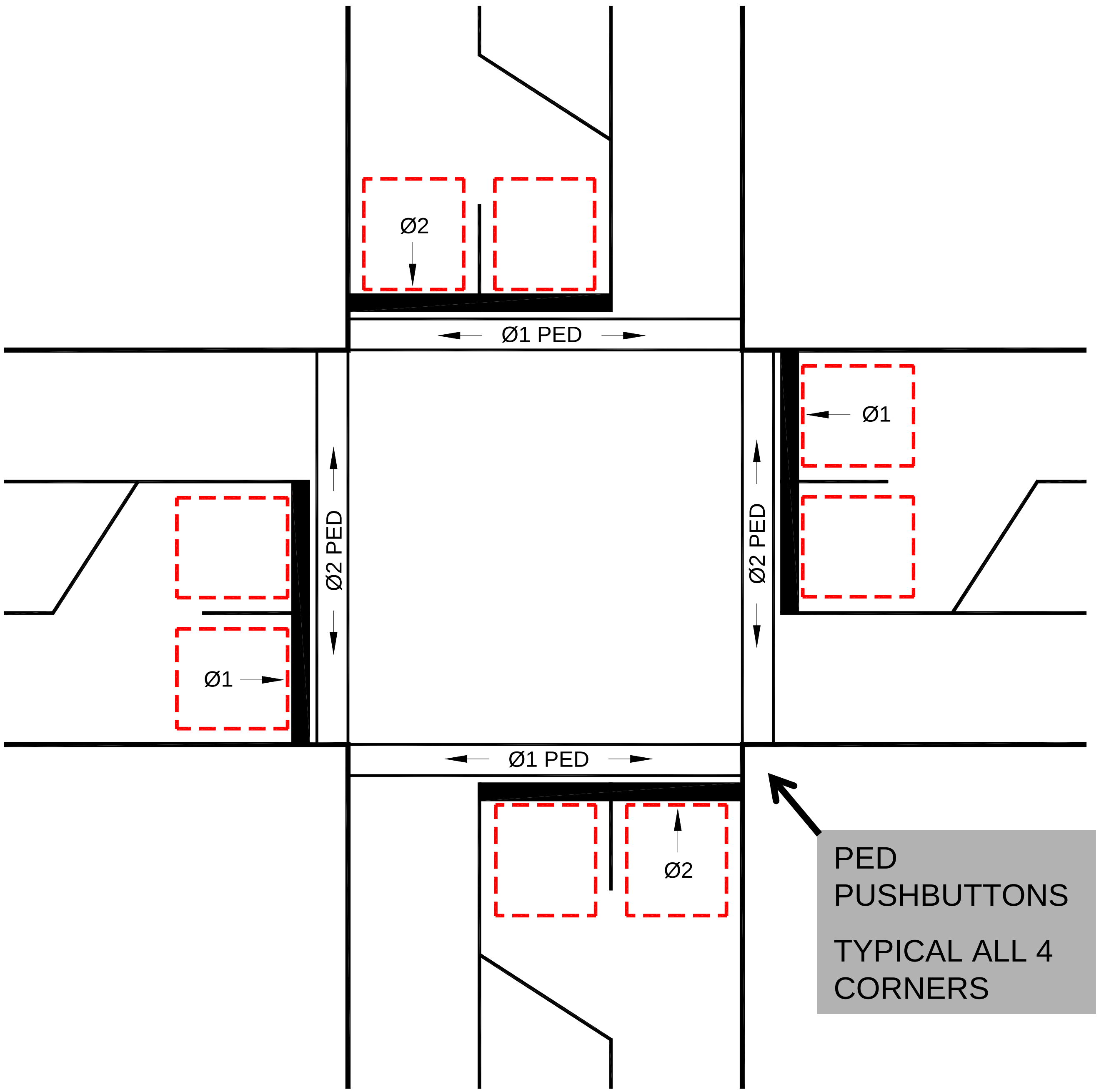

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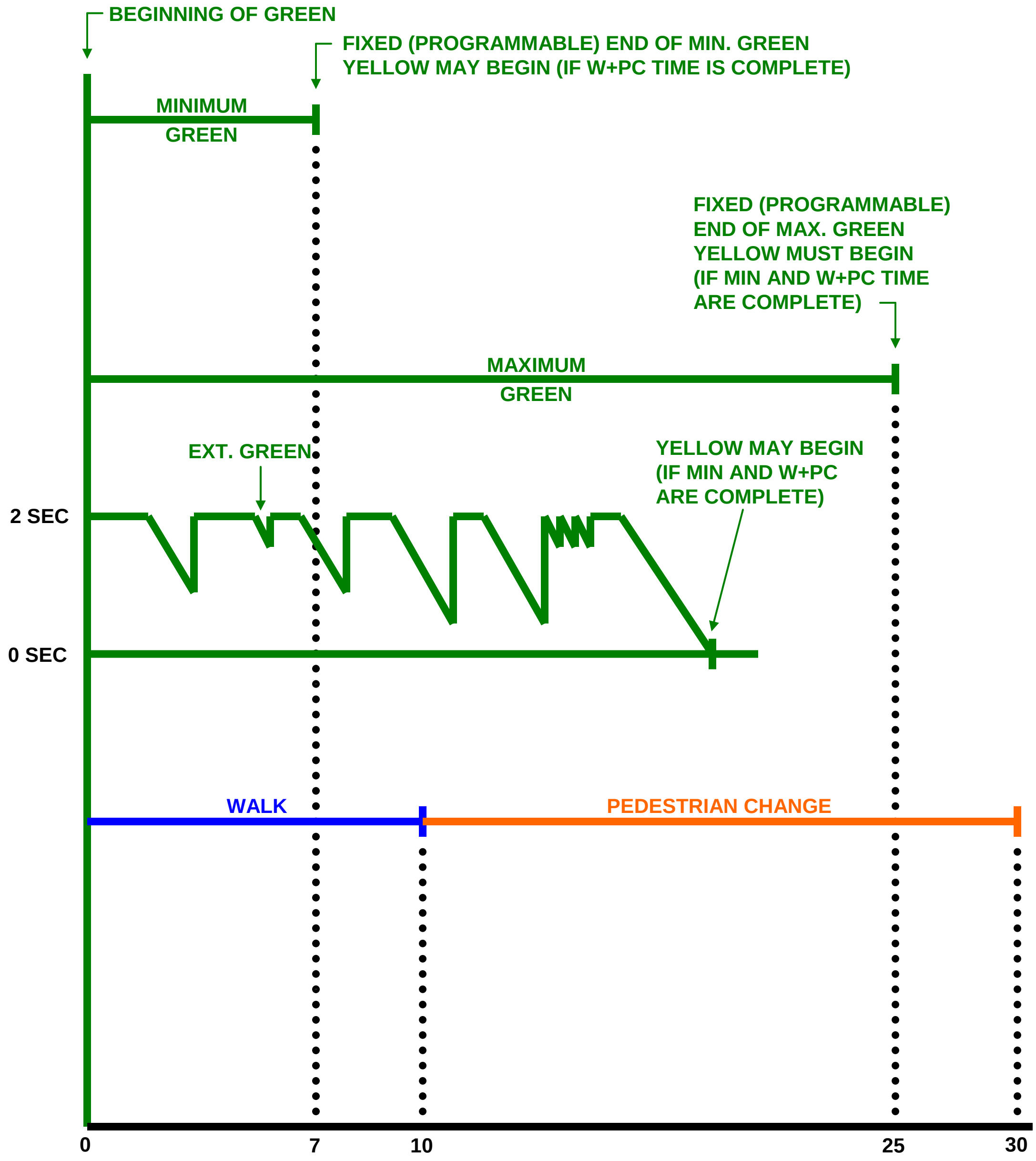
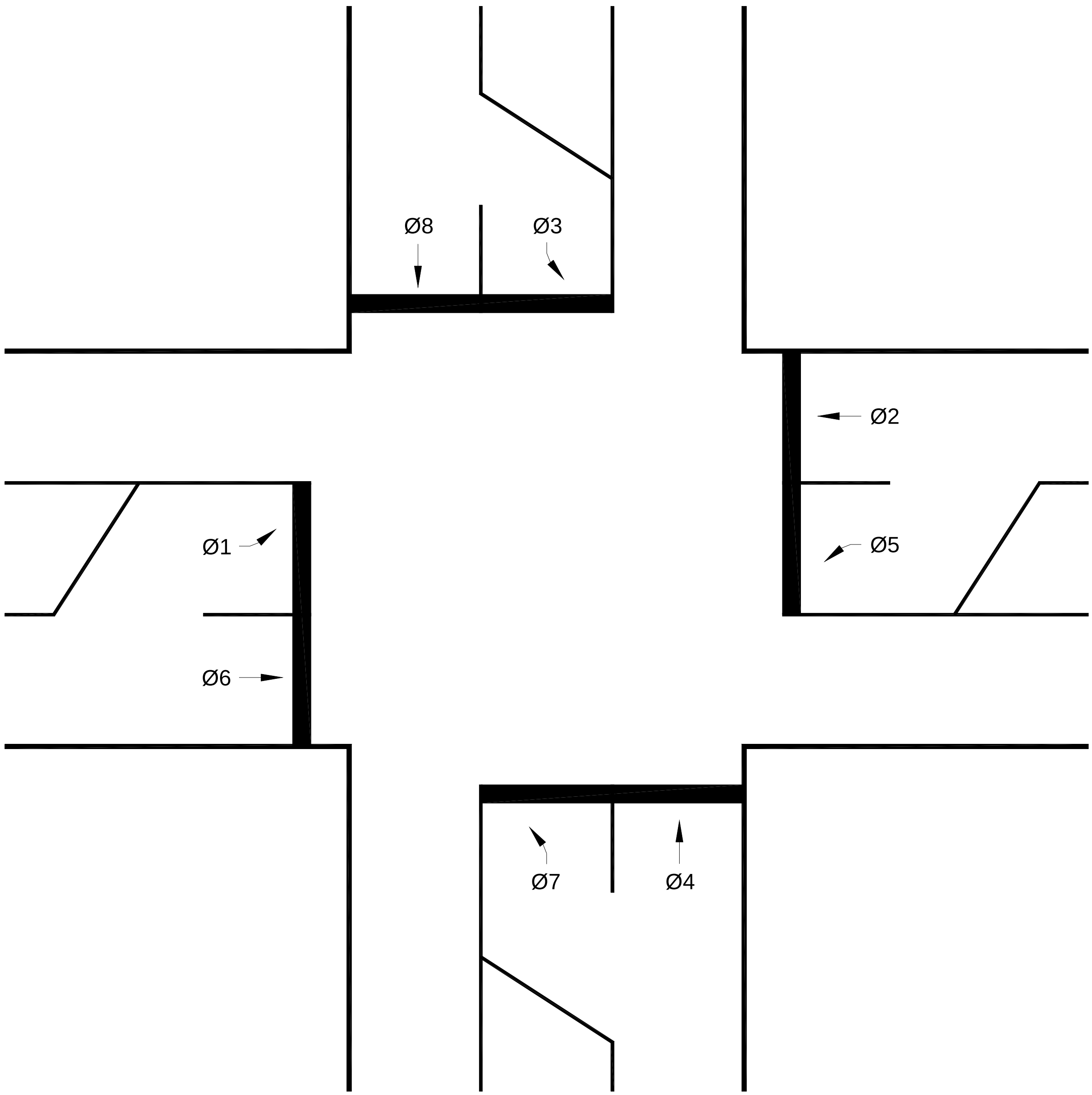
BASIC TRAFFIC SIGNAL TIMING





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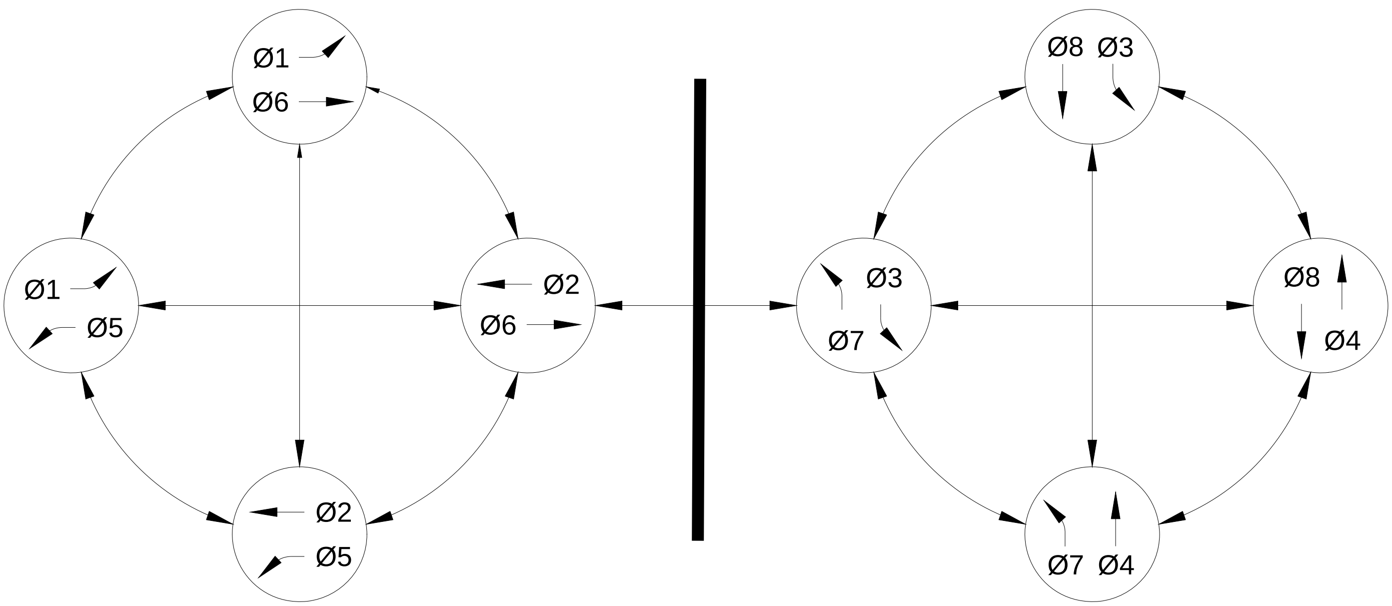
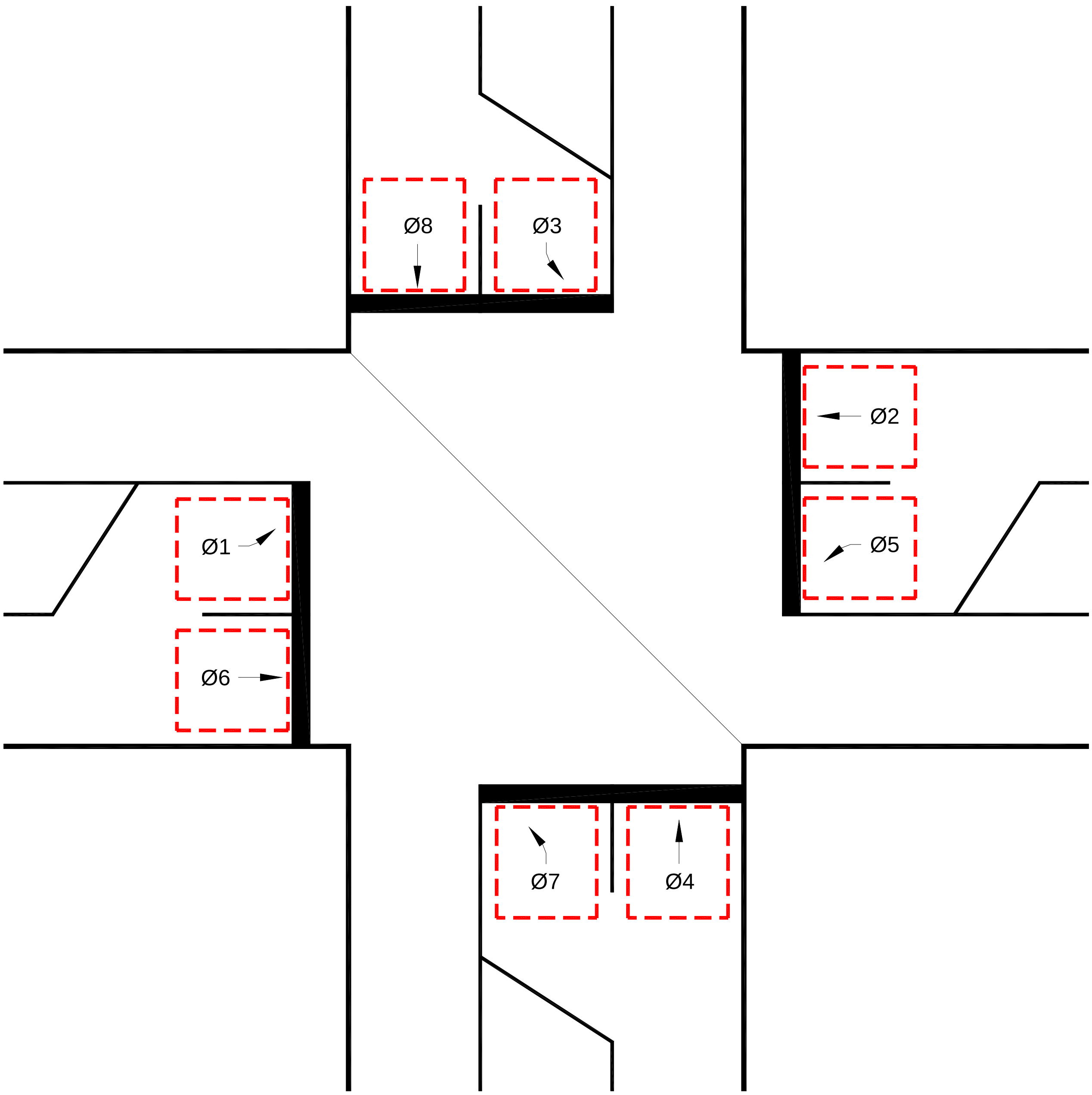
8 PHASE SEQUENCE



VERTICAL LINES REPRESENT
"BARRIERS"

RING 1	**1 - 2 - 3 - 4**
RING 2	**5 - 6 - 7 - 8**



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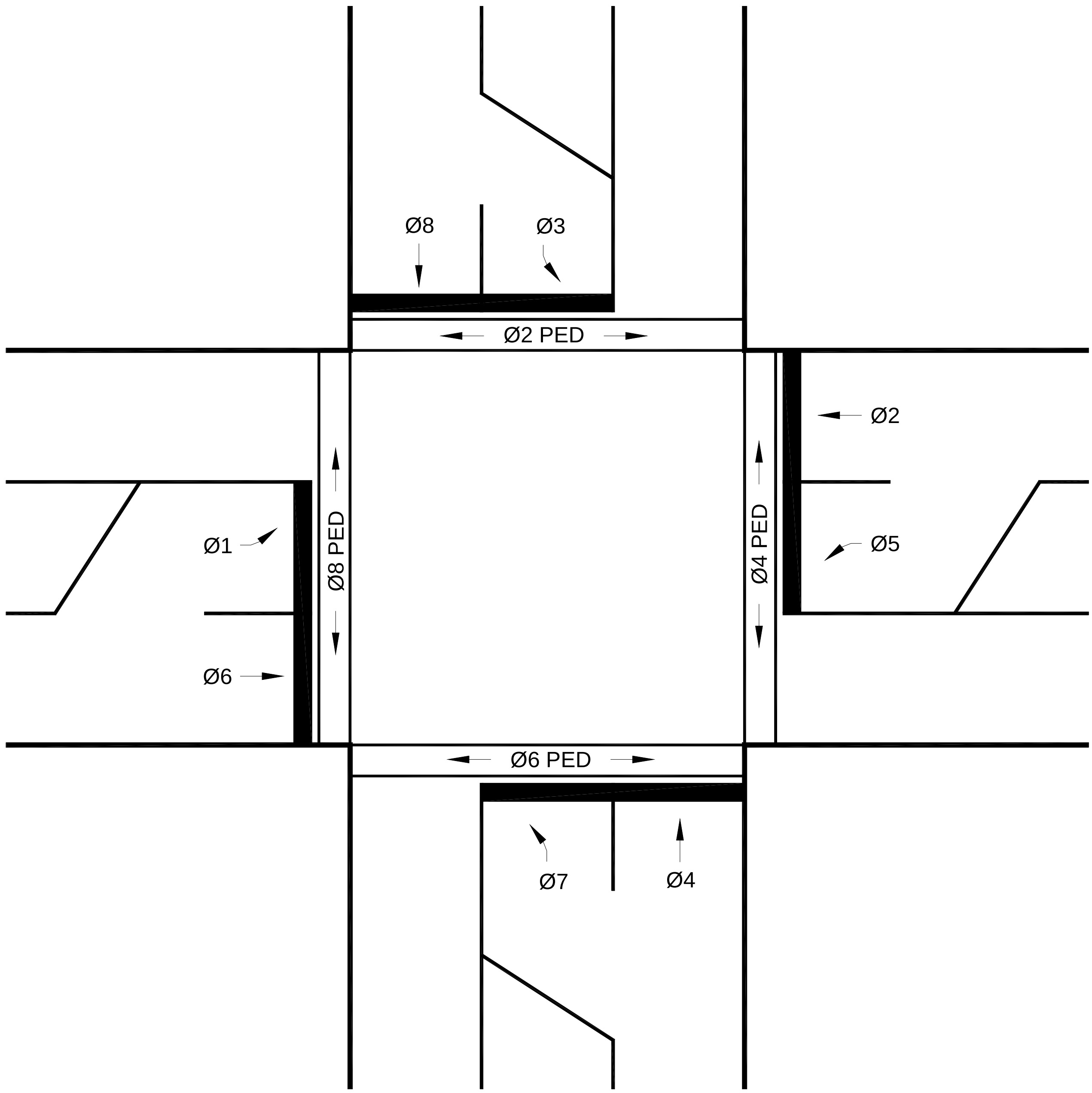

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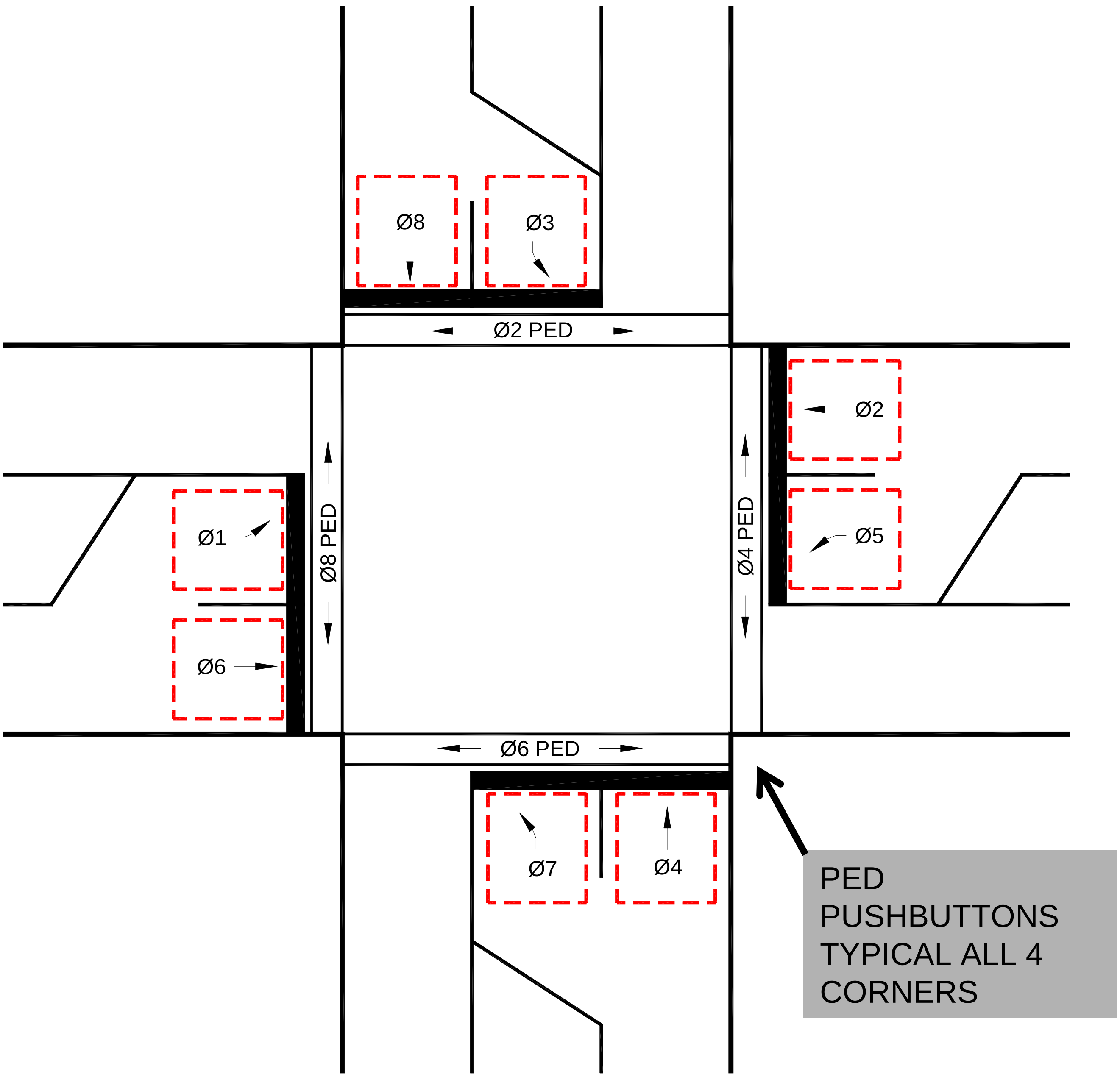

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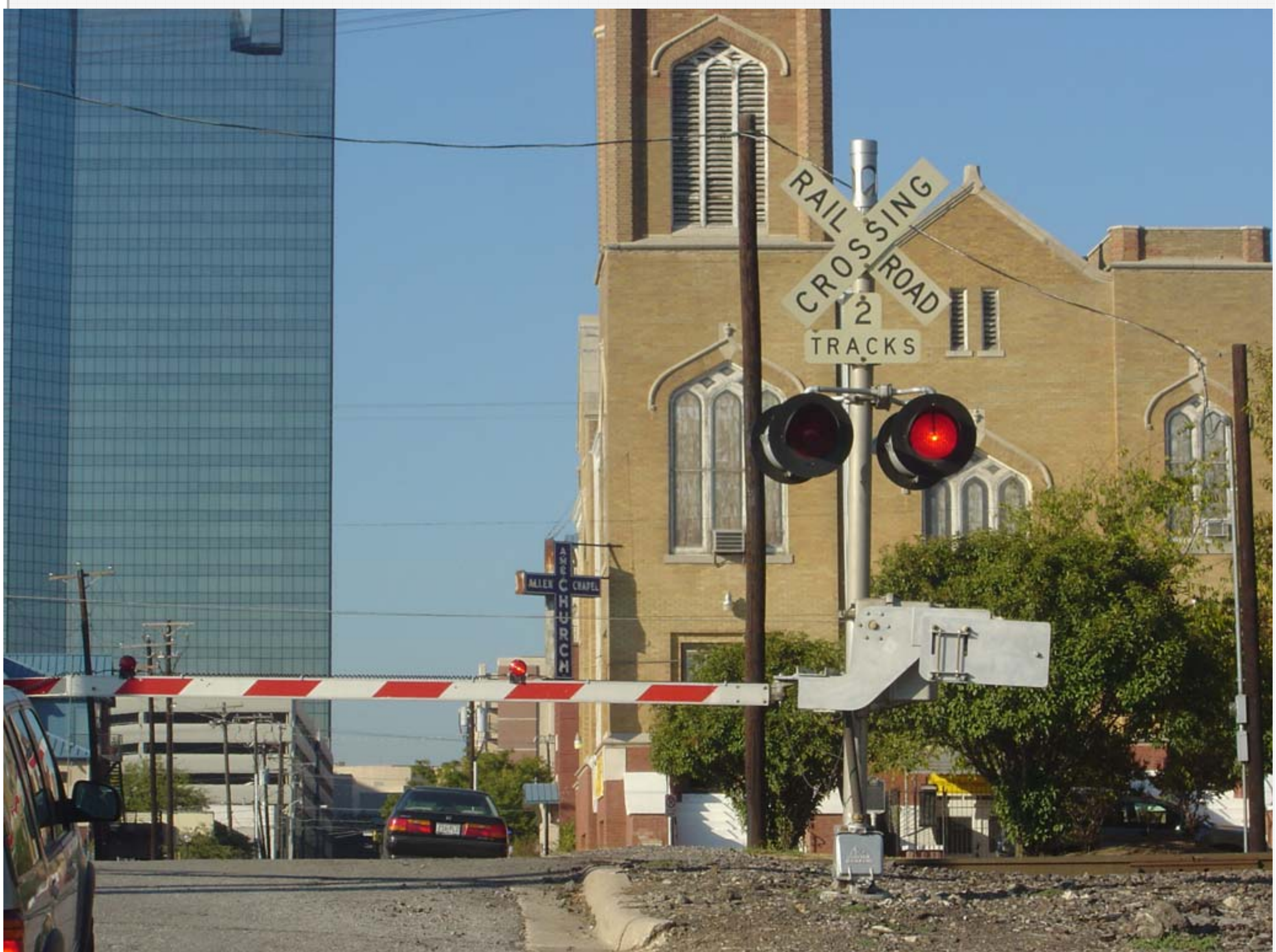
GRADE CROSSING WARNING DEVICES



MUTCD
2003 EDITION

PART 8
Traffic Controls for Highway-Rail Grade Crossings

Section 8A.01 Introduction

Support:

Traffic control for highway-rail grade crossings includes all signs, signals, markings, other warning devices, and their supports along highways approaching and at highway-rail grade crossings. The function of this traffic control is to permit reasonably safe and efficient operation of both rail and highway traffic at highway-rail grade crossings.

For purposes of installation, operation, and maintenance of traffic control devices at highway-rail grade crossings, it is recognized that the crossing of the highway and rail tracks is situated on a right-of-way available for the joint use of both highway traffic and railroad traffic.

The highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if applicable, jointly determine the need and selection of devices at a highway-rail grade crossing.

In Part 8, the combination of devices selected or installed at a specific highway-rail grade crossing is referred to as a "traffic control system."

Section 8A.02 Use of Standard Devices, Systems and Practices

Support:

Because of the large number of significant variables to be considered, no single standard system of traffic control devices is universally applicable for all highway-rail grade crossings.

Guidance:

The appropriate traffic control system should be determined by an engineering study involving both the highway agency and the railroad company.

Standard:

Traffic control devices, systems and practices shall be consistent with the design and application of the standards contained herein.

Before a new or modified highway-rail grade crossing traffic control system is installed, approval shall be obtained from the highway agency with the jurisdictional and/or statutory authority and from the railroad company.

CODE OF FEDERAL REGULATIONS

TITLE 23 - HIGHWAYS
SECTION 109
PART 646 - RAILROADS

§ 646.214 Design.

(a) *General.* (1) Facilities that are the responsibility of the railroad for maintenance and operation shall conform to the specifications and design standards used by the railroad in its normal practice, subject to approval by the State highway agency and FHWA.

(2) Facilities that are the responsibility of the highway agency for maintenance and operation shall conform to the specifications and design standards and guides used by the highway agency in its normal practice for Federal-aid projects.

(b) ***Grade crossing improvements.* (1) All traffic control devices proposed shall comply with the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways supplemented to the extent applicable by State standards.**

(2) Pursuant to 23 U.S.C. 109(e), where a railroad-highway grade crossing is located within the limits of or near the terminus of a Federal-aid highway project for construction of a new highway or improvement of the existing roadway, the crossing shall not be opened for unrestricted use by traffic or the project accepted by FHWA until adequate warning devices for the crossing are installed and functioning properly.

(3)(i) ***Adequate warning devices,* under §646.214(b)(2) or on any project where Federal-aid funds participate in the installation of the devices are to include automatic gates with flashing light signals when one or more of the following conditions exist:**

(A) Multiple main line railroad tracks.

(B) Multiple tracks at or in the vicinity of the crossing which may be occupied by a train or locomotive so as to obscure the movement of another train approaching the crossing.

(C) High Speed train operation combined with limited sight distance at either single or multiple track crossings.

(D) A combination of high speeds and moderately high volumes of highway and railroad traffic.

(E) Either a high volume of vehicular traffic, high number of train movements, substantial numbers of school buses or trucks carrying hazardous materials, unusually restricted sight distance, continuing accident occurrences, or any combination of these conditions.

(F) **A diagnostic team recommends them.**

(ii) **In individual cases where a diagnostic team justifies that gates are not appropriate, FHWA may find that the above requirements are not applicable.**

(4) For crossings where the requirements of §646.214(b)(3) are not applicable, the type of warning device to be installed, whether the determination is made by a State regulatory agency, State highway agency, and/or the railroad, is subject to the approval of FHWA.

(c) *Grade crossing elimination.* All crossings of railroads and highways at grade shall be eliminated where there is full control of access on the highway (a freeway) regardless of the volume of railroad or highway traffic.

[40 FR 16059, Apr. 9, 1975, as amended at 47 FR 33955, Aug. 5, 1982; 62 FR 45328, Aug. 27, 1997]

CHAPTER 4--HIGHWAY SAFETY

Sec. 409. Discovery and admission as evidence of certain reports and surveys

Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings, pursuant to sections 130, 144, and 152 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

(Added Pub. L. 100-17, title I, Sec. 132(a), Apr. 2, 1987, 101 Stat. 170; amended Pub. L. 102-240, title I, Sec. 1035(a), Dec. 18, 1991, 105 Stat. 1978; Pub. L. 104-59, title III, Sec. 323, Nov. 28, 1995, 109 Stat. 591.)

Amendments

1995--Pub. L. 104-59 inserted ``or collected'' after ``data compiled''.

1991--Pub. L. 102-240 substituted ``Discovery and admission'' for ``Admission'' in section catchline and ``subject to discovery or admitted into evidence in a Federal or State court proceeding'' for ``admitted into evidence in Federal or State court'' in text.

Effective Date of 1991 Amendment

Amendment by Pub. L. 102-240 effective Dec. 18, 1991, and applicable to funds authorized to be appropriated or made available after Sept. 30, 1991, and, with certain exceptions, not applicable to funds appropriated or made available on or before Sept. 30, 1991, see section 1100 of Pub. L. 102-240, set out as a note under section 104 of this title.

CODE OF FEDERAL REGULATIONS

TITLE 23 - HIGHWAYS
SECTION 109
PART 646 - RAILROADS

§ 646.204 Definitions.

For the purposes of this subpart, the following definitions apply:

Active warning devices means 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.

Company shall mean any railroad or utility company including any wholly owned or controlled subsidiary thereof.

Construction shall mean the actual physical construction to improve or eliminate a railroad-highway grade crossing or accomplish other railroad involved work.

A diagnostic team means a group of knowledgeable representatives of the parties of interest in a railroad-highway crossing or a group of crossings.

Main line railroad track means a track of a principal line of a railroad, including extensions through yards, upon which trains are operated by timetable or train order or both, or the use of which is governed by block signals or by centralized traffic control.

Passive warning devices means 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.

Preliminary engineering shall mean the work necessary to produce construction plans, specifications, and estimates to the degree of completeness required for undertaking construction thereunder, including locating, surveying, designing, and related work.

Railroad shall mean all rail carriers, publicly-owned, private, and common carriers, including line haul freight and passenger railroads, switching and terminal railroads and passenger carrying railroads such as rapid transit, commuter and street railroads.

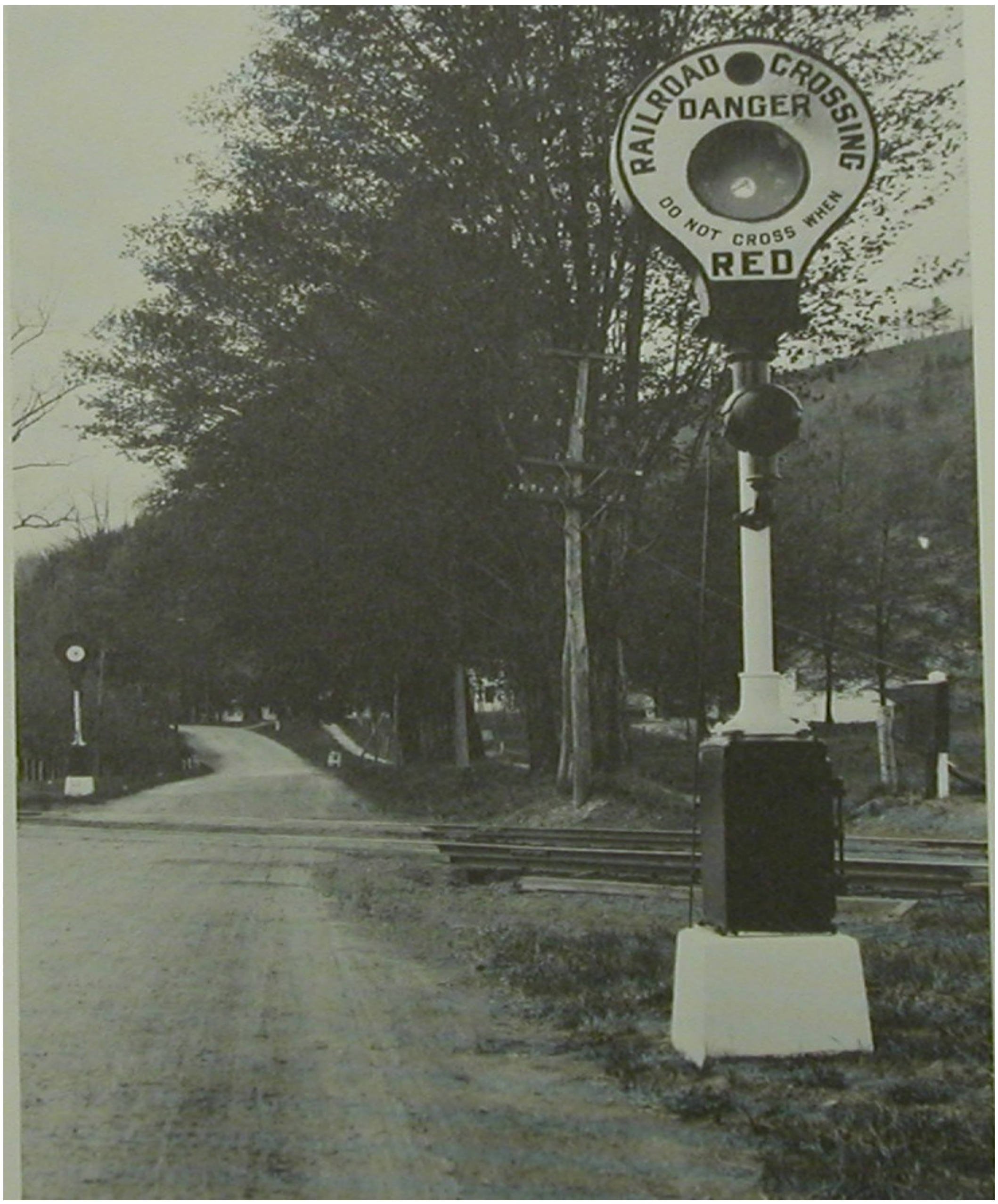
Utility shall mean the lines and facilities for producing, transmitting or distributing communications, power, electricity, light, heat, gas, oil, water, steam, sewer and similar commodities.

[40 FR 16059, Apr. 9, 1975, as amended at 62 FR 45328, Aug. 27, 1997]

• The first crossing warning device similar to today's technology consisted of a tilting crossbar and was erected in 1857 to provide warning for approaching pedestrians, horses and horse drawn wagons and carriages.

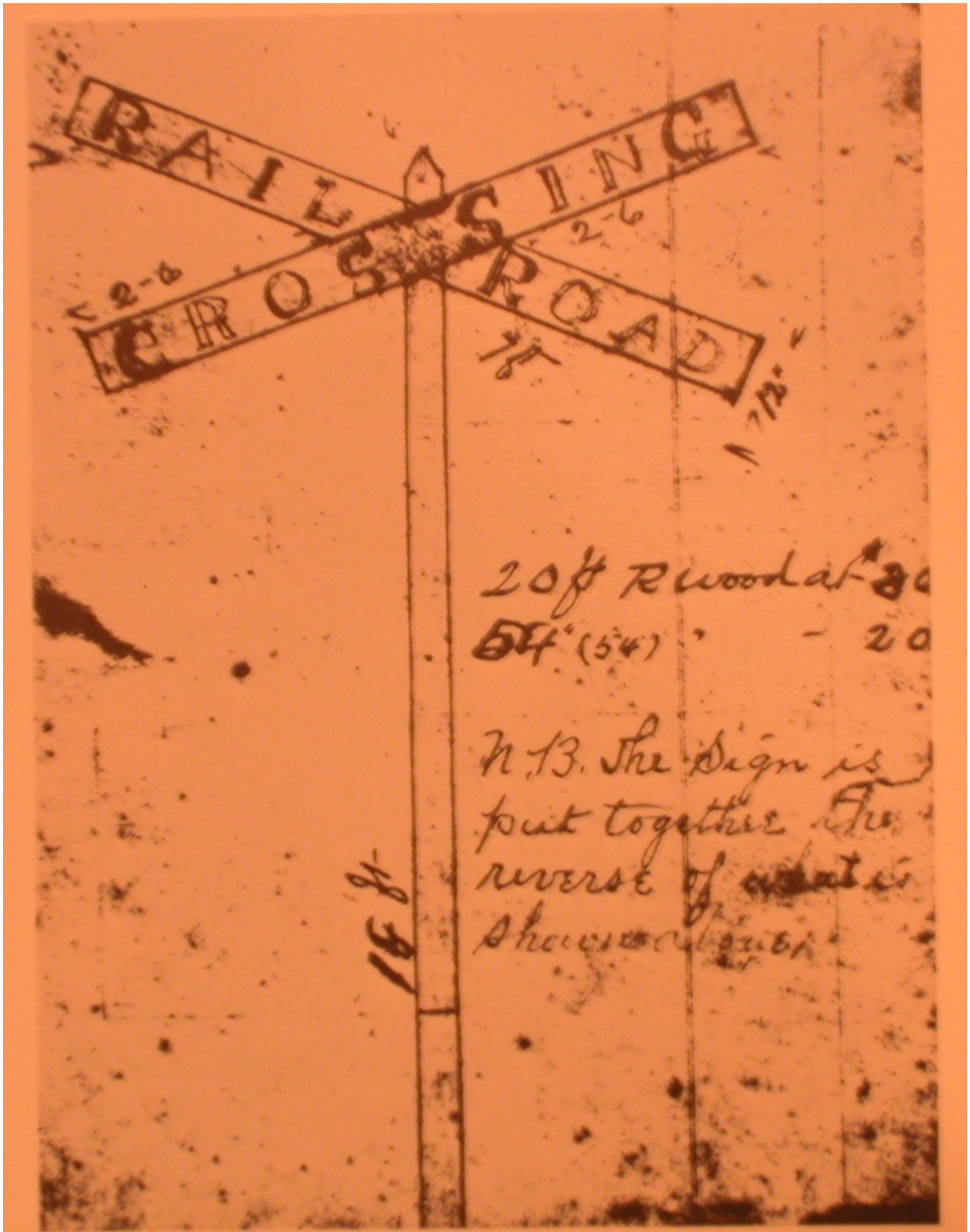
• In 1860 a red disc, red flag and at night, red lantern were added to the crossbar.

• In 1870, the first revolving red disc was used on top of a mast manufactured by the Hall Signal Company.



• The first crossbuck style signs were used in the late 1800's including legends such as STOP – LOOK – LISTEN, LOOK OUT FOR THE LOCOMOTIVE or WATCH OUT FOR THE CARS.

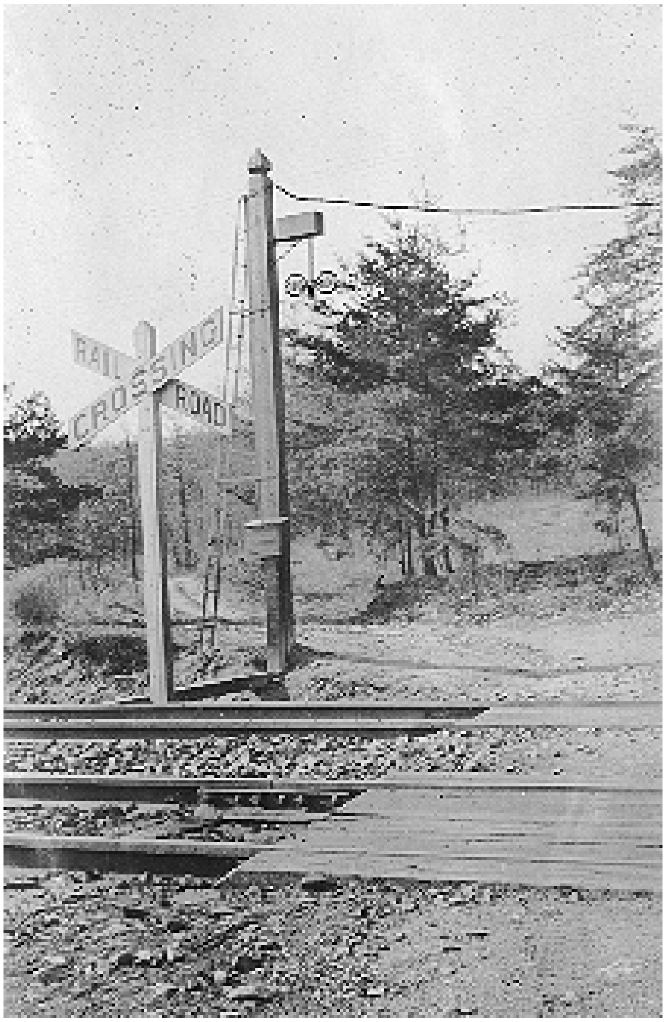
• The design was intended to suggest crossed bones and death.

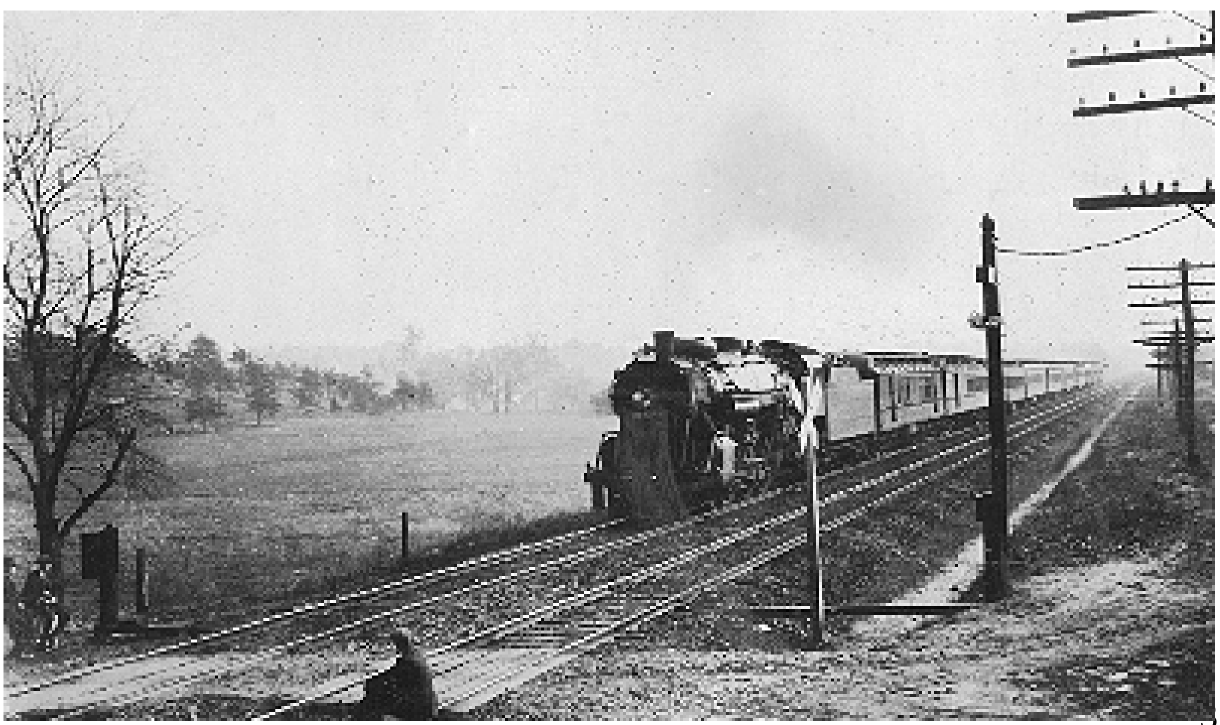


Crossing sign . . . 1884 version

• Soon after the bell was introduced, a red light for nighttime operation was added.

• A magnetically operated banner was also added creating the "Automatic Flagman" or Wig-Wag signal.


RAIL
CROSSING
ROAD

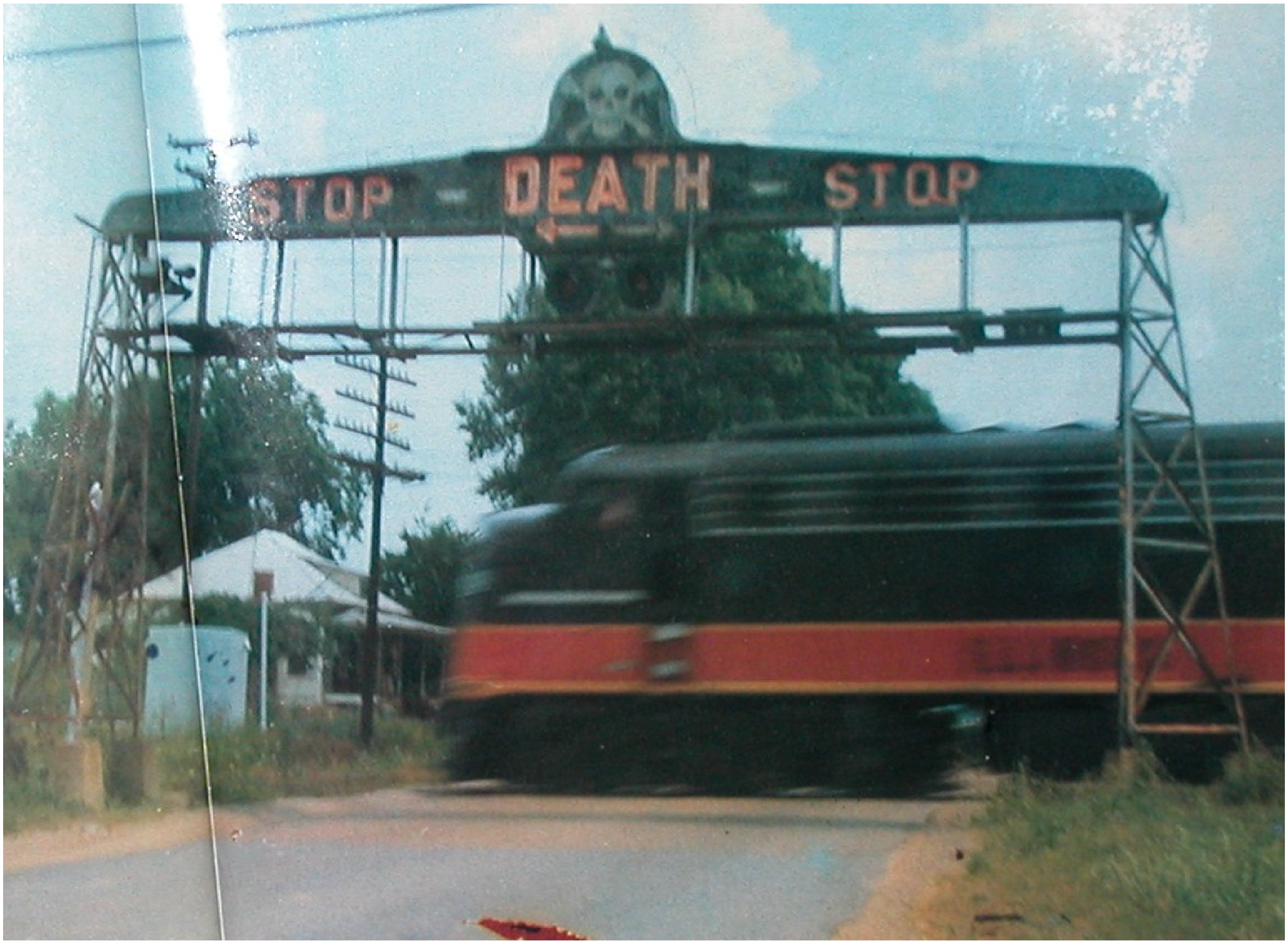


• The first flashing light signal was installed on the Central Railroad of New Jersey in 1913 at Woodbridge Avenue in Sewaren, NJ.

• It consisted of four or five lights arranged in a quadrant of a circle and when operated gave the appearance of a swinging lamp and was invented by L. S. Brach.

• The first standardized crossing signal was developed through an effort of the American Railway Association. In 1915, a task force was convened to bring order to crossing signals.

• The standard was produced in 1916 and included a crossbuck sign, black and white stripes for crossing gates when used, a circular approach sign with a cross and the letters RR, STOP signs for watchmen by day, red lights on the gates and a red light in the hand of a watchmen at night.

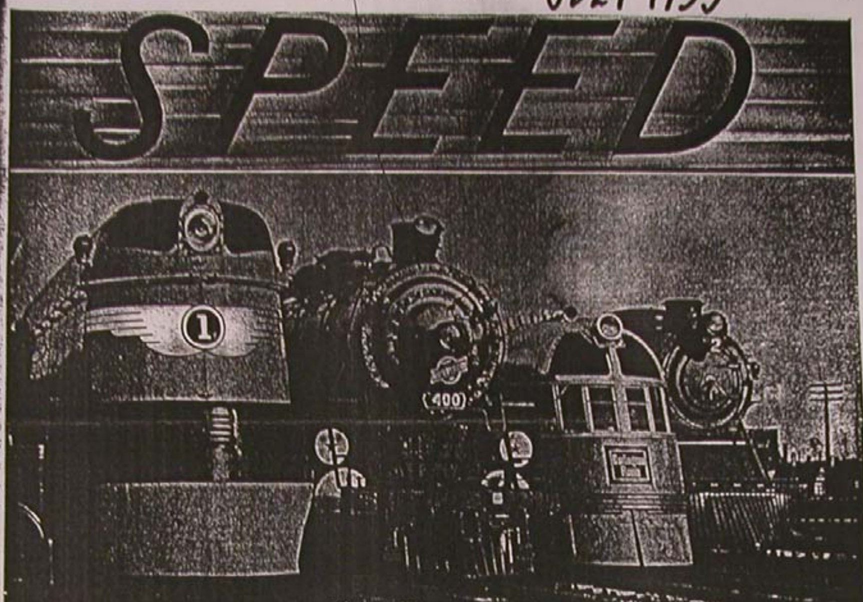


Billups Neon Crossing Signal
“Skull & Crossbones”
Installed late 1930’s
Illinois Central RR and Mississippi Highway 7
Grenada, Mississippi
Removed from service - 1970’s

• The first flashing light signal consisting of two horizontally mounted, alternately flashing red lights was invented by L. S. Brach.

• It was introduced through the A.R.A. Committee on Highway Crossing Protection around 1930 under direction of A. H. Rudd, Signal Engineer of the Pennsylvania Railroad.

• The first motor driven highway crossing gate was introduced in 1936 by adapting a semaphore signal mechanism to drive the gate and was installed on the Illinois central Railroad.



Model 6 looks like the above when train is approaching the crossing. The "STOP" sign compels attention.

Model 6 appears like photograph to the right when tracks are clear. "STOP" sign is parallel to highway.

Model 6 Signal—The Railway's Answer To Higher Rail and Highway Speeds

SPEEDS of 80 to 120 m.p.h. are daily performances for such trains as the Hiawatha, the Twin Zephyrs, the City of Portland, the Abraham Lincoln, the Flying Yankee, the Comet, the "400" and the Rebel. These super-speed trains require the ultimate in crossing protection because these trains must be protected as well as the highway traffic. Drivers of highway vehicles depend more and more on signal indications.

Model 6 Signal will provide adequate crossing protection at low cost. It compels attention and action day and night. Model 6 combines the Standard A.R.A. Flashing Light Signal with the Federal Octagon "STOP" Sign. The "STOP" Sign is operative and rotates to the "STOP" position only when a train is approaching. At all other times it is parallel to the highway and invisible to traffic. Model 6 shows "STOP" only when a "STOP" is imperative. It provides unfailing protection 24 hours of the day.

WESTERN RAILROAD SUPPLY COMPANY

2330-2360 SO. ASHLAND AVE., CHICAGO, ILL.

H. M. Buck NEW YORK — J. N. Meade DENVER — H. W. Renick LOS ANGELES — S. M. Dolan ST. LOUIS — Stanley H. Smith CLEVELAND — J. C. Duranceau ST. PAUL — C. G. Elliott, L. Y. Dolan HOUSTON

• The first use of the rails to carry electric current dates back to 1848.

• Franklin Pope, working with Thomas Edison, conducted an experiment in 1871 using a 42 foot section of rail, but his work was based on the open circuit principle. Interestingly, before producing a closed circuit track circuit, Pope was accidentally electrocuted in his home.

• The first electric track circuit based on the closed circuit principle was invented by Dr. William Robinson in 1872.

• Robinson's work occurred almost simultaneously with Pope's, and in 1870 he demonstrated a model of his circuit based on an open circuit principle at a fair in New York City. Later that year, Robinson's circuit was first installed at Kinzua, PA on the Philadelphia and Erie Railroad.

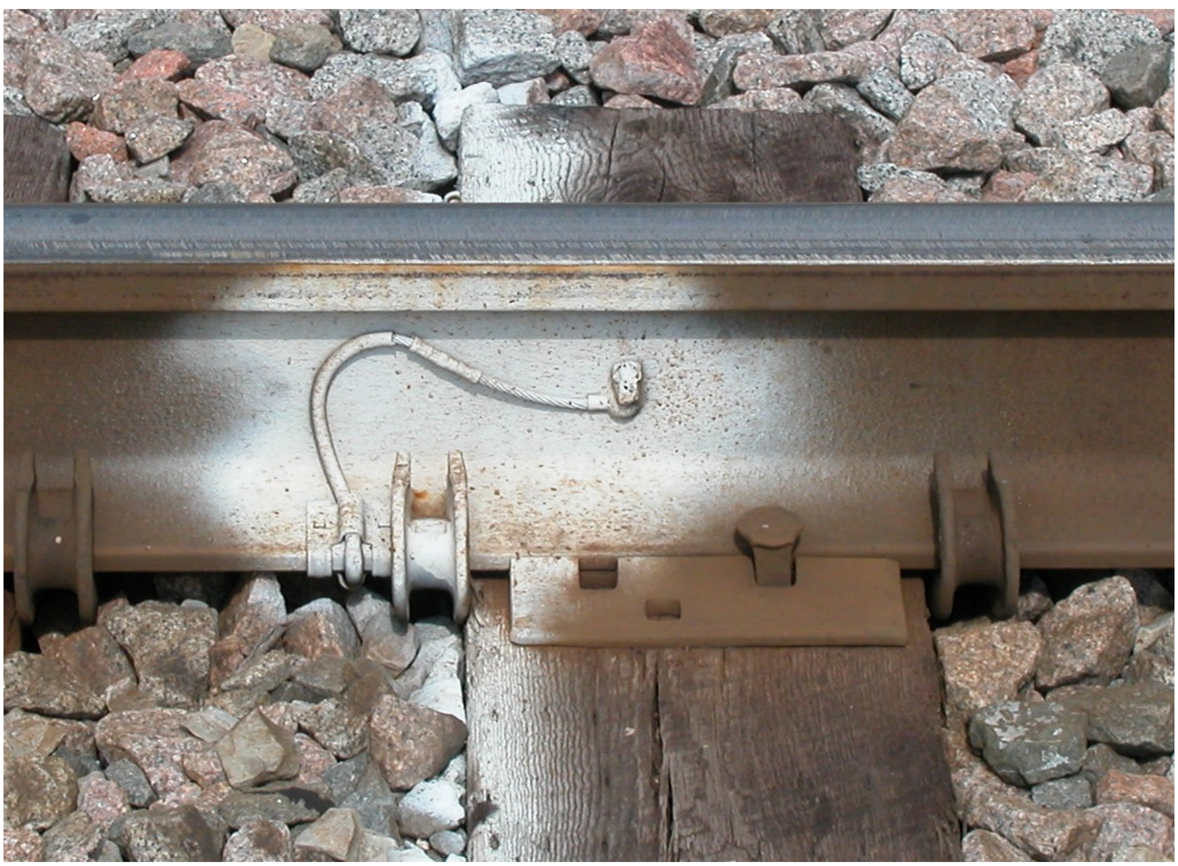
- Robinson discovered the immediate safety risks associated with an open circuit, and worked to produce a closed circuit which he demonstrated in 1872 at the State Fair in Erie, Pennsylvania.

- Robinson recognized that gravity was a necessary part of the fail safe principle.

- The first insulated joints necessary for Robinson's track circuit were made of wood.

- In 1876, fiber insulated rail joints were developed.

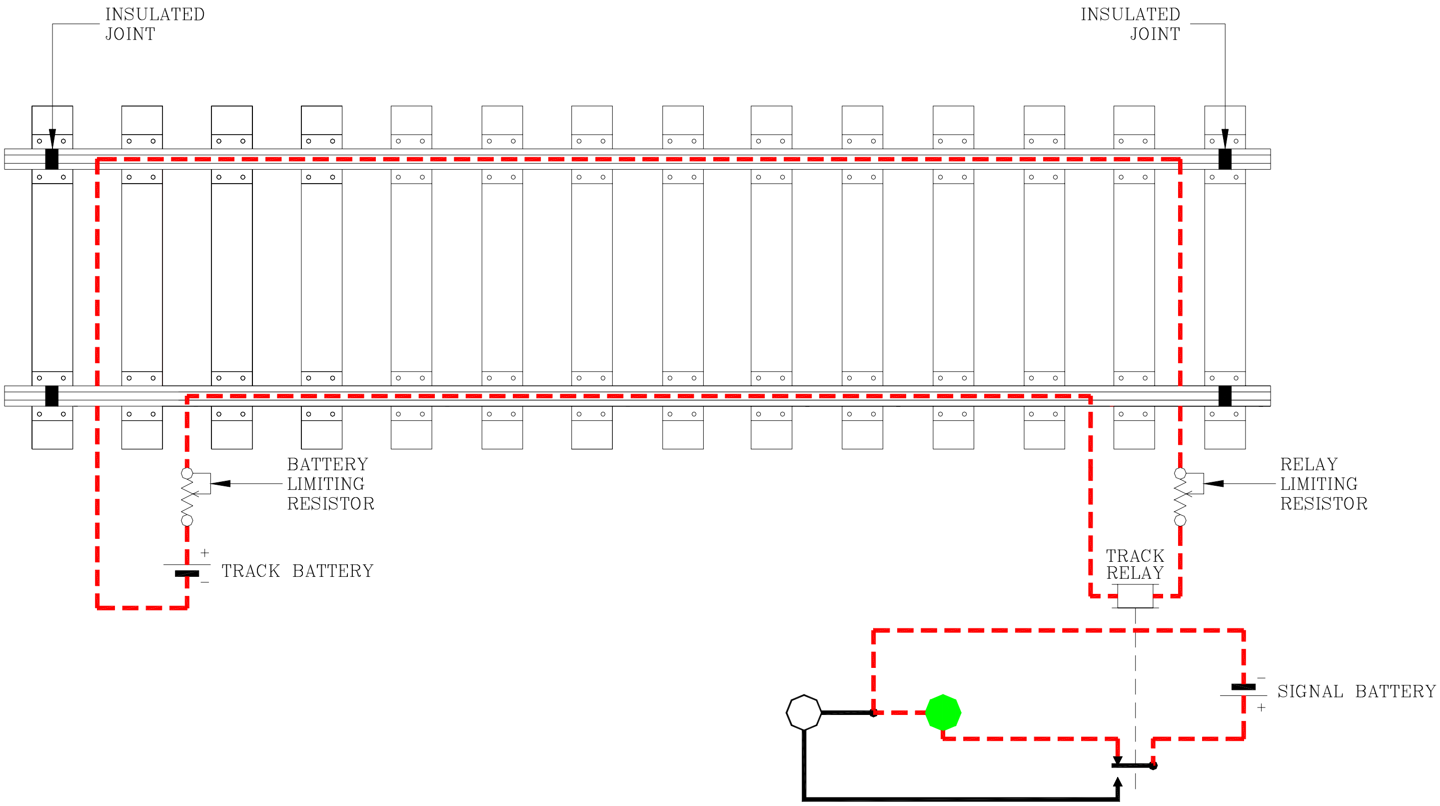
- Bond wires were also invented to be pushed into a hole drilled in the rail and held in place by a pin.



• On November 22, 1910, the following report was made by the Block Signal and Train Control Board to the Interstate Commerce Commission:

“Perhaps no single invention in the history of the development of railway transportation has contributed more toward the safety and dispatch in that field than the track circuit. By this invention, simple in itself, the foundation was obtained for the development of practically every one of the intricate systems of railway block signaling in use today,…”

• Robinson’s circuit is what we now know as the DC Track Circuit and consists of a battery and relay connected to the rails at opposite ends of the circuit.


INSULATED
JOINT
INSULATED
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BATTERY
LIMITING
RESISTOR
TRACK BATTERY
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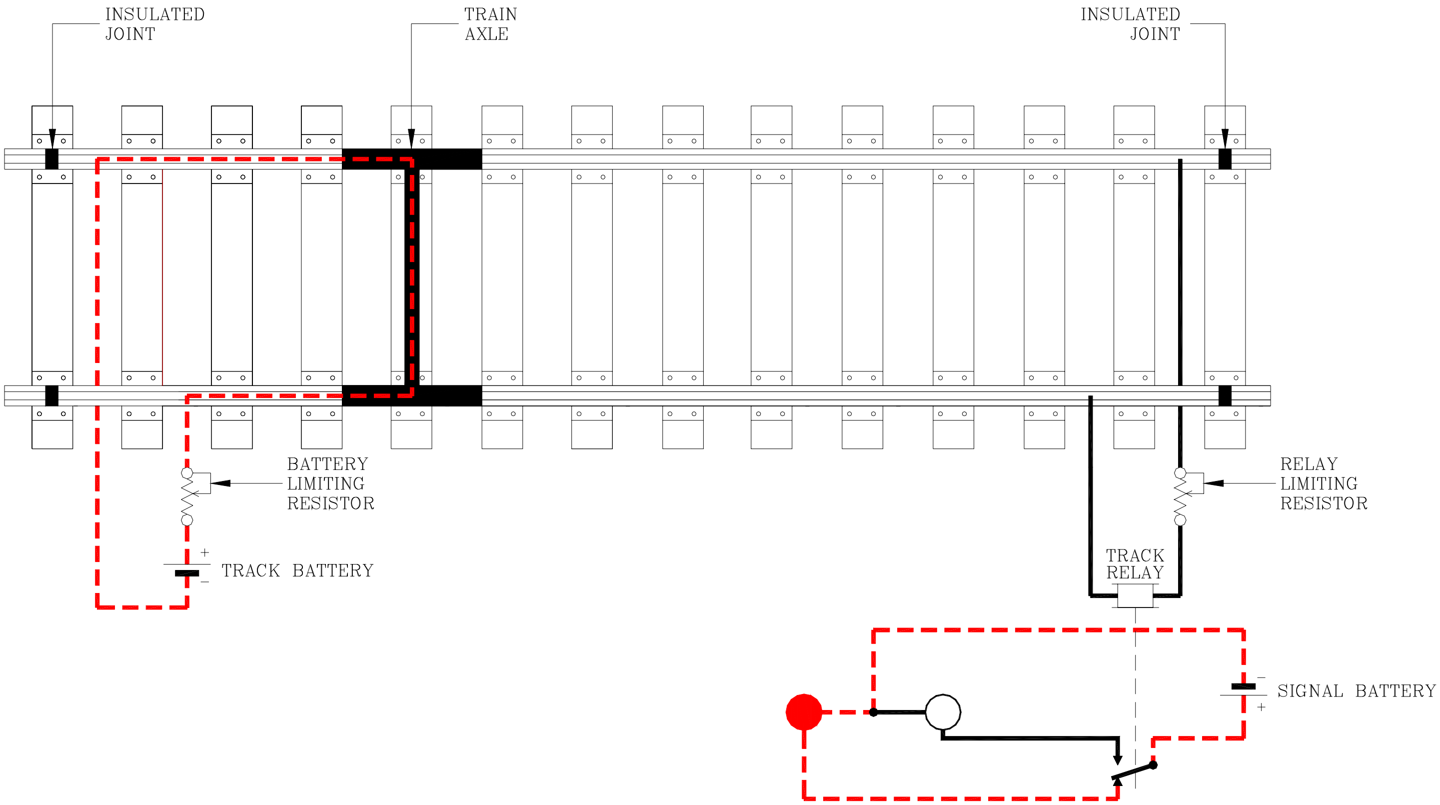
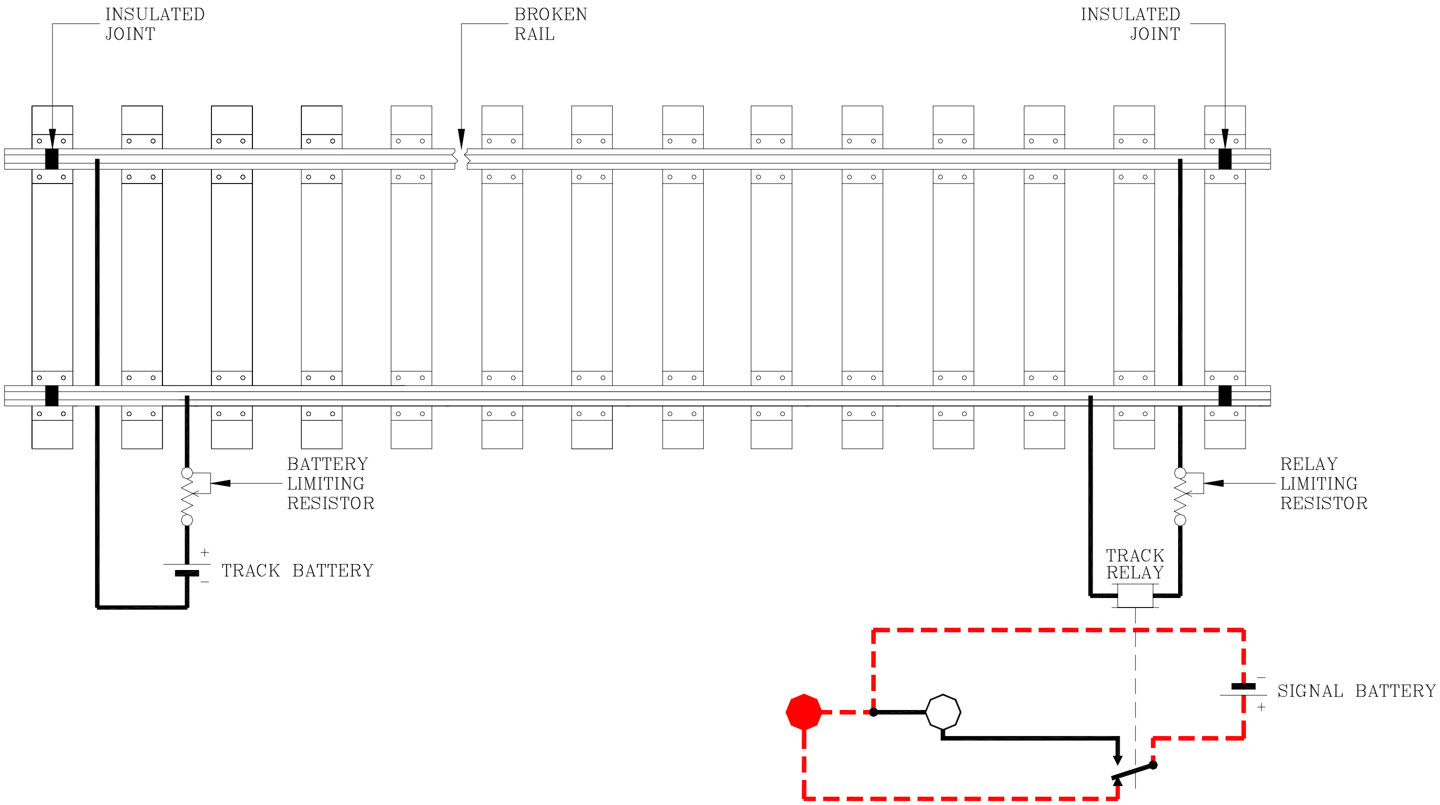
RELAY
SIGNAL BATTERY


INSULATED JOINT
TRAIN AXLE
INSULATED JOINT
BATTERY LIMITING RESISTOR
TRACK BATTERY
RELAY LIMITING RESISTOR
TRACK RELAY
SIGNAL BATTERY


INSULATED
JOINT
BROKEN
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INSULATED
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LIMITING
RESISTOR
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RELAY
LIMITING
RESISTOR
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RELAY
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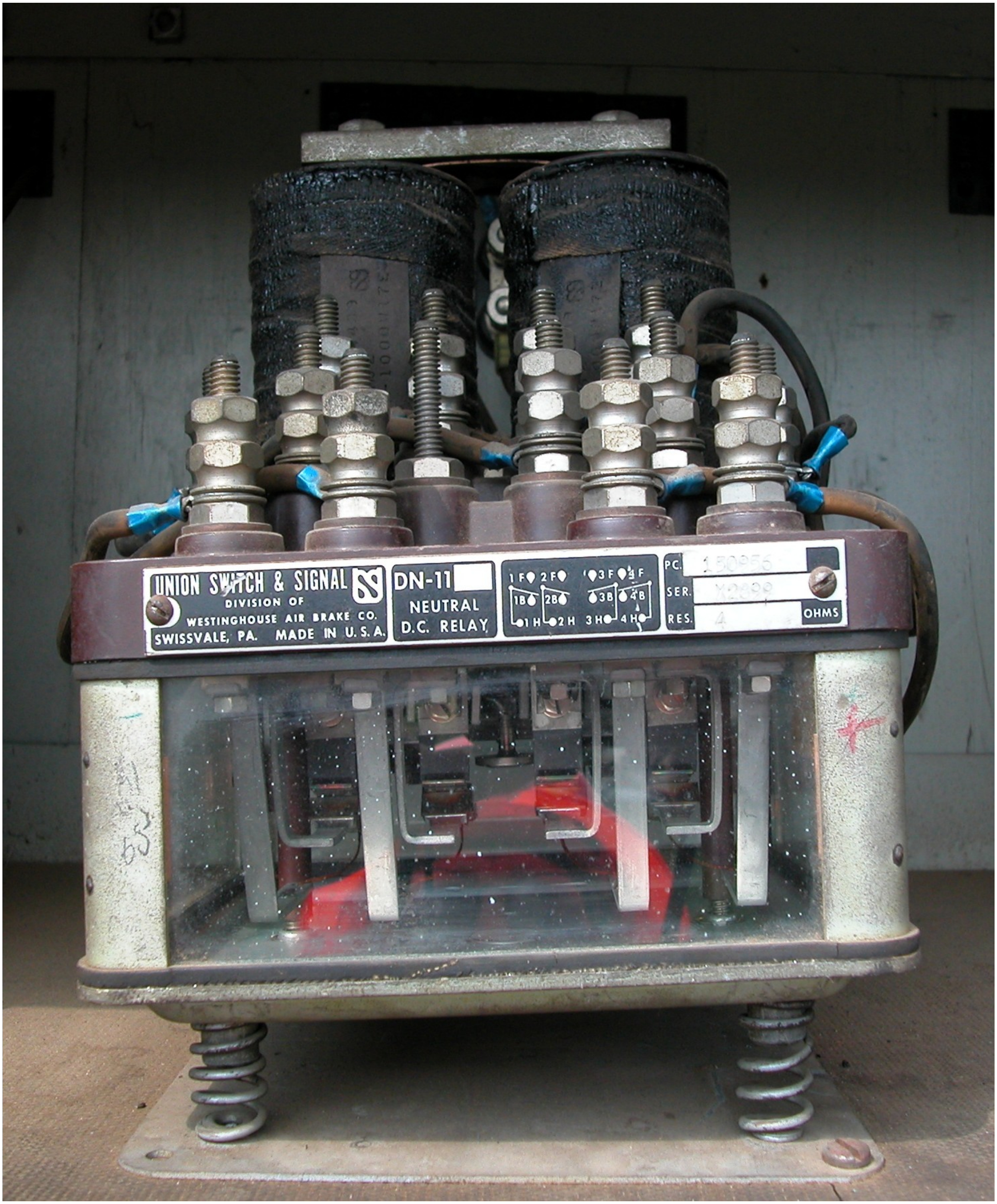
+
SIGNAL BATTERY


UNION SWITCH & SIGNAL
DIVISION OF
WESTINGHOUSE AIR BRAKE CO.
SWISSVALE, PA. MADE IN U.S.A.
DN-11
NEUTRAL
D.C. RELAY
P.C.
SER.
RES.
OHMS

TRACK RELAY

• In later years, engineers worked to design a circuit that allowed the battery and relay to be located at the same end of the circuit.

• It was determined that in order to accomplish the goal of having the relay at the same end of the circuit, the energy source would have to utilize AC current.

• A rectifier (now known as a diode) was installed at the distant end of the circuit.

• A higher AC voltage could be applied to the rails which allowed better shunting (sensitivity) where large amounts of rust exist due to infrequent use.

• In the mid 1960's everyone was embracing a new device that would revolutionize the world, the transistor.

• Railroad signal engineers looked for ways to improve the state of the art through the use of solid state electronics.

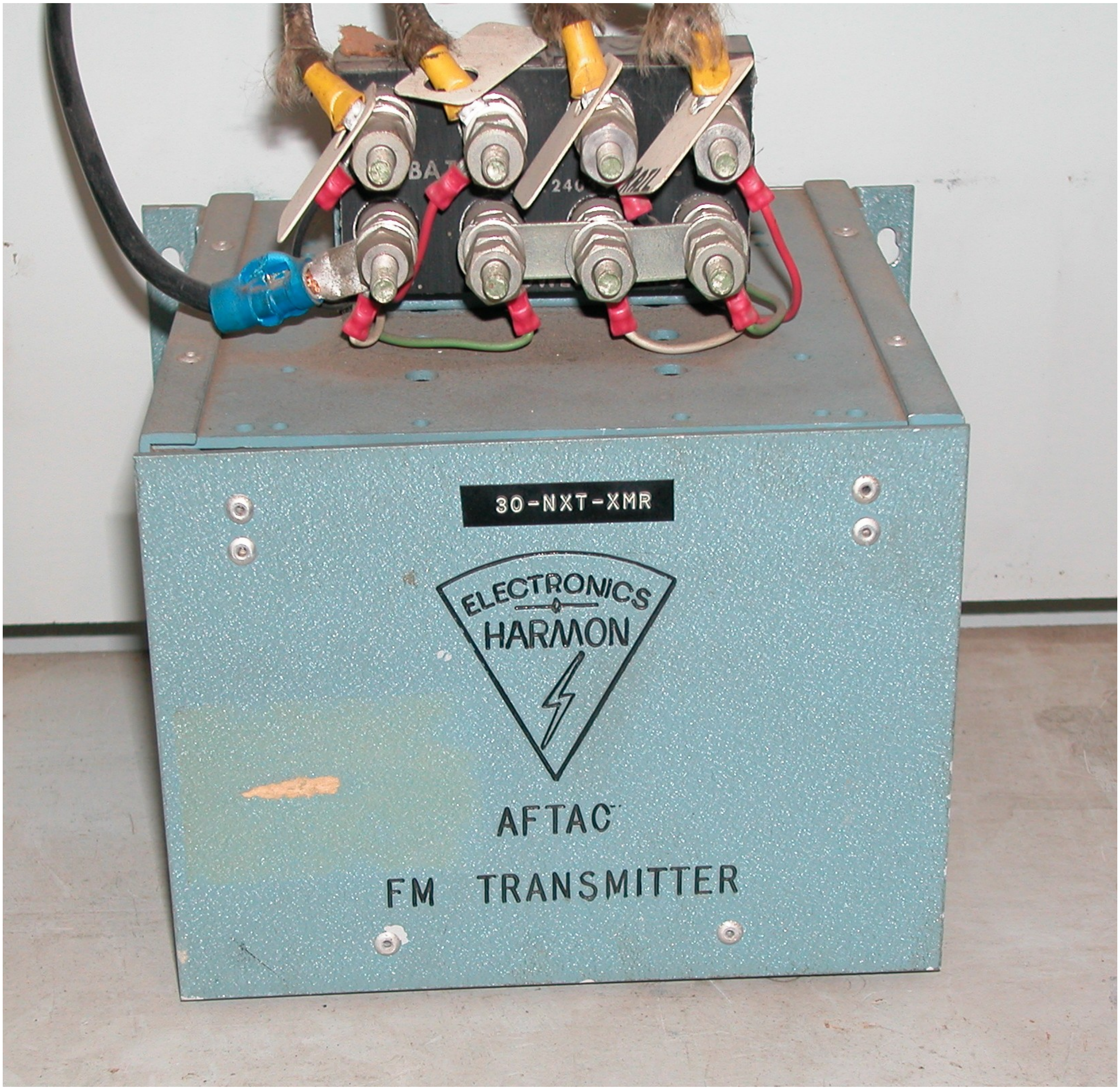
• The result was the Solid State Audio Frequency Overlay (AFO) track circuit.

• The AFO track circuit was unique in that it did not require insulated joints.

• A transmitter was connected to the rails at one end of the circuit.

• A receiver was connected to the rails at the other end of the circuit.

•The fail safe operation is maintained with the AFO circuit.


30-NXT-XMR
ELECTRONICS
HARMON
AFTAC
FM TRANSMITTER

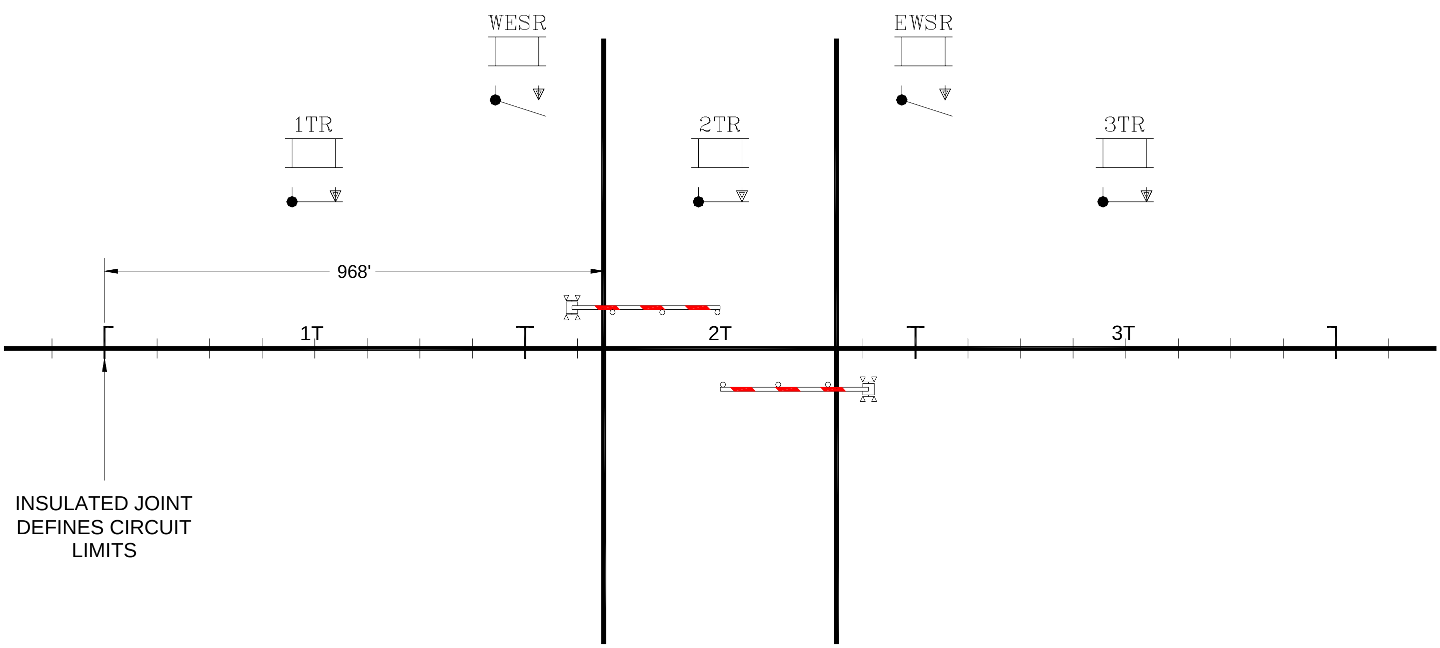
• Although the AFO circuit simplified highway crossing circuits by allowing multiple approaches to overlap, it was unable to provide more information than an occupied/unoccupied condition.

• Once individual track circuits were developed, combinations of track circuit occupancy were used to provide more intelligent control.

• In highway-rail grade crossing control, circuitry was developed to allow warning devices to begin operating as a train approached a crossing, but permitted the devices to stop operating as soon as the train cleared the crossing

• This circuit made use of “stick” relays. A stick circuit allows the train direction to be established through a crossing.

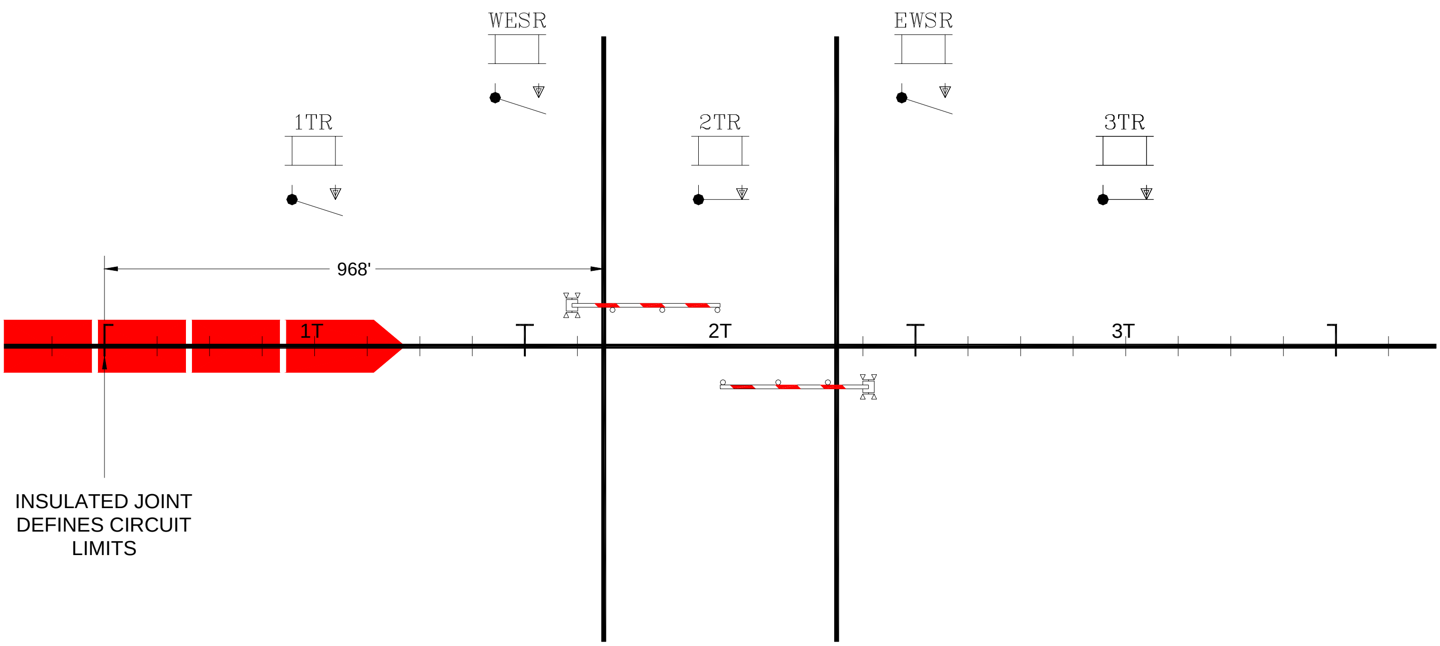
CONVENTIONAL 3 TRACK CIRCUIT



MT =	**20 SEC.**
CT =	**<u>0 SEC</u>.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**<u>2 SEC</u>.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968'

CONVENTIONAL 3 TRACK CIRCUIT



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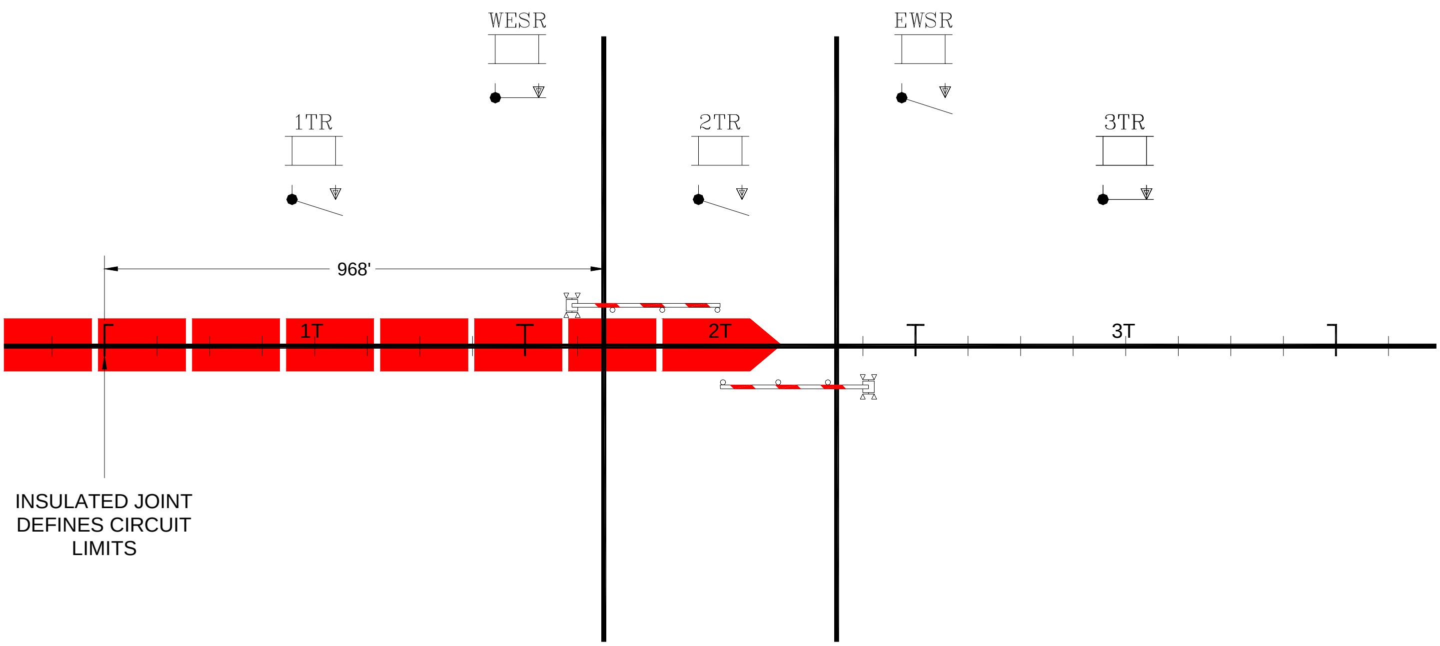
CT =	**0 SEC.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**2 SEC.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968'

CONVENTIONAL 3 TRACK CIRCUIT



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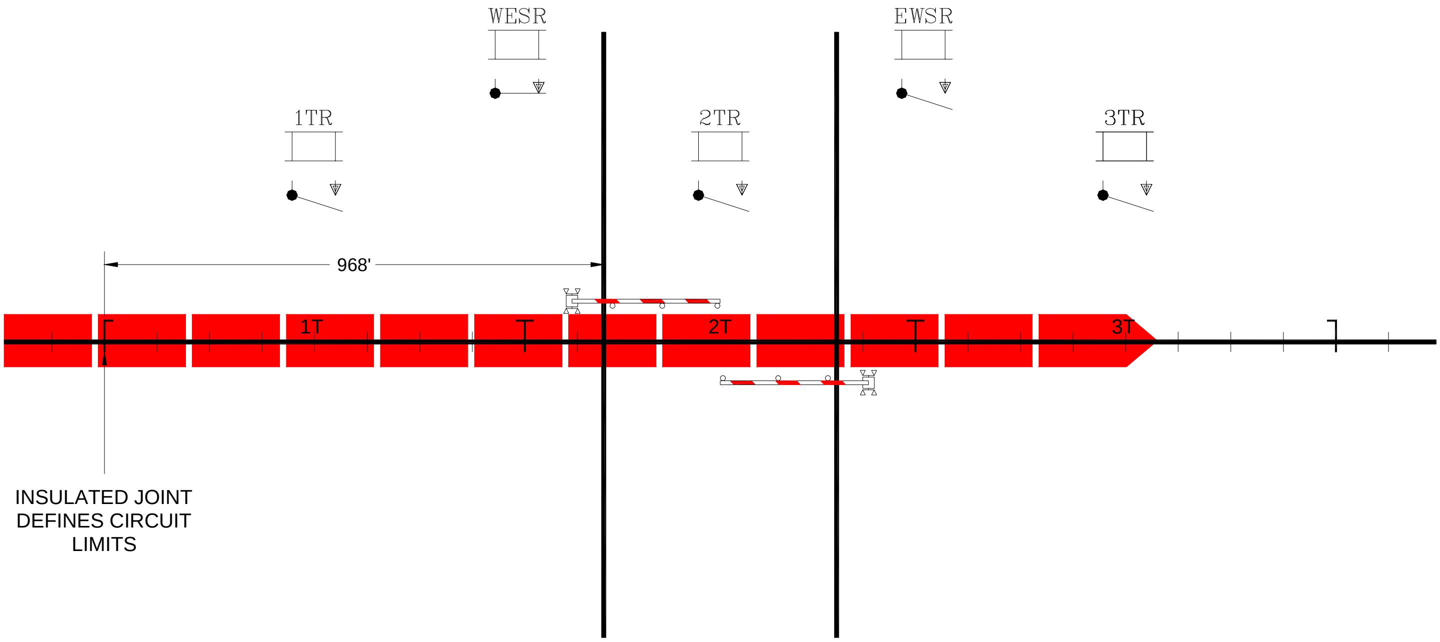
CT =	**0 SEC.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**2 SEC.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968'

CONVENTIONAL 3 TRACK CIRCUIT



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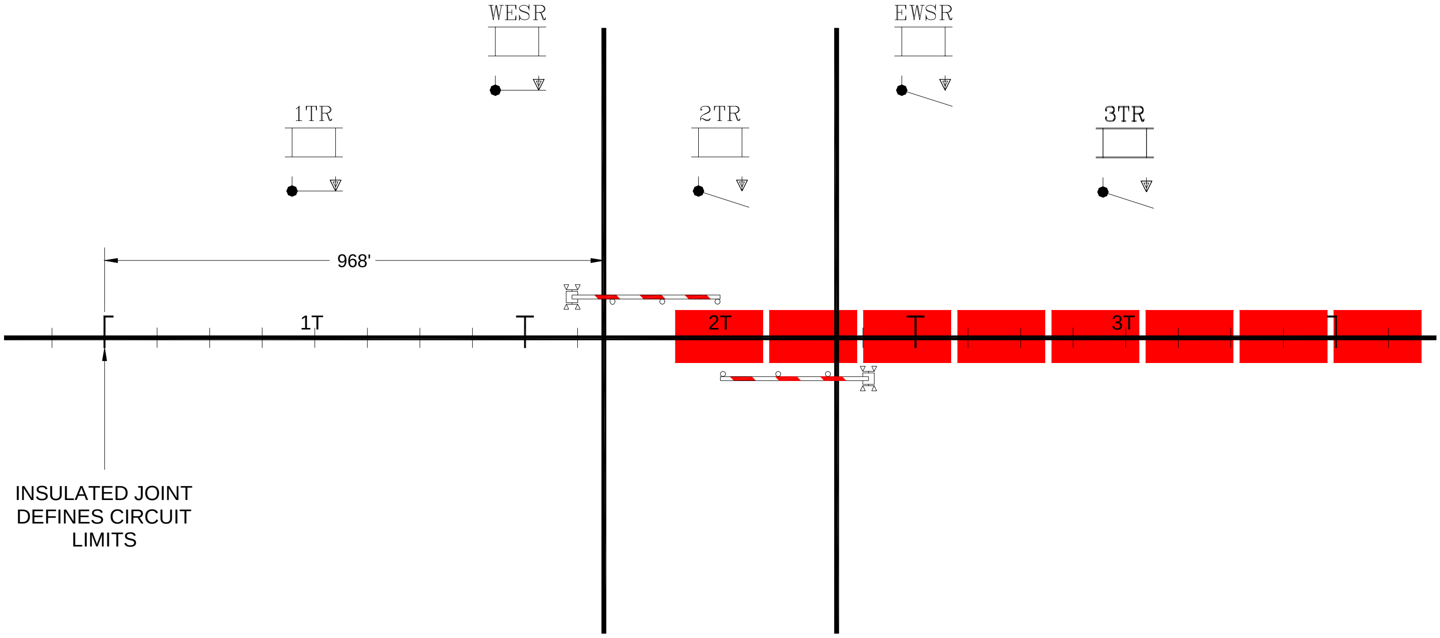
CT =	**<u>0 SEC</u>.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**<u>2 SEC</u>.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968'

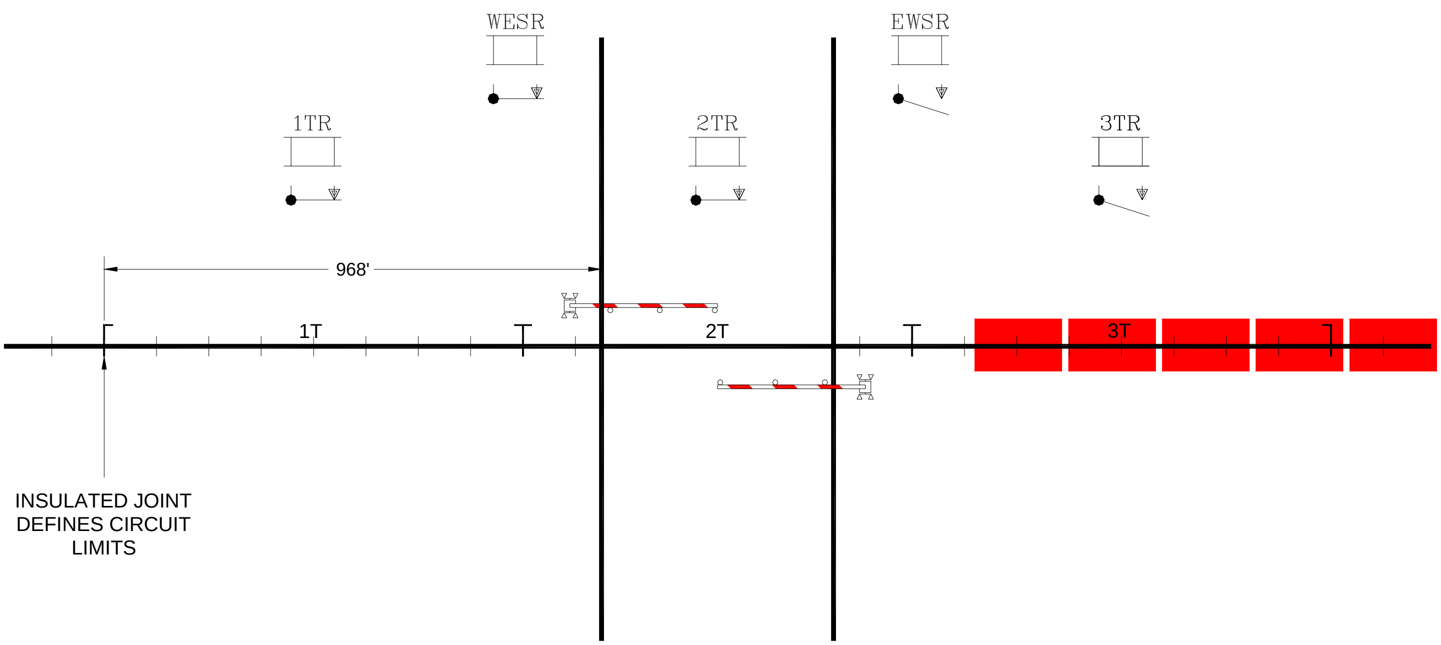
CONVENTIONAL 3 TRACK CIRCUIT



MT =	**20 SEC.**
CT =	**<u>0 SEC</u>.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**<u>2 SEC</u>.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968'

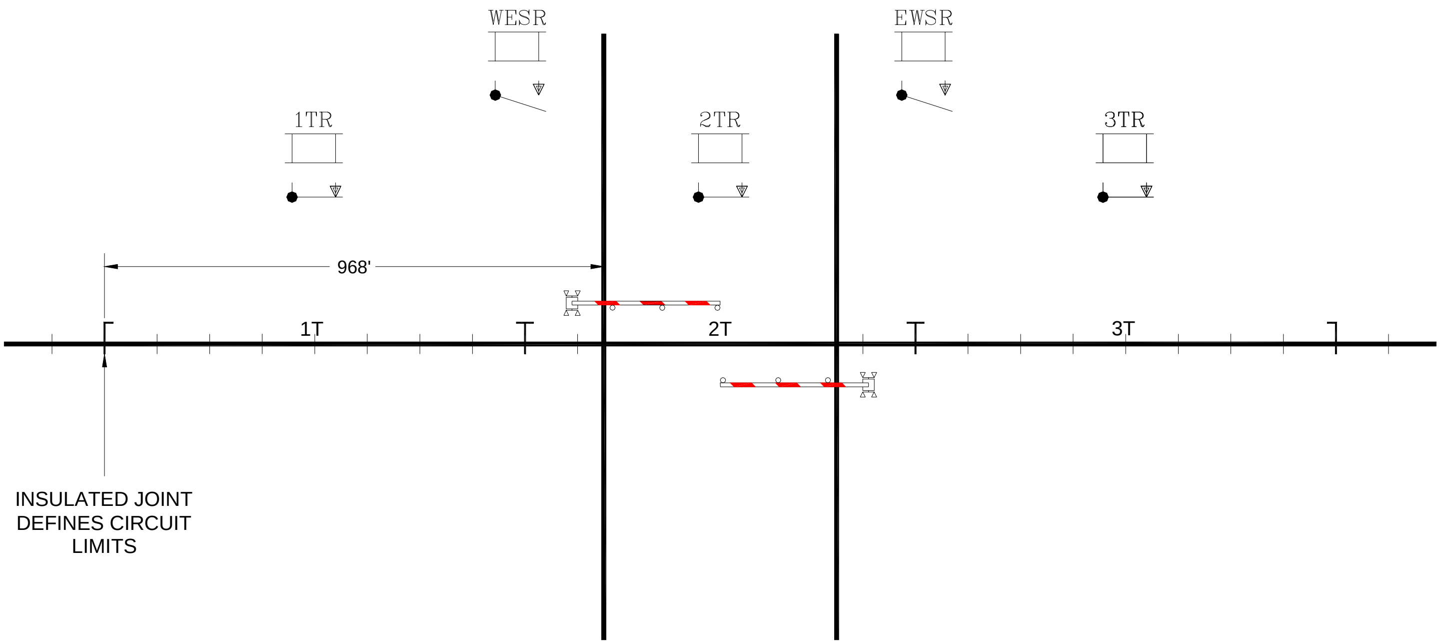
CONVENTIONAL 3 TRACK CIRCUIT



MT =	**20 SEC.**
CT =	**0 SEC.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**2 SEC.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968'

CONVENTIONAL 3 TRACK CIRCUIT



MT =	**20 SEC.**
CT =	**<u>0 SEC</u>.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**<u>2 SEC</u>.**
APPROACH TIME=	**22 SEC.**

APPROACH LENGTH @ 30 MPH - 968’

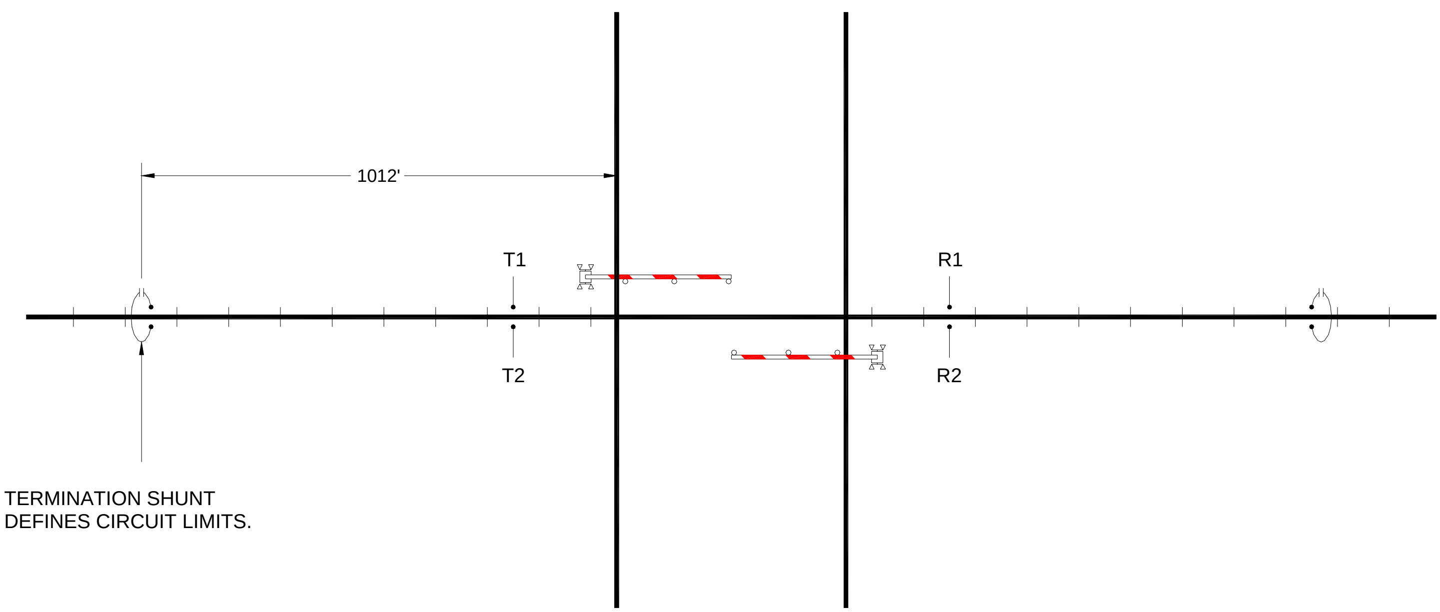

BNSF TRACK

- In the late 1960’s, the first Solid State Motion Sensor was developed.

- It was built on principles from the AFO track circuit.

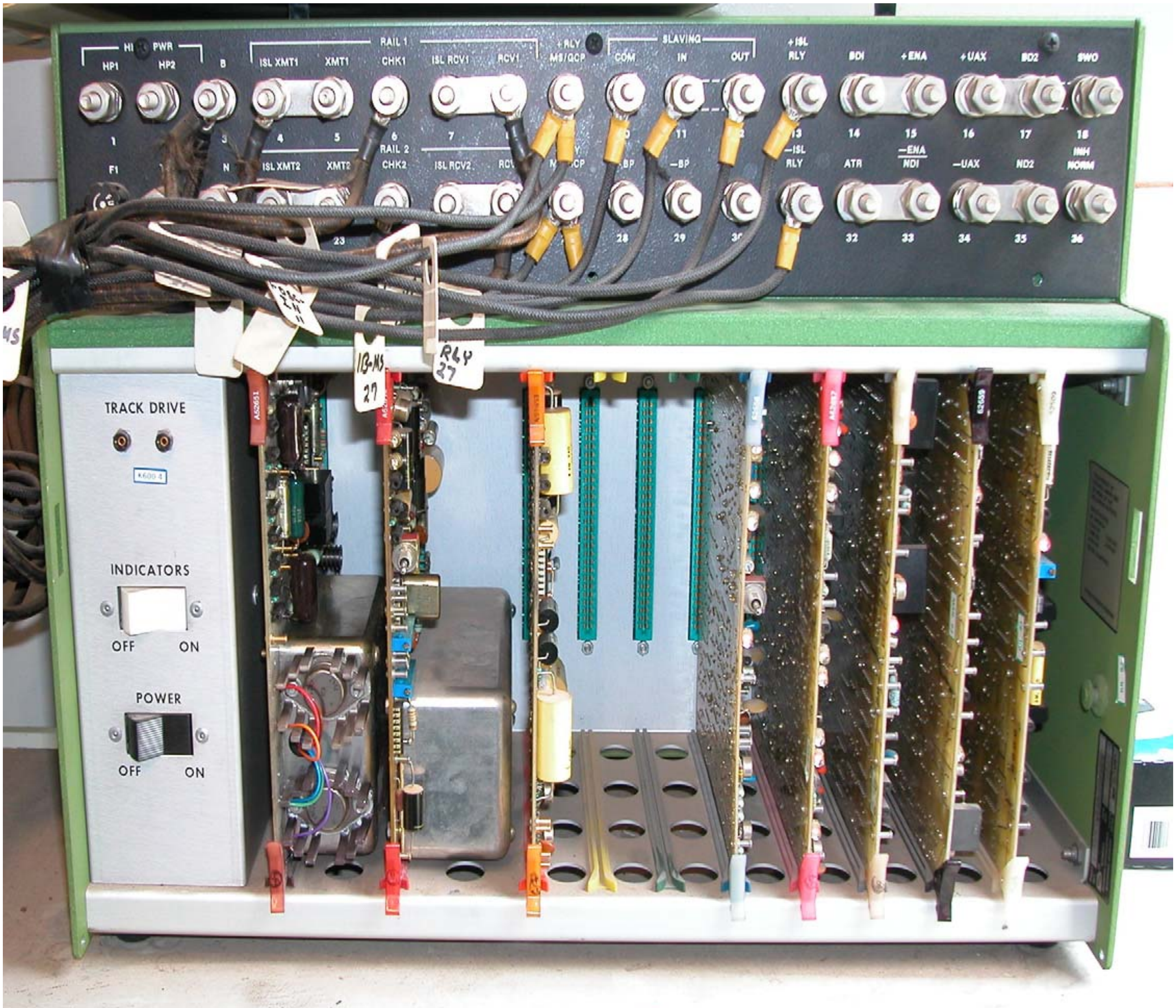
- The Motion Sensor provided a means to determine if a train was moving toward the crossing, moving away from the crossing or stopped within the approach circuit to a crossing.

MOTION SENSOR CIRCUIT



MT =	**20 SEC.**
CT =	**<u>0 SEC</u>.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
ERT=	**<u>3 SEC</u>.**
APPROACH TIME=	**23 SEC.**

APPROACH LENGTH @ 30 MPH - 1012'



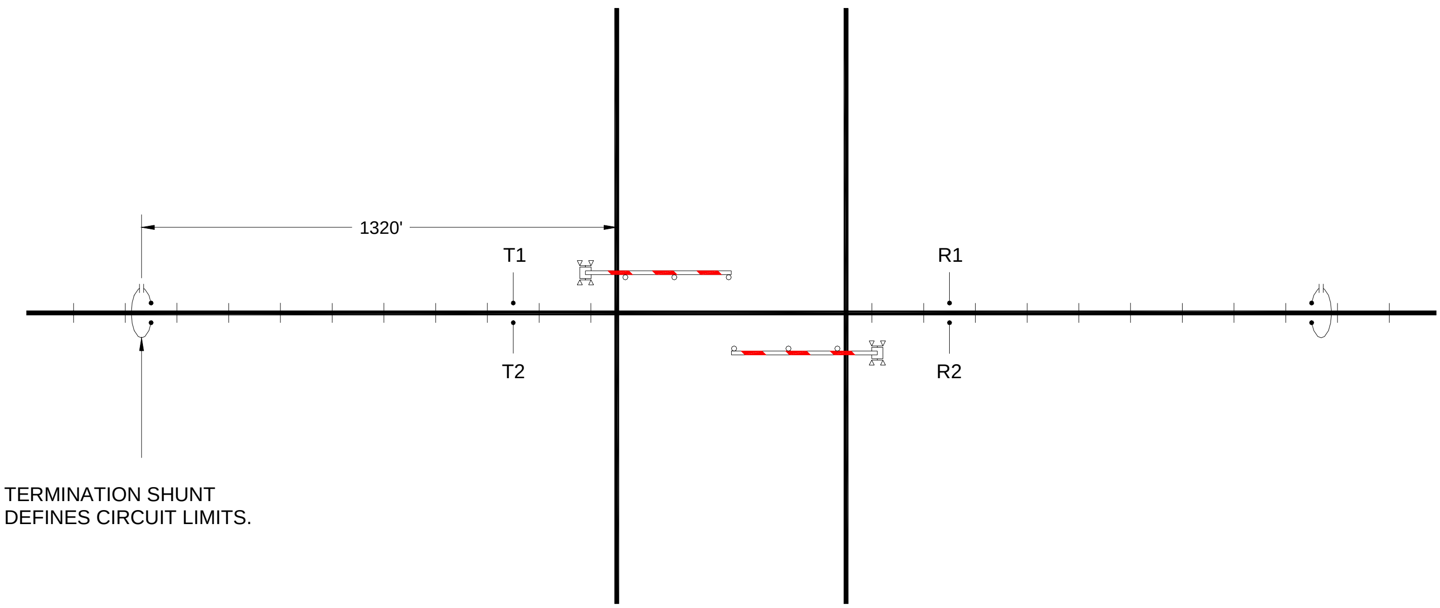
HI PWR
HP1
HP2
B
RAIL 1
ISL XMT1
XMT1
CHK1
ISL RCV1
RCV1
+RLY
MS/QCP
SLAVING
COM
IN
OUT
+ISL
RLY
BDI
+ENA
+UAX
BD2
SWO
F1
N
RAIL 2
ISL XMT2
XMT2
CHK2
ISL RCV2
−BP
−ISL
RLY
ATR
−ENA
NDI
−UAX
ND2
INH
NORM
TRACK DRIVE
INDICATORS
OFF
ON
POWER
OFF
ON

• Product design engineers quickly realized that, with a slight amount of additional information, a Motion Sensor could be adapted to measure train speed by measuring the rate of voltage change against a fixed distance.

• Although the calculations were performed through analog means, this formed the first Constant Warning Time system.

• With the development of the microprocessor and the reliability derived from the use of CMOS logic devices, the first HXP-1 Digital Grade Crossing Processor was developed by Harmon Electronics in the early 1970's.

CONSTANT WARNING TIME CIRCUIT

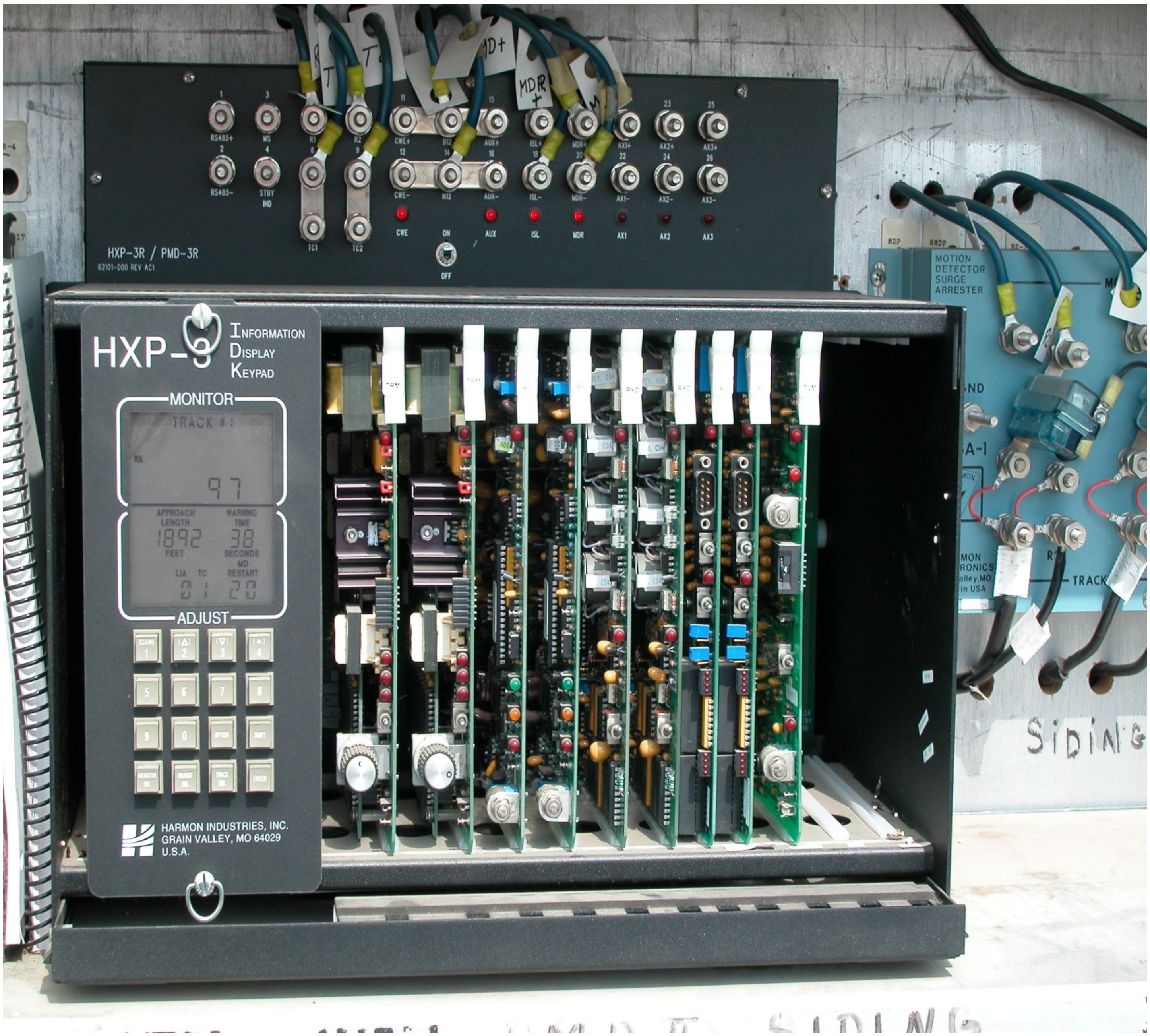


MT =	**20 SEC.**
CT =	**0 SEC.**
MWT =	**20 SEC.**
MWT=	**20 SEC.**
BT=	**5 SEC.**
TOTAL WARNING TIME=	**25 SEC.**
APT=	**0 SEC.**
ERT=	**5 SEC.**
APPROACH TIME=	**30 SEC.**

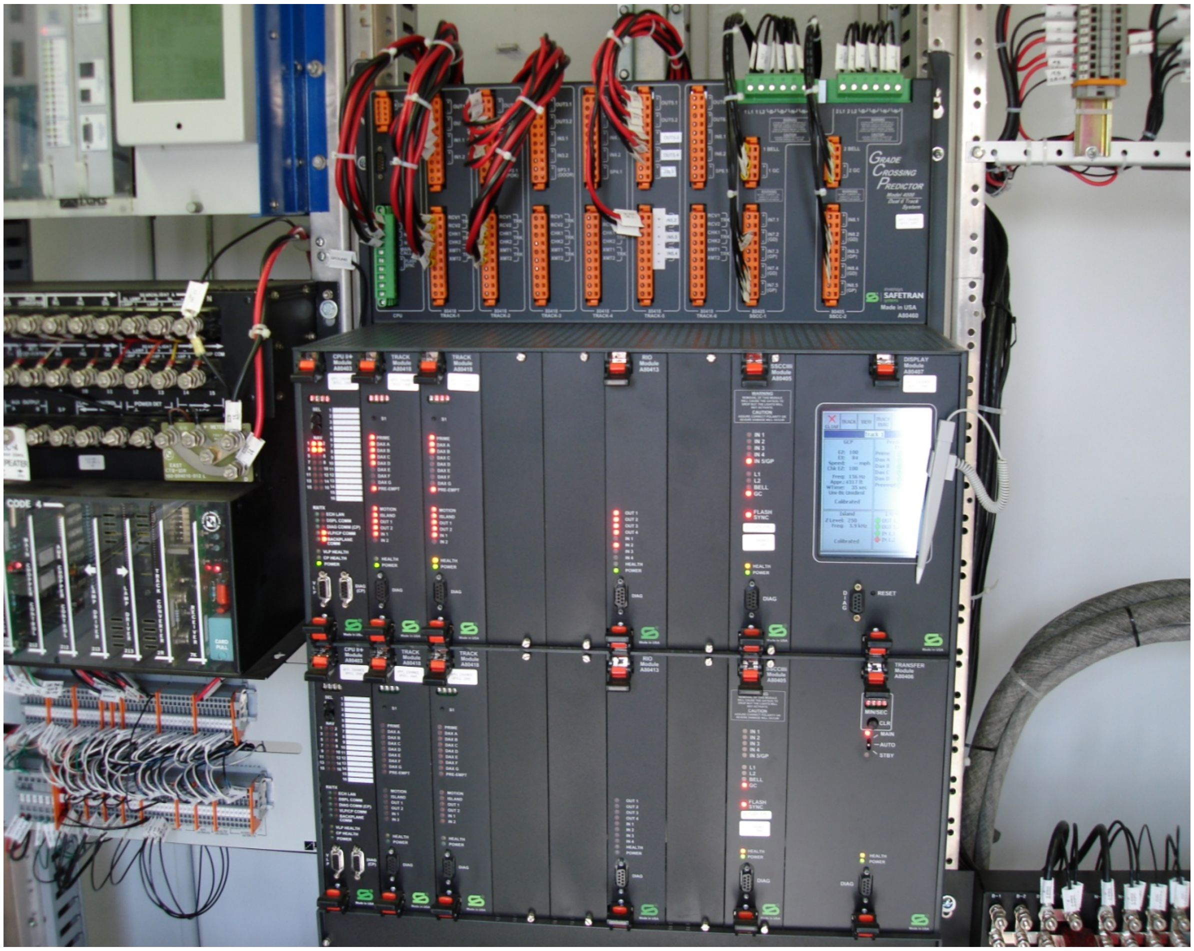
APPROACH LENGTH @ 30 MPH - 1320'

• Today, microprocessors have revolutionized all facets of railroad signaling.

• Items we now take for granted such as personal computers, keyboards and displays ease user interface with increasingly complex equipment.



GE Model HXP3R Constant Warning Time System



Safetran Model 4000 Grade Crossing Predictor

INTERCONNECTED TRAFFIC CONTROL SIGNALS

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PART 8
Traffic Controls for Highway-Rail Grade Crossings

Section 8D.07 Traffic Control Signals at or Near Highway-Rail Grade Crossings

Guidance:

The highway agency with jurisdiction, the regulatory agency with statutory authority, if applicable and the railroad company should jointly determine the preemption operation at highway-rail grade crossings adjacent to signalized highway intersections.

When a highway-rail grade crossing is equipped with a flashing-light signal system and is located within 60m (200 ft) of an intersection or mid-block location controlled by a traffic control signal, the traffic control signal should be provided with preemption in accordance with Section 4D.13.

Coordination with the flashing-light signal system should be considered for traffic control signals located farther than 60m (200 ft) from the highway-rail grade crossing. Factors to be considered should include traffic volumes, vehicle mix, vehicle and train approach speeds, frequency of trains and queue lengths.

Standard:

If preemption is provided, the normal sequence of traffic control signal indications shall be preempted upon the approach of trains to avoid entrapment of vehicles on the highway-rail grade crossing by conflicting aspects of the traffic control signals and the highway-rail grade crossing flashing-light signals.

This preemption feature shall have an electrical circuit of the closed-circuit principle, or a supervised communication circuit between the control circuits of the highway-rail grade crossing warning system and the traffic control signal controller. The traffic control signal controller preemptor shall be activated via the supervised communication circuit or the electrical circuit that is normally energized by the control circuits of the highway-rail grade crossing warning system. The approach of a train to a highway-rail grade crossing shall de-energize the electrical circuit or activate the supervised communication circuit, which in turn shall activate the traffic control signal controller preemptor. This shall establish and maintain the preemption condition during the time the highway-rail grade crossing warning system is activated, except that when crossing gates exist, the preemption condition shall be maintained until the crossing gates are energized to start their upward movement. When multiple or successive preemptions occur, train activation shall receive first priority.

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DEFINITIONS

Section 8A.01

Standard:

1. **Advance Preemption—the notification of an approaching train that is forwarded to the highway traffic signal controller unit or assembly by the railroad equipment in advance of the activation of the railroad warning devices.**

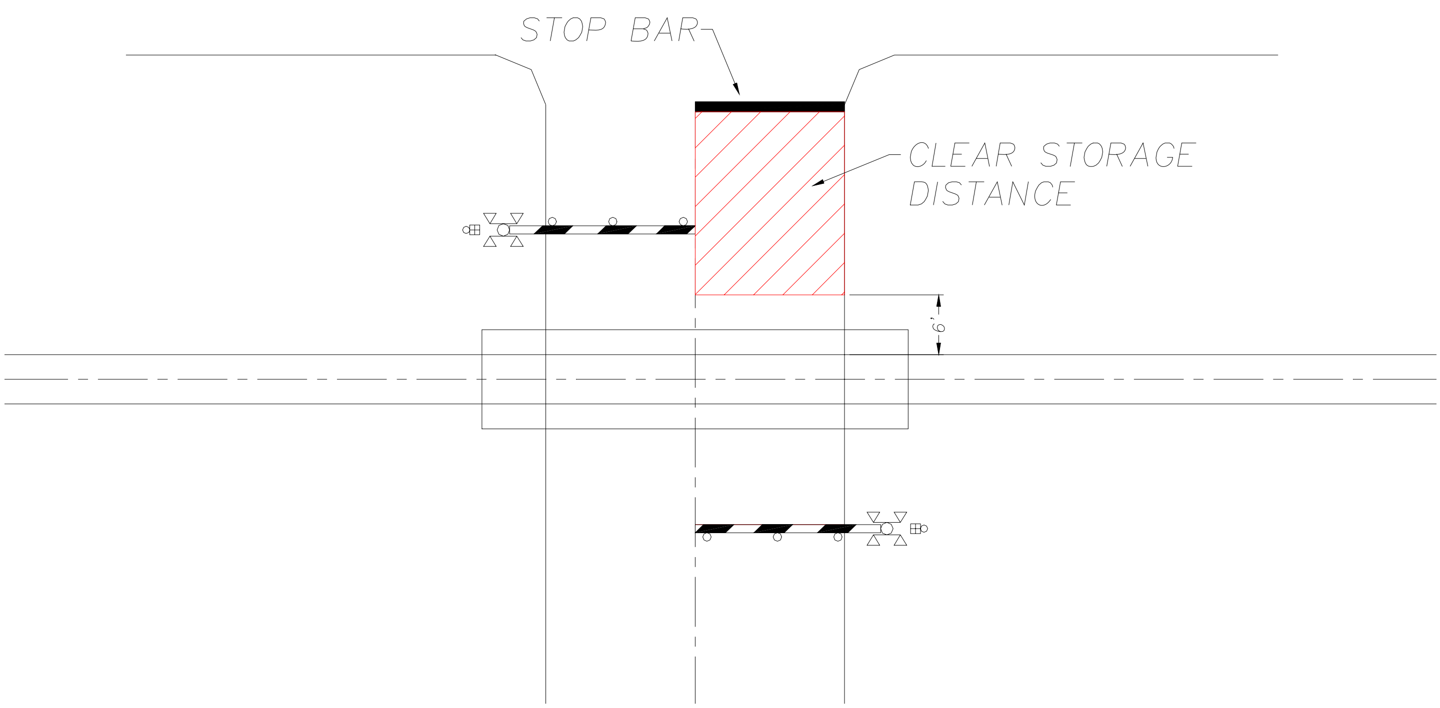
2. **Advance Preemption Time—the period of time that is the difference between the required maximum highway traffic signal preemption time and the activation of the railroad warning devices.**

3. **Cantilevered Signal Structure—a structure that is rigidly attached to a vertical pole and is used to provide overhead support of signal units.**

4. **Clear Storage Distance—the distance available for vehicle storage measured between 1.8 m (6 ft) from the rail nearest the intersection to the intersection stop line or the normal stopping point on the highway. At skewed highway-rail grade crossings and intersections, the 1.8 m (6 ft) distance shall be measured perpendicular to the nearest rail either along the centerline or edge line of the highway, as appropriate, to obtain the shorter distance. Where exit gates are used, the distance available for vehicle storage is measured from the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the centerline or edge line of the highway, as appropriate, to obtain the shorter distance.**

CLEAR STORAGE DISTANCE
(two-quadrant gate system)

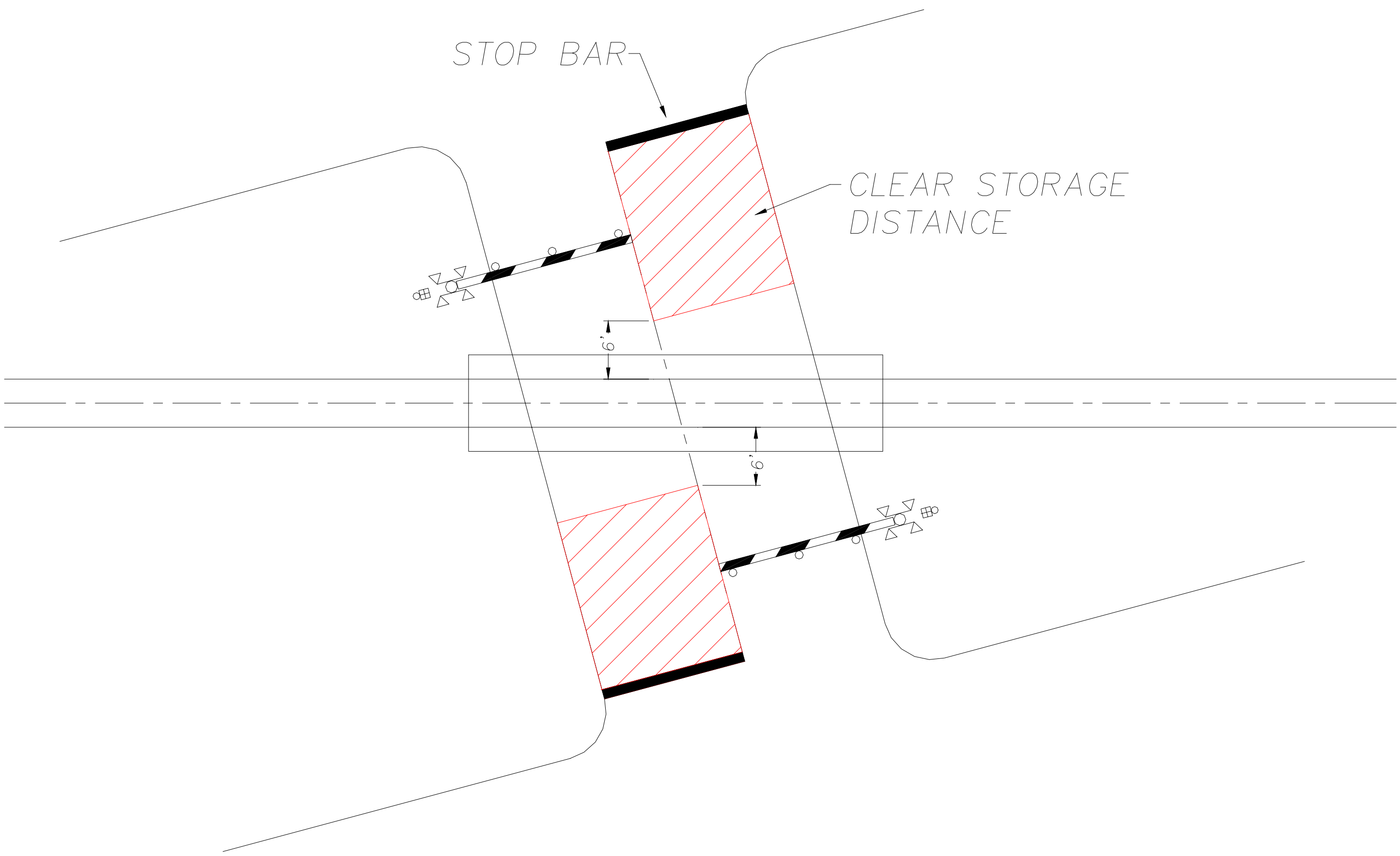
Clear Storage Distance at 90 Degree Crossing



Clear Storage Distance shown in Red

CLEAR STORAGE DISTANCE
(two-quadrant gate system)

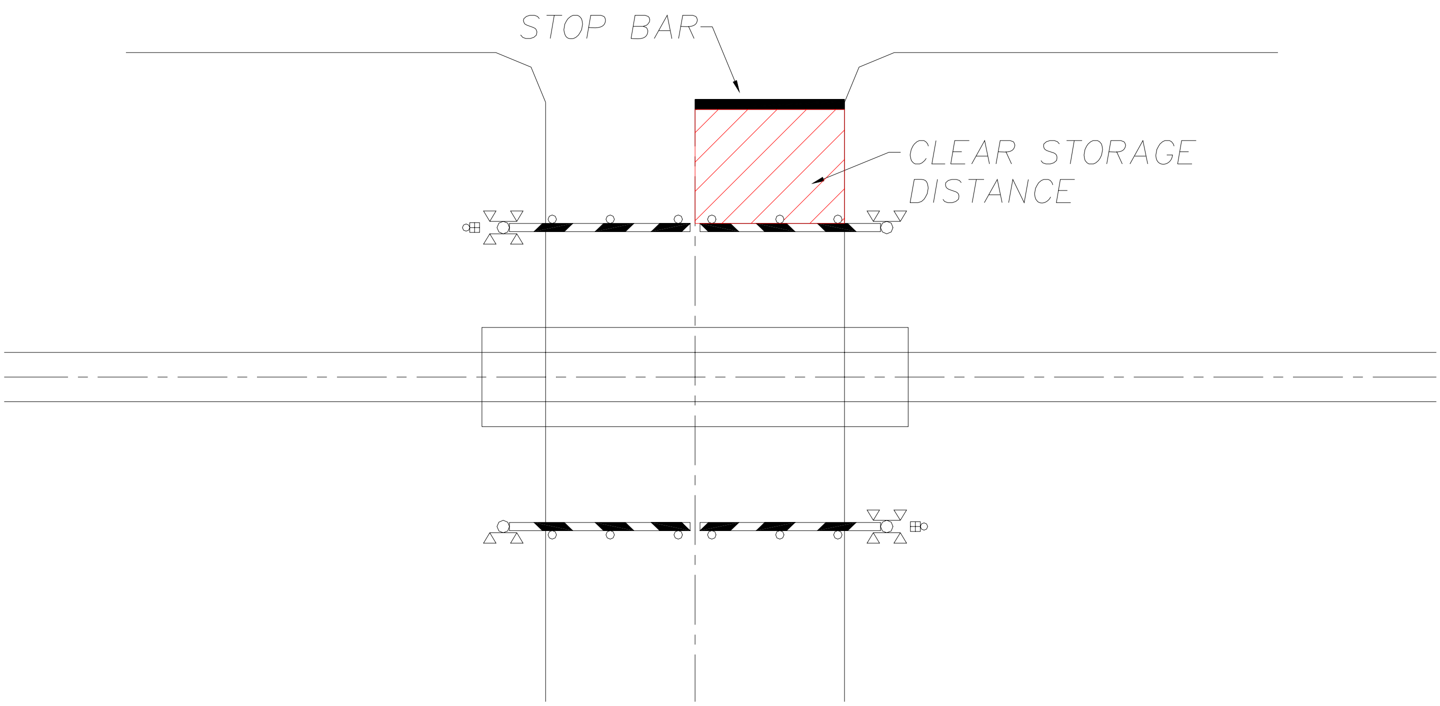
Clear Storage Distance at Skewed Crossing



Clear Storage
Distance
shown in Red

CLEAR STORAGE DISTANCE
(four-quadrant gate system)

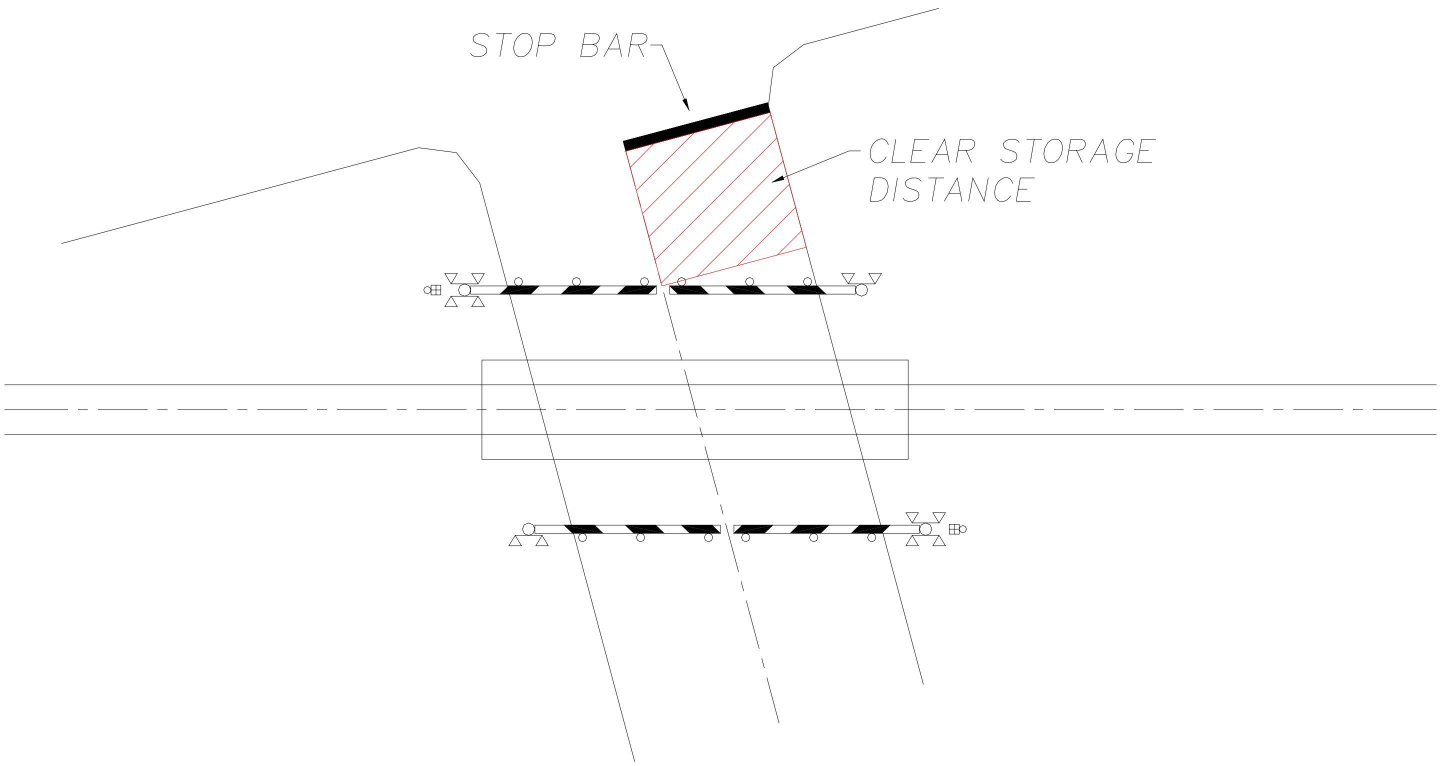
Clear Storage Distance at 90 Degree Crossing



Clear Storage Distance shown in Red

CLEAR STORAGE DISTANCE
(four-quadrant gate system)

Clear Storage Distance at Skewed Crossing



Clear Storage
Distance
shown in Red

5. **Design Vehicle—the longest vehicle permitted by statute of the road authority (State or other) on that roadway.**

6. **Dynamic Envelope—the clearance required for the train and its cargo overhang due to any combination of loading, lateral motion, or suspension failure (see Figure 8A-1).**

7. **Dynamic Exit Gate Operating Mode—a mode of operation where the exit gate operation is based on the presence of vehicles within the minimum track clearance distance.**

8. **Exit Gate Clearance Time—for Four-Quadrant Gate systems, the exit gate clearance time is the amount of time provided to delay the descent of the exit gate arm(s) after entrance gate arm(s) begin to descend.**

9. **Exit Gate Operating Mode—for Four-Quadrant Gate systems, the mode of control used to govern the operation of the exit gate arms.**

10. **Flashing-Light Signals—a warning device consisting of two red signal indications arranged horizontally that are activated to flash alternately when a train is approaching or present at a highway-rail grade crossing.**

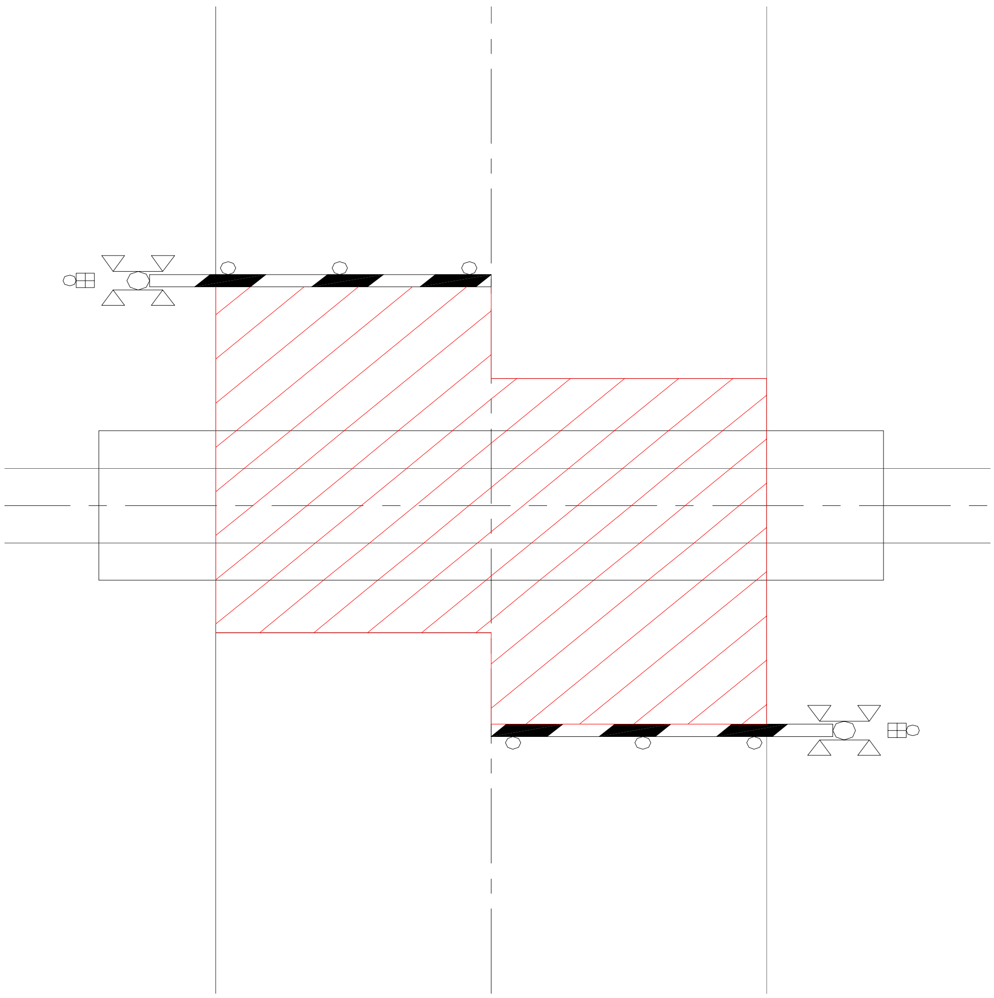
11. **Interconnection—the electrical connection between the railroad active warning system and the highway traffic signal controller assembly for the purpose of preemption.**

12. **Maximum Highway Traffic Signal Preemption Time—the maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the right-of-way transfer time, queue clearance time, and separation time.**

13. Minimum Track Clearance Distance—for standard two-quadrant railroad warning devices, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the highway stop line, warning device, or 3.7 m (12 ft) perpendicular to the track centerline, to 1.8 m (6 ft) beyond the track(s) measured perpendicular to the far rail, along the centerline or edge line of the highway, as appropriate, to obtain the longer distance. For Four- Quadrant Gate systems, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the highway stop line or entrance warning device, to the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the centerline or edge of the highway, as appropriate, to obtain the longer distance.

MTCD (two-quadrant gate system)

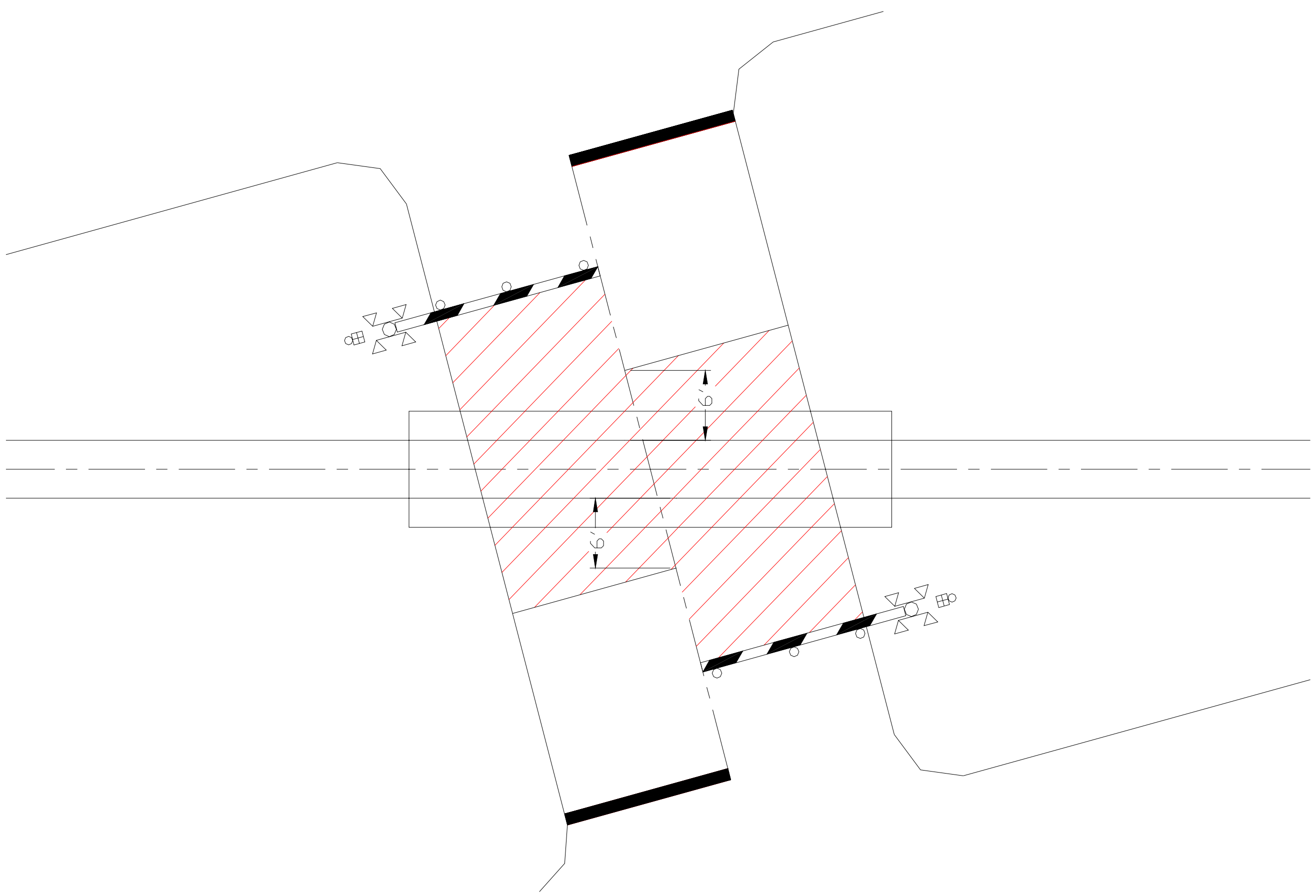
Minimum Track Clearance Distance for two-quadrant gate system



MTCD shown in Red

MTCD (two-quadrant gate system)

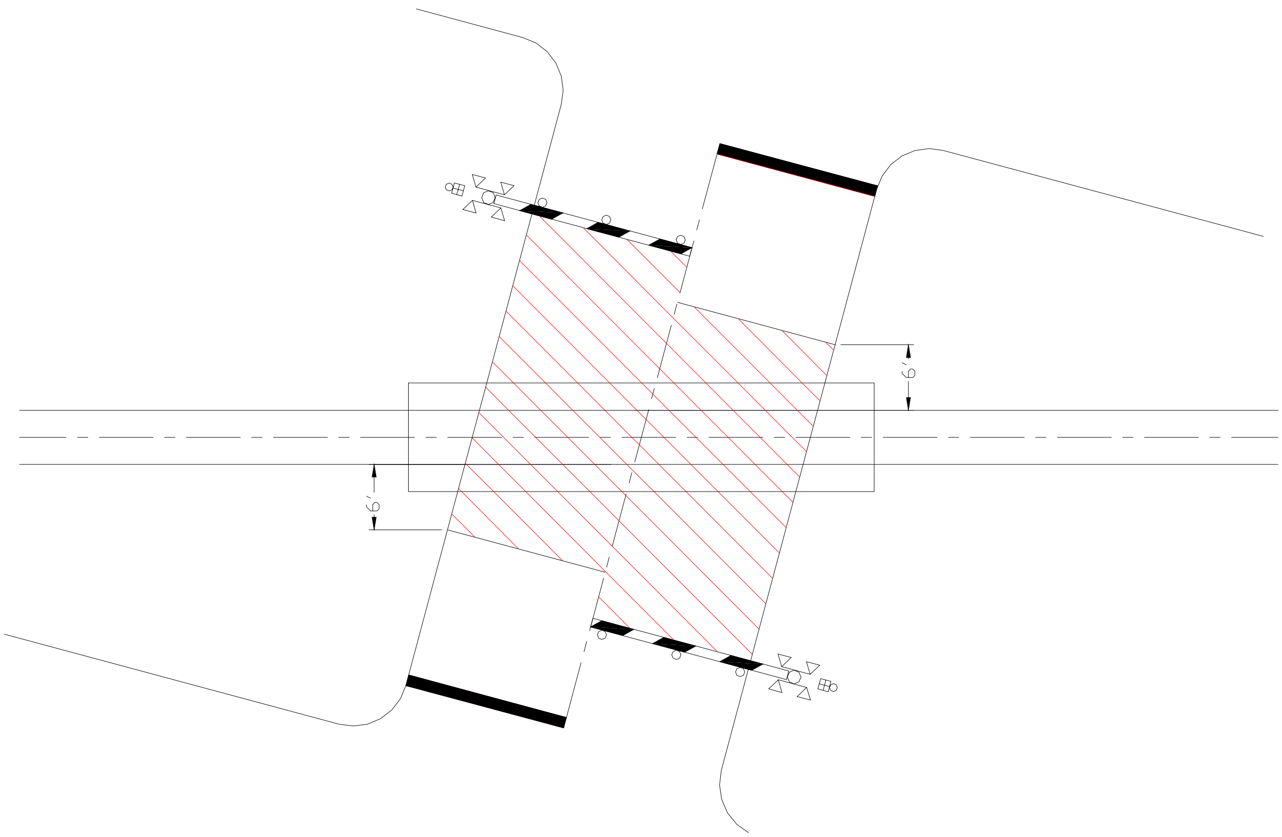
Minimum Track Clearance Distance for two-quadrant gate system



MTCD shown in Red

MTCD (two-quadrant gate system)

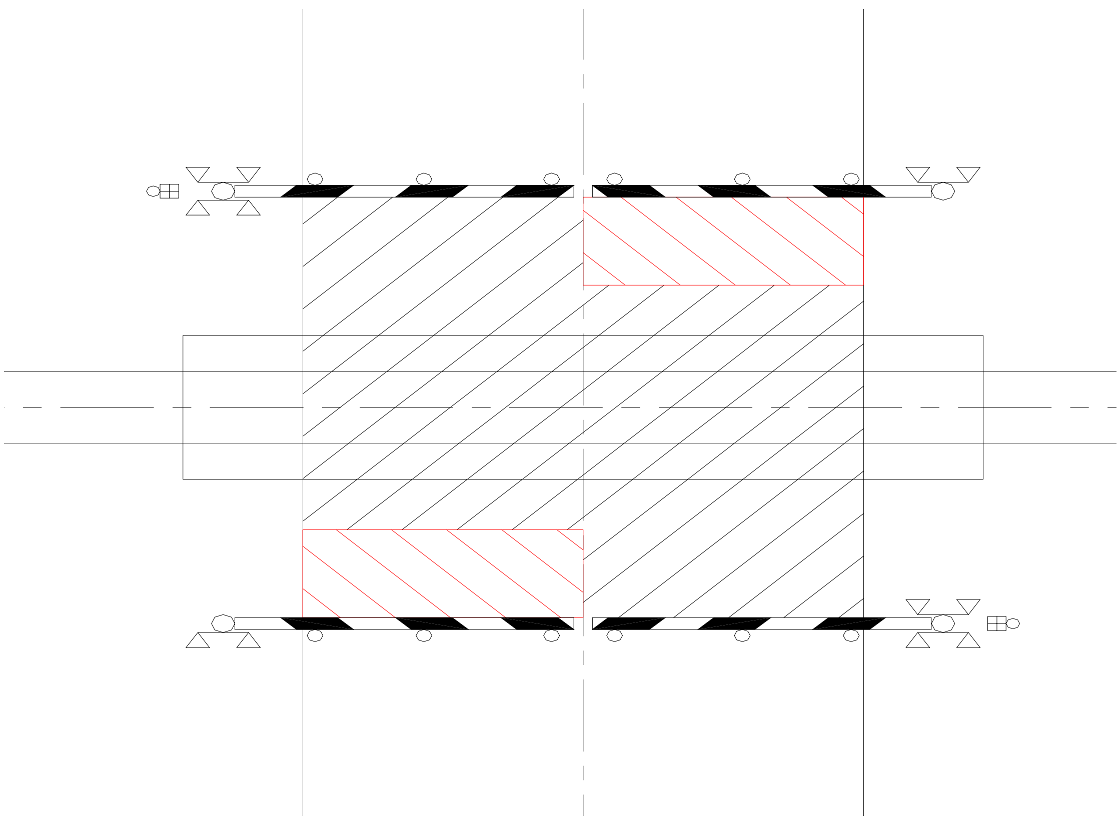
Minimum Track Clearance Distance for two-quadrant gate system



MTCD shown in Red

MTCD (four-quadrant gate system)

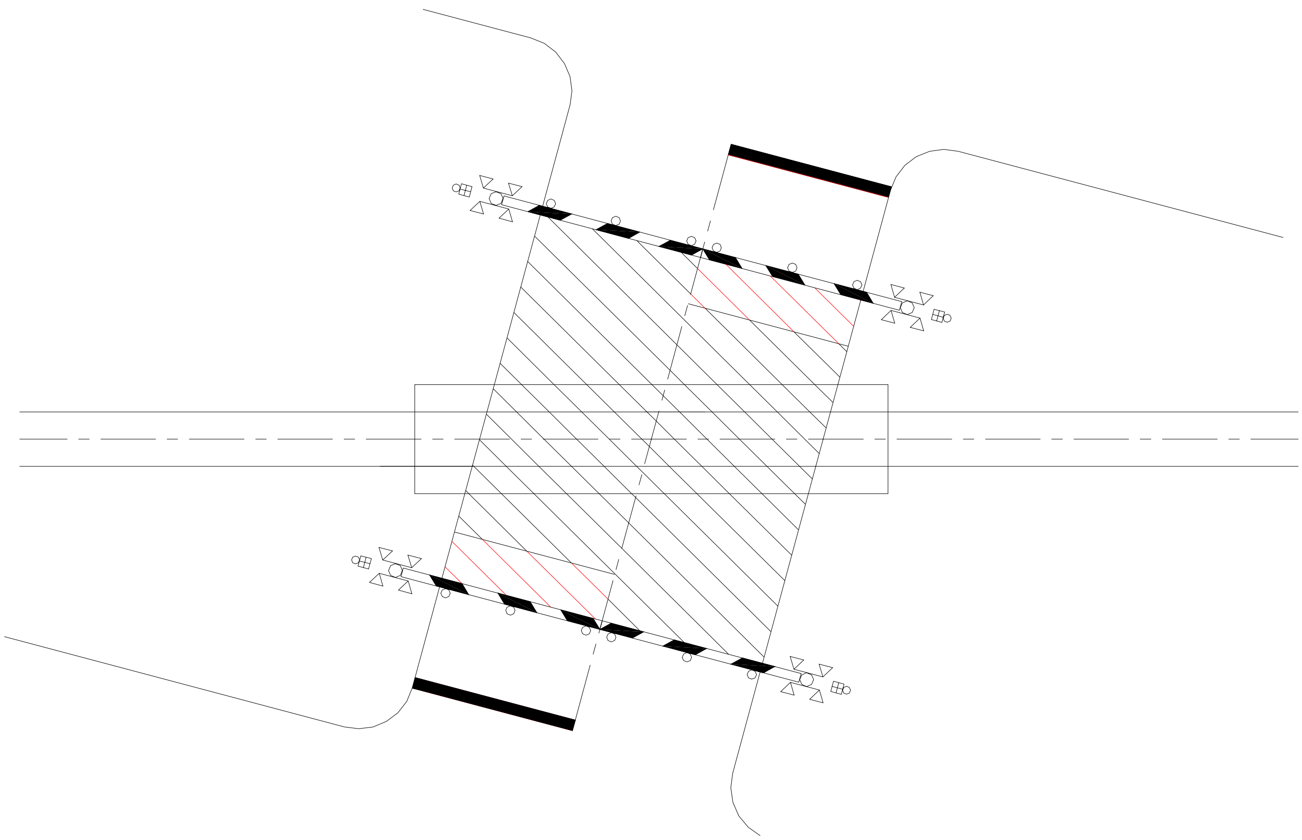
Minimum Track Clearance Distance for four-quadrant gate system



Additional MTCD shown in Red

MTCD (four-quadrant gate system)

Minimum Track Clearance Distance for four-quadrant gate system



Additional MTCD shown in Red

14. Minimum Warning Time—Through Train Movements—the least amount of time active warning devices shall operate prior to the arrival of a train at a highway-rail grade crossing.

15. Preemption—the transfer of normal operation of highway traffic signals to a special control mode.

16. Pre-signal—supplemental highway traffic signal faces operated as part of the highway intersection traffic signals, located in a position that controls traffic approaching the highway-rail grade crossing in advance of the intersection.

17. Queue Clearance Time—the time required for the design vehicle of maximum length stopped just inside the minimum track clearance distance to start up and move through and clear the entire minimum track clearance distance. If presignals are present, this time shall be long enough to allow the vehicle to move through the intersection, or to clear the tracks if there is sufficient clear storage distance. If a Four-Quadrant Gate system is present, this time shall be long enough to permit the exit gate arm to lower after the design vehicle is clear of the minimum track clearance distance.

18. Right-of-Way Transfer Time—the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval. This includes any railroad or highway traffic signal control equipment time to react to a preemption call, and any traffic control signal green, pedestrian walk and clearance, yellow change, and red clearance intervals for conflicting traffic.

19. Separation Time—the component of maximum highway traffic signal preemption time during which the minimum track clearance distance is clear of vehicular traffic prior to the arrival of the train.

20. Simultaneous Preemption—notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly and railroad active warning devices at the same time.

21. Timed Exit Gate Operating Mode—a mode of operation where the exit gate descent is based on a predetermined time interval.

22. Vehicle Intrusion Detection Devices—a detector or detectors used as a part of a system incorporating processing logic to detect the presence of vehicles within the minimum track clearance distance and to control the operation of the exit gates.

23. Wayside Equipment—the signals, switches, and/or control devices for railroad operations housed within one or more enclosures located along the railroad right-of-way and/or on railroad property.

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PART 4
Highway Traffic Signals

Section 4D.02 Responsibility for Operation and Maintenance

Guidance:

Prior to installing any traffic control signal, the responsibility for the maintenance of the signal and all of the appurtenances, hardware, software and the timing plan(s) should be clearly established. The responsible agency should provide for the maintenance of the traffic control signal and all of its appurtenances in a competent manner.

To this end the agency should:

A. Keep every controller assembly in effective operation in accordance with its predetermined timing schedule; check the operation of the controller assembly frequently enough to ensure that it is operating in accordance with the predetermined timing schedule and ensure that a record of all timing changes is maintained and that only authorized persons make timing changes.

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PART 4
Highway Traffic Signals

Section 4D.13 Preemption and Priority Control of Traffic Control Signals

Standard:

During the transition into preemption control:

A. The yellow change interval, and any red clearance interval that follows, shall not be shortened or omitted.

B. The shortening or omission of any pedestrian walk interval and/or pedestrian change interval shall be permitted.

C. The return to the previous steady green signal indication shall be permitted following a steady yellow signal indication in the same signal face, omitting the red clearance interval, if any.

During preemption control and during the transition out of preemption control:

A. The shortening or omission of any yellow change interval, and of any red clearance interval that follows, shall not be permitted.

B. A signal indication sequence from a steady yellow signal indication to a steady green signal indication shall not be permitted.

Guidance:

If a traffic control signal is installed near or within a highway-railroad grade crossing or if a highway-railroad grade crossing with active traffic control devices is within or near a signalized highway intersection, Chapter 8D should be consulted.

Section 4E.07 Countdown Pedestrian Signals

Standard:
If used, countdown pedestrian signals shall consist of Portland orange numbers that are at least 150 mm (6 in) in height on a black opaque background. The countdown pedestrian signal shall be located immediately adjacent to the associated UPRAISED HAND (symbolizing DONT WALK) pedestrian signal head indication. If used, the display of the number of remaining seconds shall begin only at the beginning of the pedestrian change interval. After the countdown displays zero, the display shall remain dark until the beginning of the next countdown. If used, the countdown pedestrian signal shall display the number of seconds remaining until the termination of the pedestrian change interval. Countdown displays shall not be used during the walk interval nor during the yellow change interval of a concurrent vehicular phase.

Guidance:
Because some technology includes the countdown pedestrian signal logic in a separate timing device that is independent of the timing in the traffic signal controller, care should be exercised by the engineer when timing changes are made to pedestrian change intervals.

If the pedestrian change interval is interrupted or shortened as a part of a transition into a preemption sequence (see Section 4E.10), the countdown pedestrian signal display should be discontinued and go dark immediately upon activation of the preemption transition.

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PART 4
Highway Traffic Signals

Section 4E.10 Pedestrian Intervals and Signal Phases

Standard:

When pedestrian signal heads are used, a WALKING PERSON (symbolizing WALK) signal indication shall be displayed only when pedestrians are permitted to leave the curb or shoulder.

A pedestrian clearance time shall begin immediately following the WALKING PERSON (symbolizing WALK) signal indication. The first portion of the pedestrian clearance time shall consist of a pedestrian change interval during which a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed. The remaining portions shall consist of the yellow change interval and any red clearance interval (prior to a conflicting green being displayed), during which a flashing or steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed.

If countdown pedestrian signals are used, a steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed during the yellow change interval and any red clearance interval (prior to a conflicting green being displayed) (see Section 4E.07).

At intersections equipped with pedestrian signal heads, the pedestrian signal indications shall be displayed except when the vehicular traffic control signal is being operated in the flashing mode. At those times, the pedestrian signal lenses shall not be illuminated.

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PART 4
Highway Traffic Signals

Section 4E.10 Pedestrian Intervals and Signal Phases

Guidance:

Except as noted in the Option, the walk interval should be at least 7 seconds in length so that pedestrians will have adequate opportunity to leave the curb or shoulder before the pedestrian clearance time begins.

Option:

If pedestrian volumes and characteristics do not require a 7-second walk interval, walk intervals as short as 4 seconds may be used.

Recommended Functional/Operating Guidelines for Interconnection Between Highway Traffic Signals and Highway-Rail Grade Crossing Warning Systems

Revised 2008 (9 Pages)

A. Purpose

This Manual Part recommends functional/operating guideline for an interconnection to provide notification to a highway traffic signal controller or other traffic control device from a highway-rail grade crossing warning system. See Manual Part 1.4.1 (Identical Items "Boilerplate" for all Manual Parts), Section A.

B. Warning Devices

1. For highway-rail grade crossing warning devices, see Manual Part 3.1.1 (Recommended Functional/Operating Guidelines for Highway-Rail Grade Crossing Warning Devices).

2. Control of highway-rail grade crossing warning devices shall conform to Manual Part 3.1.15 (Recommended Functional/Operating Guidelines for Control of Automatic Highway-Rail Grade Crossing Warning Systems).

C. Definitions

1. Advance Preemption and Advance Preemption Time – Notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly by railroad equipment for a period of time prior to activating the railroad active warning devices. This period of time is the difference in the Maximum Preemption Time required for highway traffic signal operation and the Minimum Warning Time needed for railroad operation and is called the Advance Preemption Time.

2. Cantilevered Signal Structure – A cantilevered signal structure is a structure that is rigidly attached to a vertical pole and is used to provide overhead support of signal units.

3. Clear Storage Distance – The distance available for vehicle storage measured between 6 ft. from the rail nearest the intersection to the intersection STOP BAR or the normal stopping point on the highway. At skewed crossings and intersections, the 6 ft. distance shall be measured perpendicular to the nearest rail either along the centerline, or edge line of the highway as appropriate to obtain the shorter clear distance. Where exit gates are utilized, the distance available for vehicle storage is measured from the point clear of the exit gate. Note that in cases where the exit gate arm is parallel to the track(s) and/or not perpendicular to the roadway,

clearance will be either along the centerline or edge line of the highway, as appropriate, to obtain the shorter clear distance.

4. Design Vehicle – The longest vehicle permitted by statute of the road authority (State or other) on that roadway.

5 Interconnection – The electrical connection between the railroad active warning system and the traffic signal controller assembly for the purpose of preemption.

6. Maximum Preemption Time – The maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the Right-of-Way Transfer Time, Queue Clearance Time and Separation Time.

7. Minimum Track Clearance Distance (MTCD) – For standard two-quadrant railroad warning devices, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the railroad stop line, warning device or 12 ft. perpendicular to the track centerline to 6 ft. beyond the track(s) measured perpendicular to the far rail, along the centerline or edge line of the highway, as appropriate, to obtain the longer distance. For four quadrant railroad warning devices, the minimum track clearance distance is the length along a highway at one or more railroad tracks, measured either from the railroad stop line or entrance warning device to the point clear of the exit gate. Note that in cases where the exit gate arm is parallel to the track(s) and/or not perpendicular to the roadway, clearance will be either along the centerline or edge line of the highway, as appropriate, to obtain the longer distance.

8 Minimum Warning Time – Through Train Movements – The least amount of time active warning devices shall operate prior to the arrival of a train at a highway-rail grade crossing in accordance with the Manual on Uniform Traffic Control Devices (FHWA).

9. Monitored Interconnected Operation – An interconnected operation that has the capability to be monitored by the railroad and/or highway authority at a location away from the highway-rail grade crossing.

10. Preemption – The transfer of normal operation of traffic signals to a special control mode.

11. Pre-Signal – Supplemental highway traffic signal faces operated as part of the highway intersection traffic signals, located in a position that controls traffic approaching the railroad crossing and intersection.

12. Queue Clearance Time – The time required for the design vehicle stopped within the minimum track clearance distance to start up and move through the minimum track clearance distance. If pre-signals are present, this time
1 should be long enough to allow the vehicles to move through the intersection, or clear the tracks if there is sufficient clear storage distance. Note that queue clearance time must include time for a design vehicle of maximum length just inside of MTCD to start up and clear the entire MTCD. At locations utilizing four quadrant gates, queue clearance time must be of adequate duration to permit exit gates to lower after the design vehicle is clear of MTCD.

13. Right-of-Way Transfer Time – The maximum amount of time needed for the worst-case condition, prior to display of the clear track green interval. This includes any railroad or traffic signal control equipment time to react to a preemption call, and any traffic signal green, pedestrian walk and clearance, yellow change and red clearance intervals for opposing traffic.

14. Separation Time – The component of maximum preemption time during which the minimum track clearance distance is clear of vehicular traffic prior to the arrival of the train.

15. Simultaneous Preemption – Notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly and railroad active warning devices at the same time.

16. Track Clearance Green Interval – The portion of the traffic signal sequence when the right of way transfer time has completed and green signal indications are displayed to roadway users in order to clear the minimum track clearance distance.

D. <u>General</u>

1. When a highway intersection controlled by traffic signals is located at or near a highway-rail grade crossing and vehicle queues build inside of the MTCD, interconnection and preemption of the normal operating sequence of the traffic signal controller should be provided. The traffic signal controller's normal operating sequence should be preempted to provide proper signal information to roadway users to clear the MTCD of vehicles before the train occupies the crossing. Refer to Manual on Uniform Traffic Control Devices (MUTCD) Section 8D.07 for additional information.

2. The highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if applicable, jointly determine the need and selection of devices at a highway-rail grade crossing. This includes the need for preemption, type of preemption, time interval for any advance preemption, exit gate clearance time and exit gate operating mode (see

Manual Part 3.1.15). Refer to MUTCD Section 8A.01 and 8D.07 for additional information. As a part of any preemption needs study, a thorough evaluation should be conducted of all site specific parameters including traffic signal operating sequences and timing, railroad warning devices, warning times and impact of train operations on warning times. Refer to Manual Part 3.1.12 (Example Instructions for Determining Highway Traffic Signal Preemption Time for Interconnected Highway-Rail Grade Crossing Warning Systems).

3. At locations where a highway intersection not controlled by traffic signals is located at or near a highway-rail grade crossing with or without active warning devices and vehicle queues build inside of the MTCD, installation of a highway traffic signal and/or railroad active warning devices should be considered. Interconnection and preemption of the traffic signal controller should then be considered if it falls within the requirements of MUTCD. Refer to MUTCD Section 8D.07 for additional information.

E. <u>Operation</u>

1. The interconnection shall conform to Manual Part 16.30.10 (Recommended Vital Circuit Design Guidelines for Highway Traffic Signal Interconnection). Where gates are utilized, enhanced interconnection circuitry and traffic signal preemption programming (internal or external to the traffic signal controller unit) should be considered to prevent the traffic signal from leaving the clear track green interval until the appropriate gate arm(s) is/are fully lowered. A warning label shall be affixed within the railroad equipment housing indicating the presence of the interconnection and providing contact information for the agency responsible for the operation and maintenance of the traffic signal. (Refer to Figure 3110-1)

2. The determination to implement simultaneous or advance preemption should be closely evaluated by the highway agency or authority with jurisdiction and the regulatory agency with statutory authority, if applicable. It is necessary to calculate the right-of-way transfer time, queue clearance time (based on the proper design vehicle and grade of the roadway) and the separation time in order to determine the Maximum Preemption Time. Note that these intervals and the resulting time are required regardless of whether simultaneous or advance preemption operation is implemented as they are based on traffic signal minimum timing, vehicle acceleration and physical distances along the roadway.

   In many cases, the amount of time required will necessitate the installation of additional circuitry by the railroad and may result in increased complexity. Therefore, it is recommended that the highway authority review all timing requirements with the railroad in order to provide the required functionality in an effective manner.

3. Where advance preemption is utilized, a thorough analysis of preemption operation and sequencing should be conducted throughout the range of anticipated railroad warning times and traffic signal right-of-way transfer times. The preemption operation must be designed to accommodate the wide variability that may be encountered. This is to prevent the traffic signal from leaving the track clearance green interval prior to the lowering of the gates. Typically, this can occur when the traffic signal controller unit enters the track clearance green interval with very little or no right-of-way transfer time and/or the approaching train is decelerating. Refer to Manual Part 16.30.10 (Recommended Vital Circuit design for Highway Traffic Signal Interconnections). The following are two examples of mutually exclusive methods which may be implemented to address and resolve variability:

    a. Gate Down – Gate down circuitry is utilized to provide a means to hold the downstream traffic signal controller unit in the track clearance green interval until the gate(s) controlling access over the highway-rail grade crossing approaching the signalized intersection is/are down. This does not affect Pre-Signals or traffic signals governing traffic on to the crossing. Any additional track clearance green time necessary would complete its timing following the receipt of the gate down confirmation signal. Island circuit occupancy shall release the track clearance green interval in the event a gate is broken or is not fully lowered.

    b. Timing Correction – Timing correction is utilized to resolve Right of Way Transfer Time (RWTT) variability by adding the RWTT time to the track clearance green interval in the traffic signal controller unit. In addition, a timing circuit should be employed to maintain a maximum time interval between the initiation of advance preemption and operation of the warning system for a train move where speed is decreasing (it should be noted however, that this time interval would decrease in the event train speed is increasing).

   Use of gate down typically results in more consistent warning system operating times where timing correction starts the warning system operation early in order to maintain the specified advance preemption time interval. Each of these methods utilizes different means to overcome variability and may not be suited for a specific application. It is important to note that timing correction may create the appearance of false activations and/or extended warning time where station stops and/or switching movements occur within the approach to the highway-rail grade crossing and should be closely studied to determine suitability in rail operations. Each method should be closely evaluated to determine the impact on the operation of the warning system and highway traffic signal.

4. When a highway intersection controlled by traffic signals is interconnected with a highway-rail grade crossing equipped with four quadrant gates, advance preemption should be considered since additional operating time is required for the exit gates (EGCT - exit gate clearance time). In the majority of cases, EGCT and Maximum Preemption Time run concurrently as a function of queue clearance time. It is critical to assure that adequate time is provided for right-of-way transfer time, queue clearance time, separation time and exit gate clearance time. See Manual Part 3.3.10 (Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Highway-Rail Grade Crossing Warning Systems) to determine exit gate operating times.

5. An engineering study as referenced in MUTCD Section 8D.05 should be conducted to establish the type of exit gate control circuitry employed. The study should consider the need for vehicle intrusion detection devices to assure exit gates are not lowered until vehicles are clear of the MTCD under all modes of traffic signal operation including flashing operation of highway traffic signals. See Manual Part 3.1.15 (Recommended Functional/Operating Guidelines for Control of Automatic Highway-Rail Grade Crossing Warning Systems) to determine exit gate operating modes and Manual Part 3.3.10 (Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Highway-Rail Grade Crossing Warning Systems) to determine exit gate operating times.

6. Advance or simultaneous preemption should be provided by a constant warning time control device. On approaches where restarts occur from trains stopping or switching, preemption requirements should be reviewed, as restarts could result in reduced or no advance time. If constant warning time devices are not suited for a given application such as electrified territory or approaches where shunting is erratic due to accumulation of rust or foreign material, fixed or non-motion sensing track circuits may be necessary. In this case, provisions should be made to time out or cancel preemption in the event a train stops within the approach to an interconnected highway-rail grade crossing for an extended period of time in order to restore normal traffic signal operation. When preemption is canceled or timed out due to an extended stop, provision should be made to re-initiate preemption and reactivate the

warning devices upon resumption of train operations. The re-initiation circuit may utilize a pushbutton, radio restart, train to wayside communications, or other means as may be applicable. A combination of restart circuitry and railroad operating rules may be utilized to ensure that a time interval for both preemption and minimum warning time is provided, before the train reaches the highway crossing.

7. Where station stops occur within or just outside of approaches to highway-rail grade crossings interconnected with highway traffic signals, a diagnostic review of train operations must be conducted to analyze the effects of acceleration from the station on the required warning time, including any additional clearance time for simultaneous preemption or advance time for preemption as this time could be shortened by the acceleration of the departing train. This review should be conducted jointly by the highway authority, the railroad and operators of the passenger or commuter rail system (if different from the railroad responsible for design of the signal system). In many cases, a gate hold down circuit may be necessary if the station stop occurs in close proximity to the interconnected crossing. In other cases, where the distance from the station stop to the interconnected crossing is greater, it may be necessary to implement a remote start system which activates the preemption timing sequence prior to departure from the station.

8. Where an interlocking is located within or just outside of the approach to a highway-rail grade crossing interconnected with highway traffic signals, a thorough study of train operations must be conducted to analyze the effects of starting a stopped train on the required warning time, including any additional clearance time for simultaneous preemption or advance time for preemption as this time could be shortened by the motion of the starting train.

9. Where “Island Only” circuits are utilized at highway-rail grade crossings interconnected with highway traffic signals whenever advance preemption is provided, an additional circuit should be utilized to provide adequate time for advance preemption prior to the time the warning devices are activated. Special instructions or operating rules must be provided to train crews in order to advise of the proper operation of the warning devices

10. It should be noted that because of the failsafe design criteria of the highway-rail grade crossing warning control system, any failure would result in a continuous preemption of the traffic signal controller, without a train present, until the problem is diagnosed and equipment repaired.

11. After the train clears the highway-rail grade crossing, preemption shall be canceled at the time the entrance gates start to raise (crossing circuit

energizes) where two quadrant gates are utilized. Where four quadrant gates are utilized, preemption shall be canceled at the time the exit gates start to raise (crossing circuit energizes). This is necessary to permit the traffic signal controller unit to see an interruption in the preemption request in the event another train approaches the highway-rail grade crossing as the gates are raising

12. Where advance preemption is utilized at multiple track highway-rail grade crossings, second train logic shall be provided to prevent gates from rising when advance preemption is requested on another track (crossing circuit energizes, advance preemption circuit remains de-energized).

13. Evaluation of traffic control signal equipment should be made to assure the ability to return to the start of the preemption sequence or retime the entire track clearance green interval, as appropriate, in the event of a momentary loss of the preemption request, such as the arrival of a second train.

14. Where traffic signals are operated in a flashing mode during the preemption dwell interval (period following track clearance green), consideration should be given to providing an island circuit interconnection in addition to the other interconnection circuits. This will permit the authority responsible for the operation of the traffic signal to delay the entry into the flashing interval until after the train occupies the island circuit.

15. Where advance preemption is utilized, traffic signal health monitoring should be considered to lengthen the railroad warning time in the event the traffic signal is unable to display the track clearance green interval. The warning time may be increased up to the amount of advance preemption time provided, as determined by the diagnostic team.

16. Where highway-rail grade crossing warning systems are utilized and interconnected with other traffic control devices, backup power should be provided by the public agency. If backup power is furnished, it should be provided for all interconnected devices including traffic signals, advance warning flashers, blank-out signs or other devices.

Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Highway-Rail Grade Crossing Warning Systems

Revised 2002 (4 Pages)

A. Purpose

This Manual Part recommends instructions to determine the warning time and calculate the minimum approach distance for railroad activated warning devices at highway-rail grade crossings.

B. Operating Parameters

1. Minimum Warning Time (Through Train Movements):

The least amount of time active warning devices shall operate prior to the arrival of a train at a railroad-highway grade crossing.

2. Clearance Time (CT):

a) If the MTCD (minimum track clearance distance) exceeds 35 ft., clearance time is one second for each additional 10 ft., or portion thereof, over 35 ft.

b) Clearance Time may also be added by the public agency or railroad to account for site specific needs. Examples of additional Clearance Time include additional time for simultaneous preemption, additional gate delay time and/or adjacent track clearance time.

3. Entrance Gate Operation
When gates are used, each entrance gate arm shall start its downward motion not less than 3 seconds after flashing lights begin to operate and shall assume the horizontal position at least 5 seconds before the arrival of a normal train movement at the crossing.

4. Exit Gate Clearance Time (EGCT):

For four quadrant gate systems, the exit gate clearance time is the amount of time provided to delay the descent of the exit gate arm(s) after the entrance gate arm(s) begin to descend. This time is applied to both Timed and Dynamic Modes of exit gate operation. See Manual Part 3.1.15 (Recommended Functional/Operating Guidelines for Control of Automatic Highway-Rail Grade Crossing Warning Systems) for guidance. EGCT is determined by the public agency per MUTCD.

5. Exit Gate Operating Mode (EGOM):

Special consideration must be given to determination of EGOM. Factors such as downstream highway traffic signal(s) not interconnected with the railroad warning system, stop signs, driveways, roadway width transition, vertical and horizontal curves, sight obstructions and turning movements should be evaluated to determine if vehicle queues may extend into the MTCD. In the event highway traffic does not have a free-flowing exit from the crossing, strong consideration should be given to utilization of Dynamic EGOM. EGOM is determined by the public agency per MUTCD.

6. Buffer Time (BT):

Buffer time is discretionary and may be provided in addition to MT and CT to accommodate for minor variations in train handling.

7. Equipment Response Time (ERT):

Adjustments shall be made to provide for control circuit Equipment Response Time.

8. Advance Preemption Time (APT):

The time as specified by the Public Agency to provide advance notification of an approaching train prior to activation of the highway-rail grade crossing warning devices for preemption. Buffer Time (BT) should be considered to be zero when calculating APT. See Manual Part 3.1.10, Recommended Functional/Operating Guidelines for Interconnection Between Highway Traffic Signals and Highway-Rail Grade Crossing Warning

Systems, to provide additional guidance in determining Advance Preemption Time.

3. <u>Total Warning Time (TWT)</u>:

Is determined as follows:

Minimum Time	20	seconds
Plus the greater of CT or EGCT		seconds
Equals Minimum Warning Time		seconds
Plus BT		seconds
Equals Total Warning Time		seconds

10. <u>Total Approach Time (TAT)</u>:

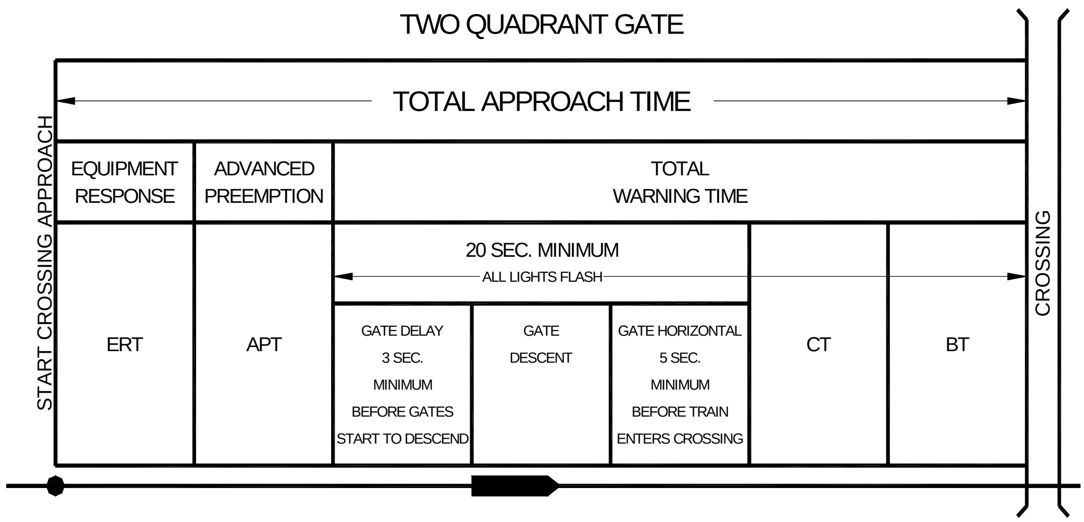
Is determined as follows:

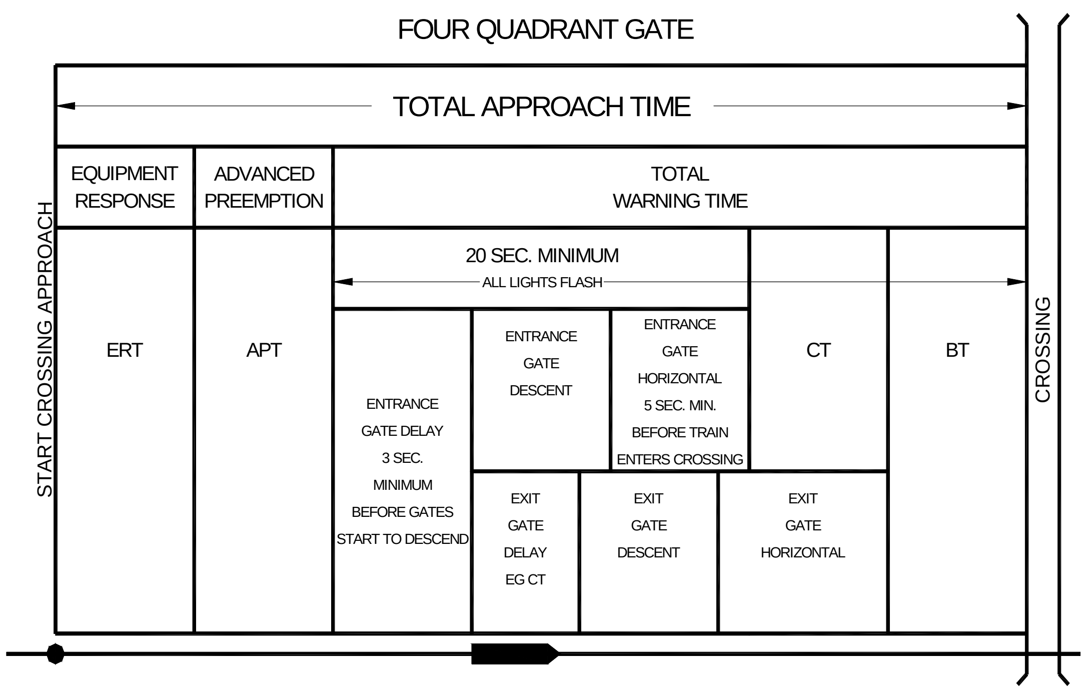
Total Warning Time		seconds
plus ERT		seconds
plus APT		seconds
Equals Total Approach Time		seconds

11. <u>Total Approach Distance (TAD)</u>:

Total Approach Distance in feet = Total Approach Time x 1.47 x Maximum Authorized Speed in MPH.

- 1.47 = Distance traveled in 1 second at 1 MPH
- Distance for each track involved to be calculated separately.


TWO QUADRANT GATE
TOTAL APPROACH TIME
START CROSSING APPROACH
EQUIPMENT RESPONSE
ADVANCED PREEMPTION
TOTAL WARNING TIME
20 SEC. MINIMUM
ALL LIGHTS FLASH
ERT
APT
GATE DELAY 3 SEC. MINIMUM BEFORE GATES START TO DESCEND
GATE DESCENT
GATE HORIZONTAL 5 SEC. MINIMUM BEFORE TRAIN ENTERS CROSSING
CT
BT
CROSSING


FOUR QUADRANT GATE
TOTAL APPROACH TIME
START CROSSING APPROACH
EQUIPMENT RESPONSE
ADVANCED PREEMPTION
TOTAL WARNING TIME
20 SEC. MINIMUM
ALL LIGHTS FLASH
ERT
APT
ENTRANCE GATE DELAY 3 SEC. MINIMUM BEFORE GATES START TO DESCEND
ENTRANCE GATE DESCENT
ENTRANCE GATE HORIZONTAL 5 SEC. MIN. BEFORE TRAIN ENTERS CROSSING
CT
BT
EXIT GATE DELAY EG CT
EXIT GATE DESCENT
EXIT GATE HORIZONTAL
CROSSING

Recommended Vital Circuit Design Guidelines For Highway Traffic Signal Interconnection

Revised 2004 (8 Pages) (16-30-10)

A. Purpose

These recommended vital circuit guidelines apply to highway traffic signal interconnection for the purpose of preemption, operation of train activated advance warning devices, operation of blank-out signs or other traffic control devices.

B. General

1. Highway traffic signal interconnection may be required as specified in Manual Part 3.1.10, (Recommended Functional/Operating Guidelines for Interconnection of Highway Traffic Signals with Highway-Rail Grade Crossing Warning Systems).

2. The type of preemption, interconnection options and any additional time required for preemption shall be specified by the public agency having jurisdictional authority as referenced in MUTCD Parts 8 and 10 and Manual Part 3.3.10, (Recommended Instructions for Determining Warning Time and Calculating Minimum Approach Distance for Highway-Rail Grade Crossing Warning Systems). Examples of interconnection options include supervisory and/or gate down circuits.

3. Examples of circuits for interconnection are shown in Part C. The systems will operate in the same manner for trains entering from either direction.

4. The Interconnection between the traffic control signal and the railroad warning system shall be a double break relay circuit or serial data circuit in accordance with IEEE Standard 1570-2002.

5. When using advance preemption in conjunction with conventional track circuits, additional track circuits are required beyond the normal crossing warning device control circuits. The length of additional track circuits depends on the advance preemption time required for the highway traffic control signal. When using simultaneous preemption, approach track circuits may need to be

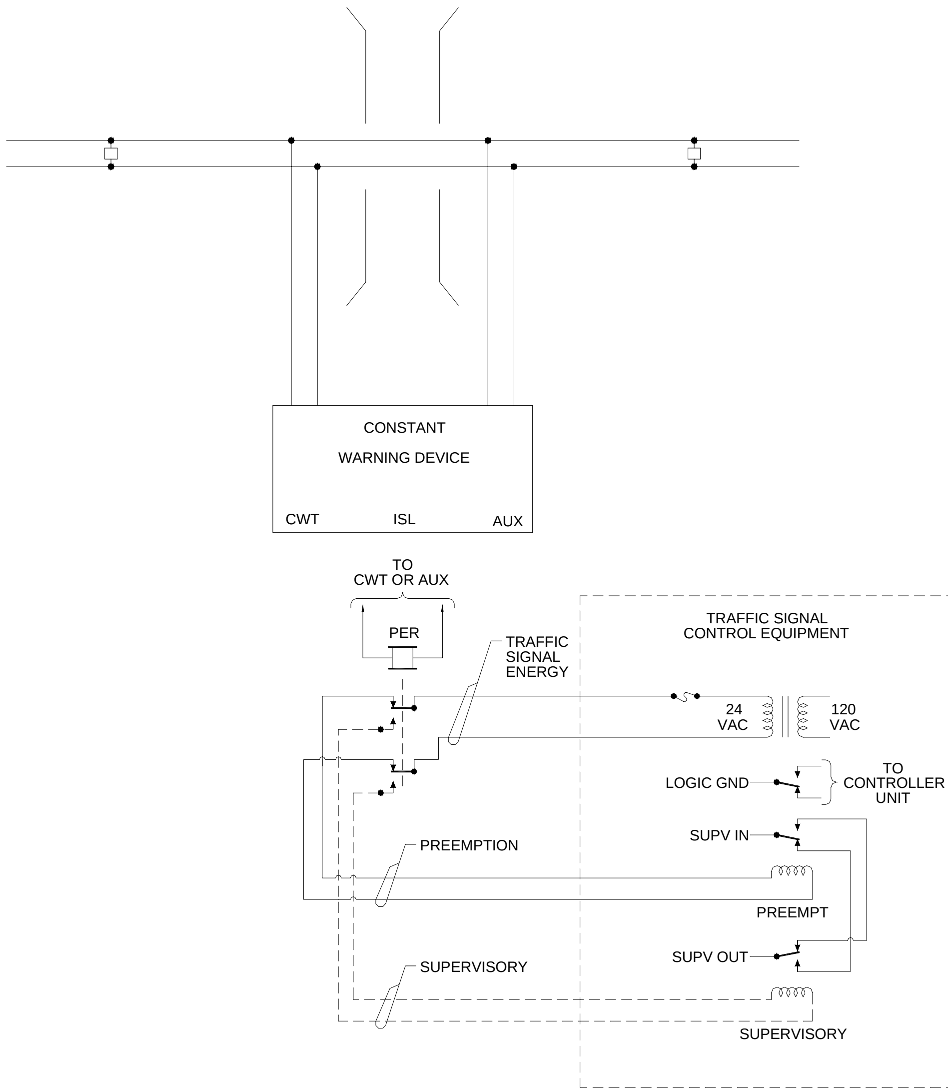
lengthened to provide additional clearance time as specified.

6. The vital circuit design guidelines provided in this manual part represent various methods for highway traffic signal interconnection applications. Some aspects of the circuit designs may vary, depending on the design practices of the individual railroad and requirements specified by the public agencies having jurisdictional authority.

C. Operation

See diagrams on following pages.

Constant Warning Time Application for Interconnection



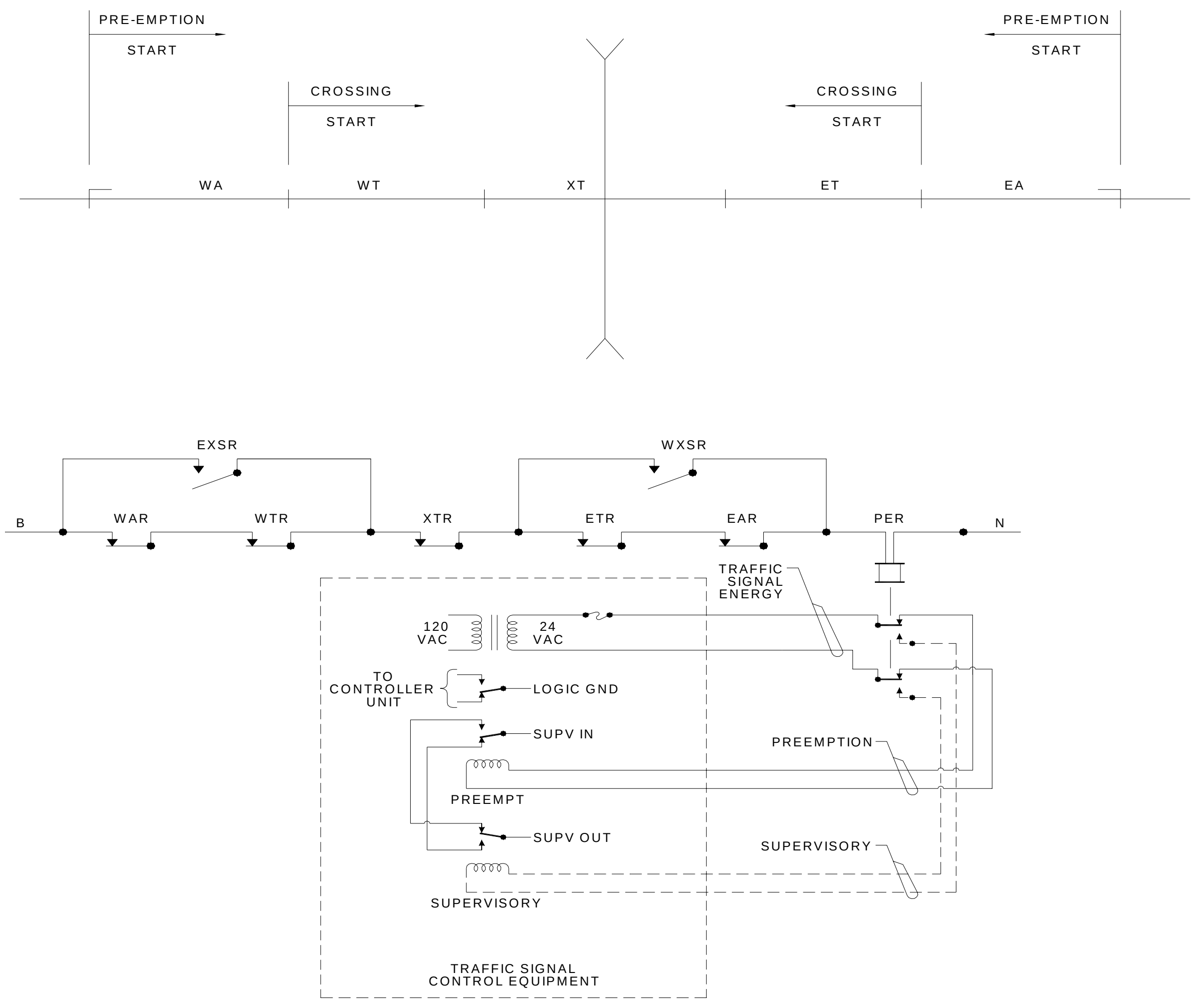
For simultaneous preemption interconnection applications, PER is connected to the CWT output directly or through a repeater relay.

For advance preemption interconnection applications, PER is connected to the AUX output directly or through a repeater relay.

Supervisory circuit wiring is shown for reference purposes.

Traffic signal circuitry is shown for illustration purposes only

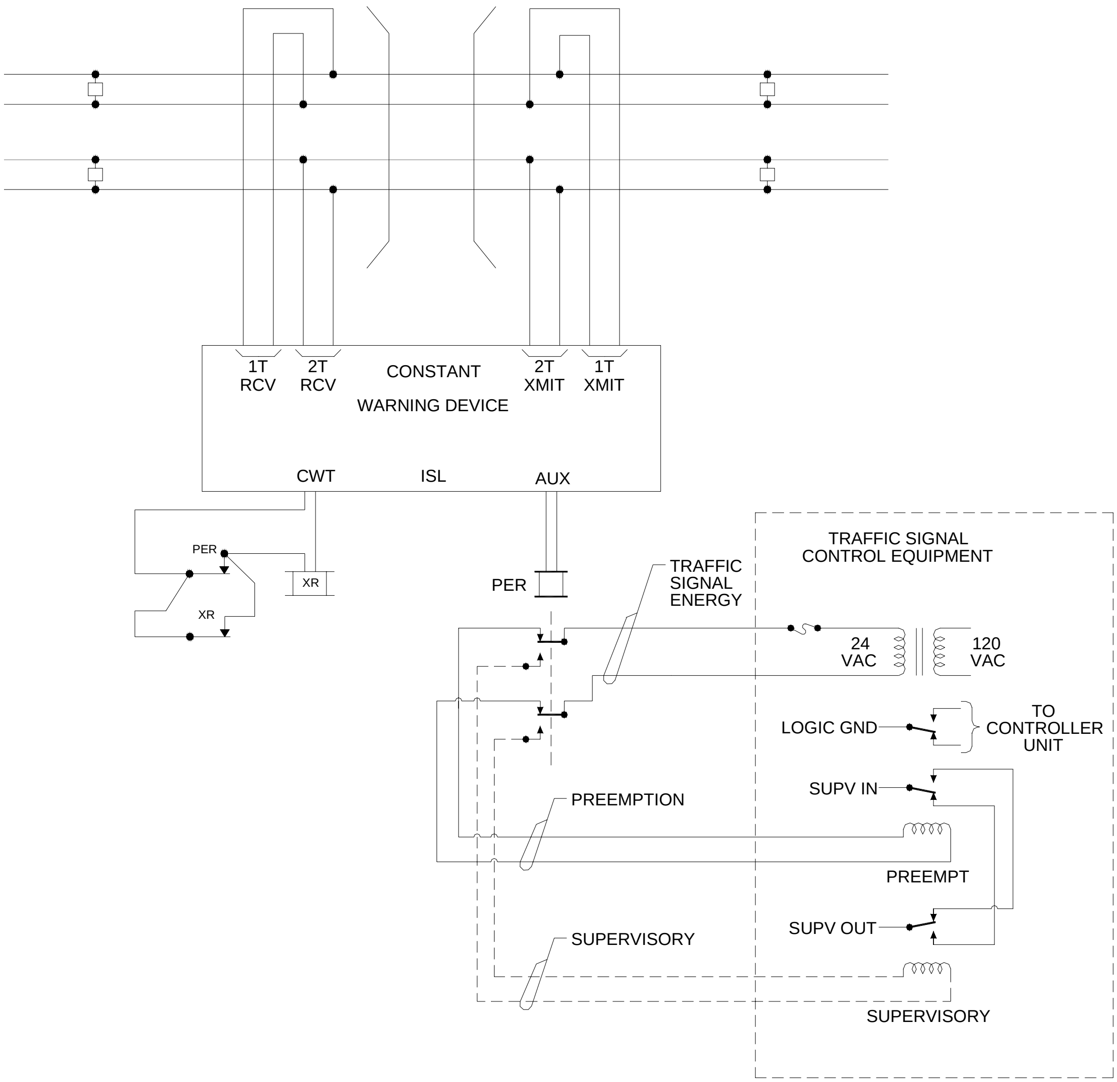
Conventional Track Circuit Logic for Advance Preemption



Supervisory circuit wiring is shown for reference purposes.

Traffic signal circuitry is shown for illustration purposes only.

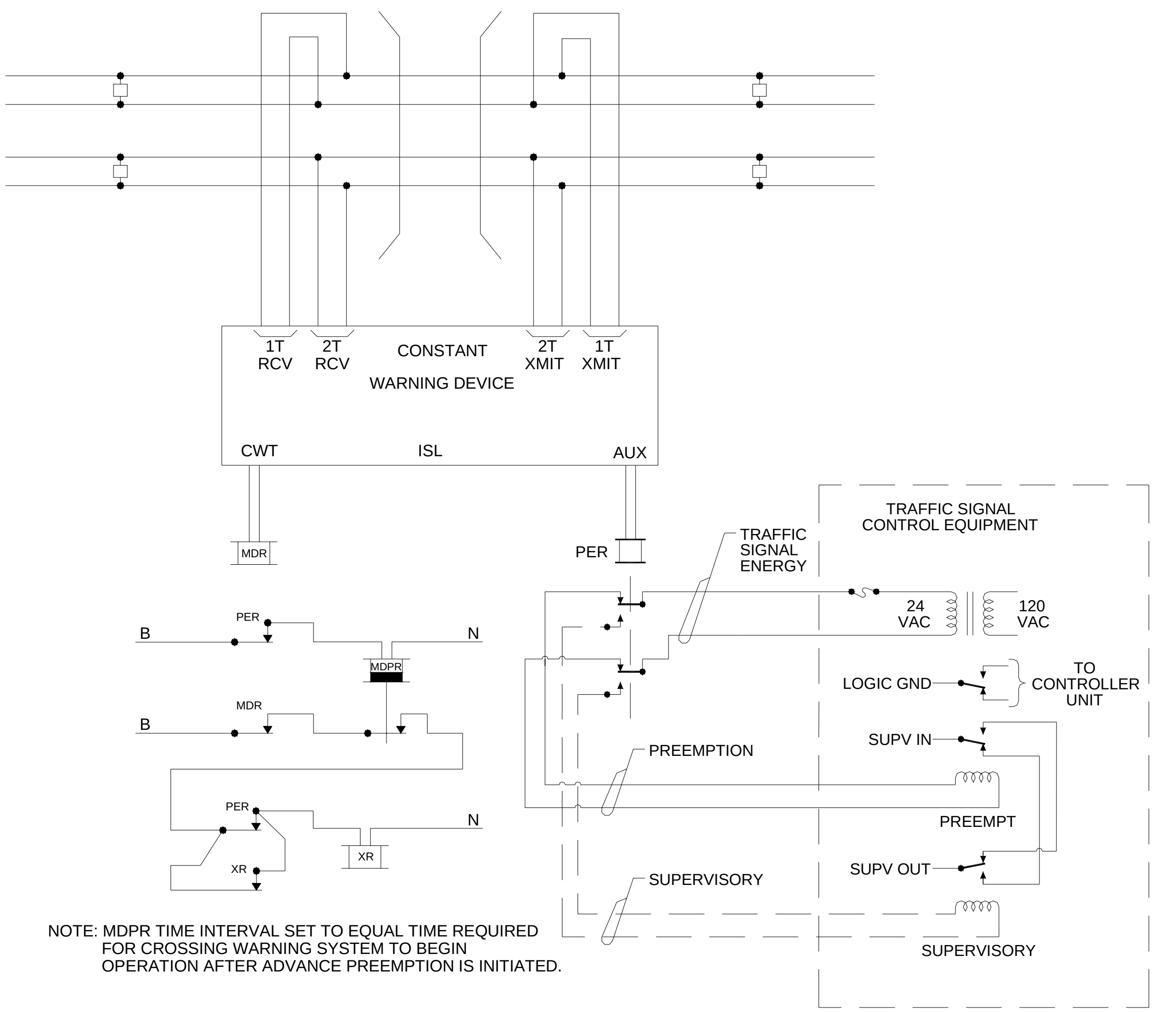
Second Train Logic



Supervisory circuit wiring is shown for reference purposes.

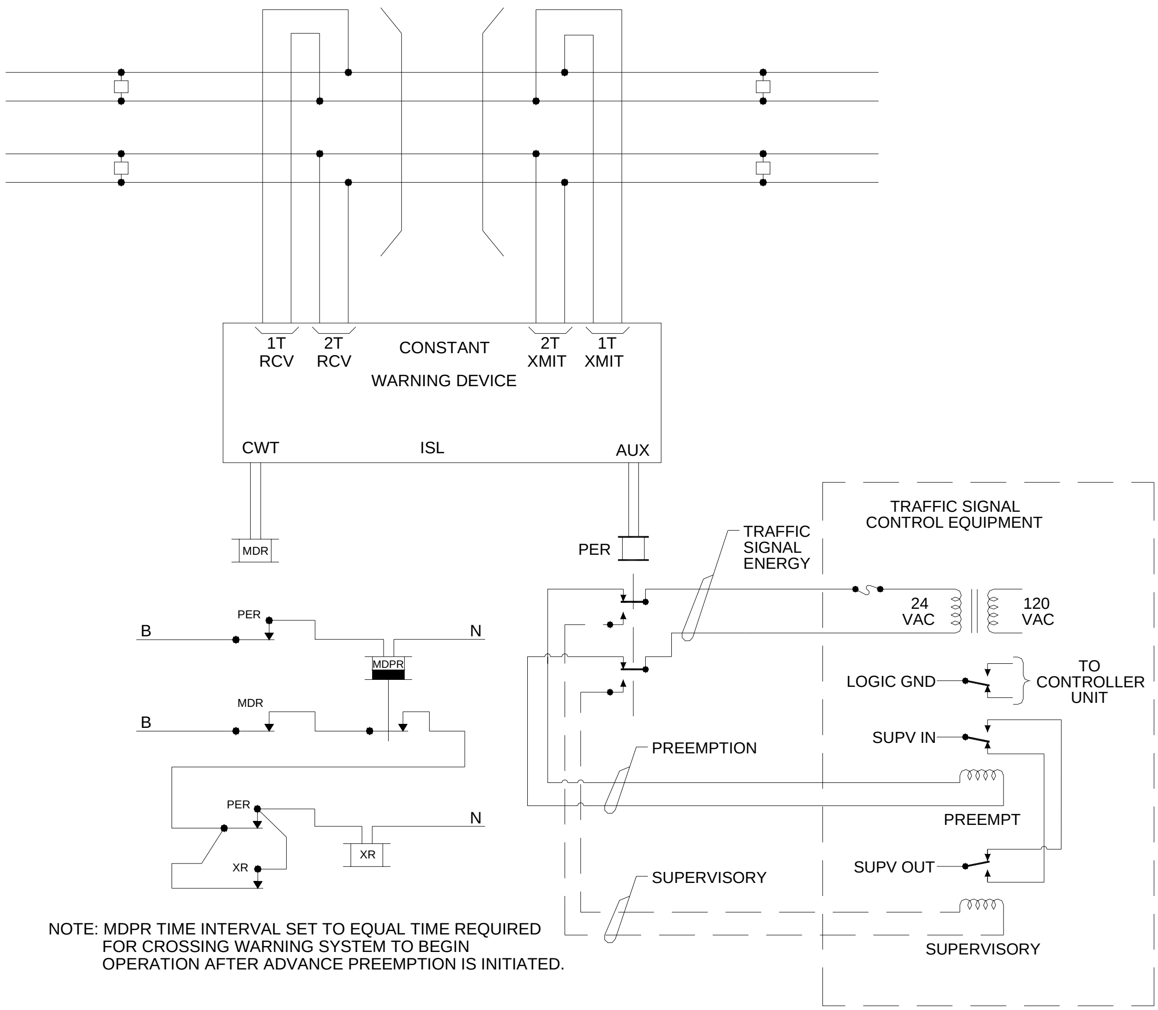
Traffic signal circuitry is shown for illustration purposes only.

Timer for Constant Time Between APT and CWT



Supervisory circuit wiring is shown for reference purposes.

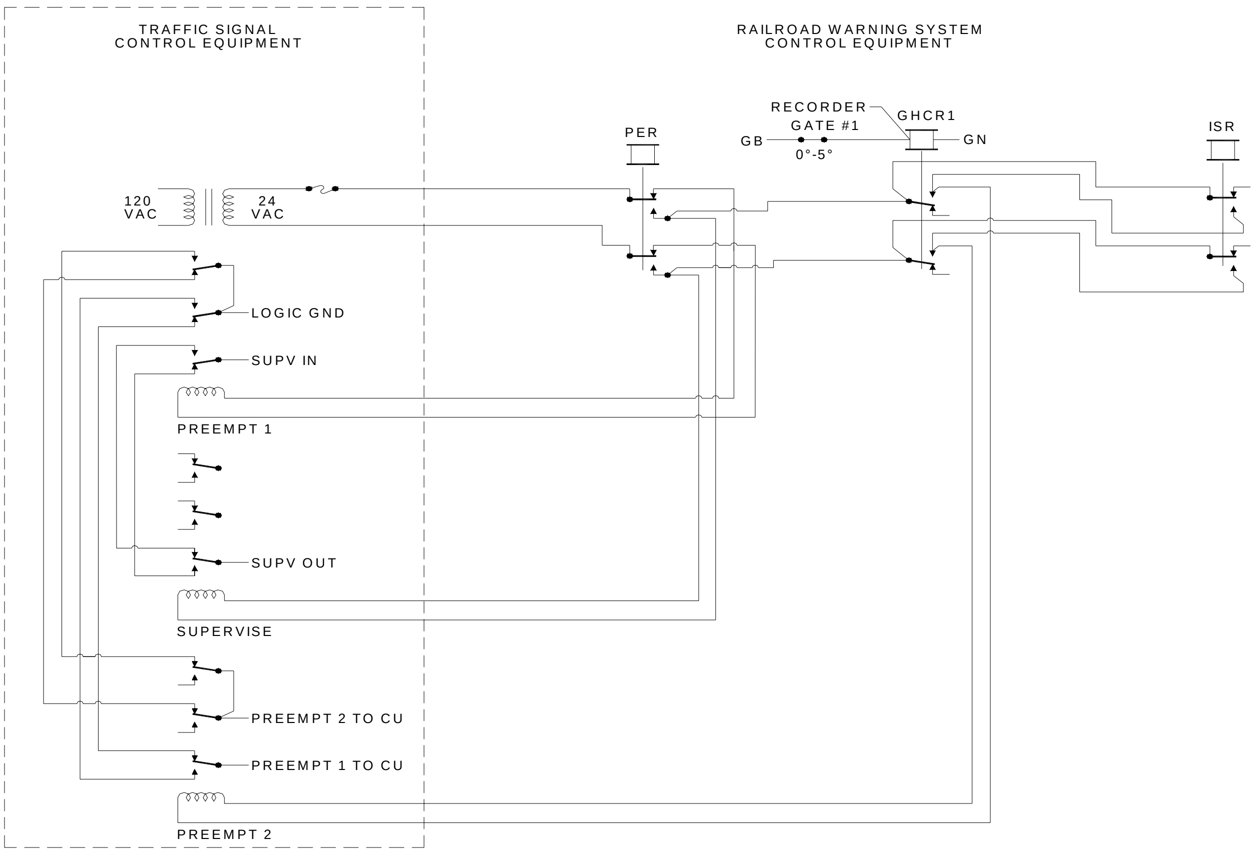
Timer for Constant Time Between APT and CWT



Supervisory circuit wiring is shown for reference purposes.

Traffic signal circuitry is shown for illustration purposes only.

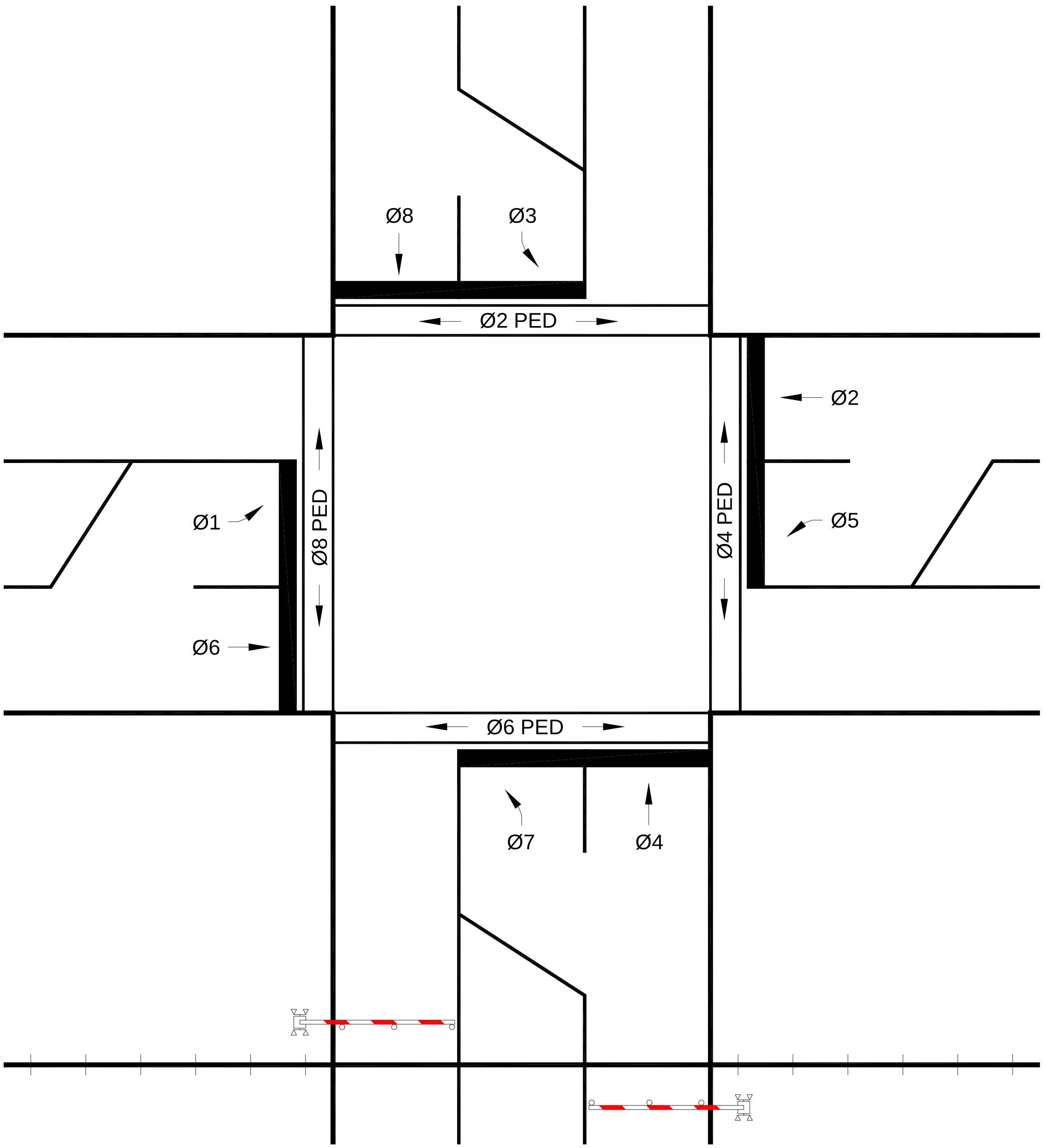
Gate Down Logic With One Gate on Roadway Approach to Highway Traffic Signal



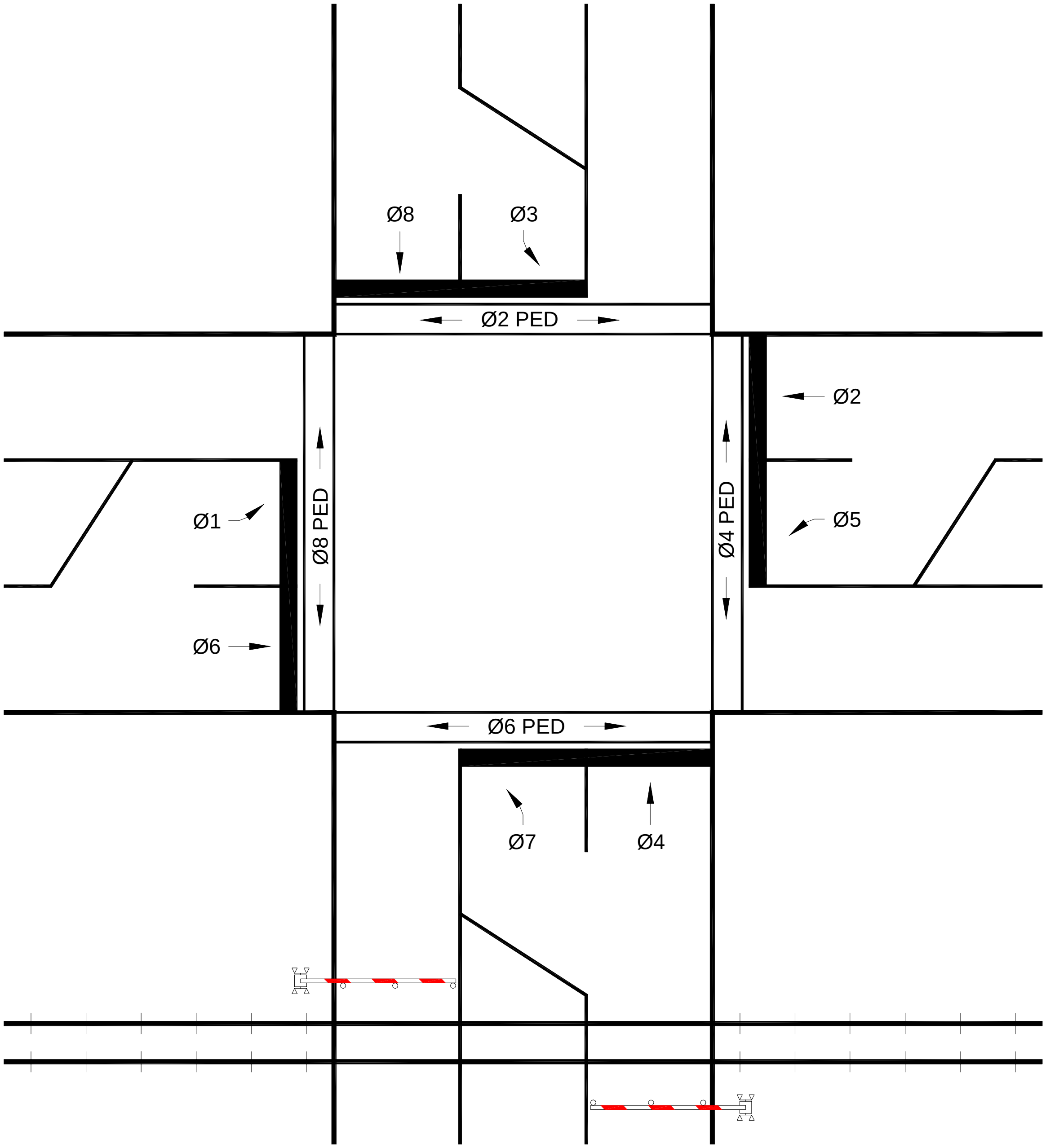
When gate down logic is required, only the gate controlling vehicular movement toward the traffic signal is circuited.

Supervisory circuit wiring is shown for reference purposes.

Traffic signal circuitry is shown for illustration purposes only.



8Ø+PED
PHASE SEQUENCE



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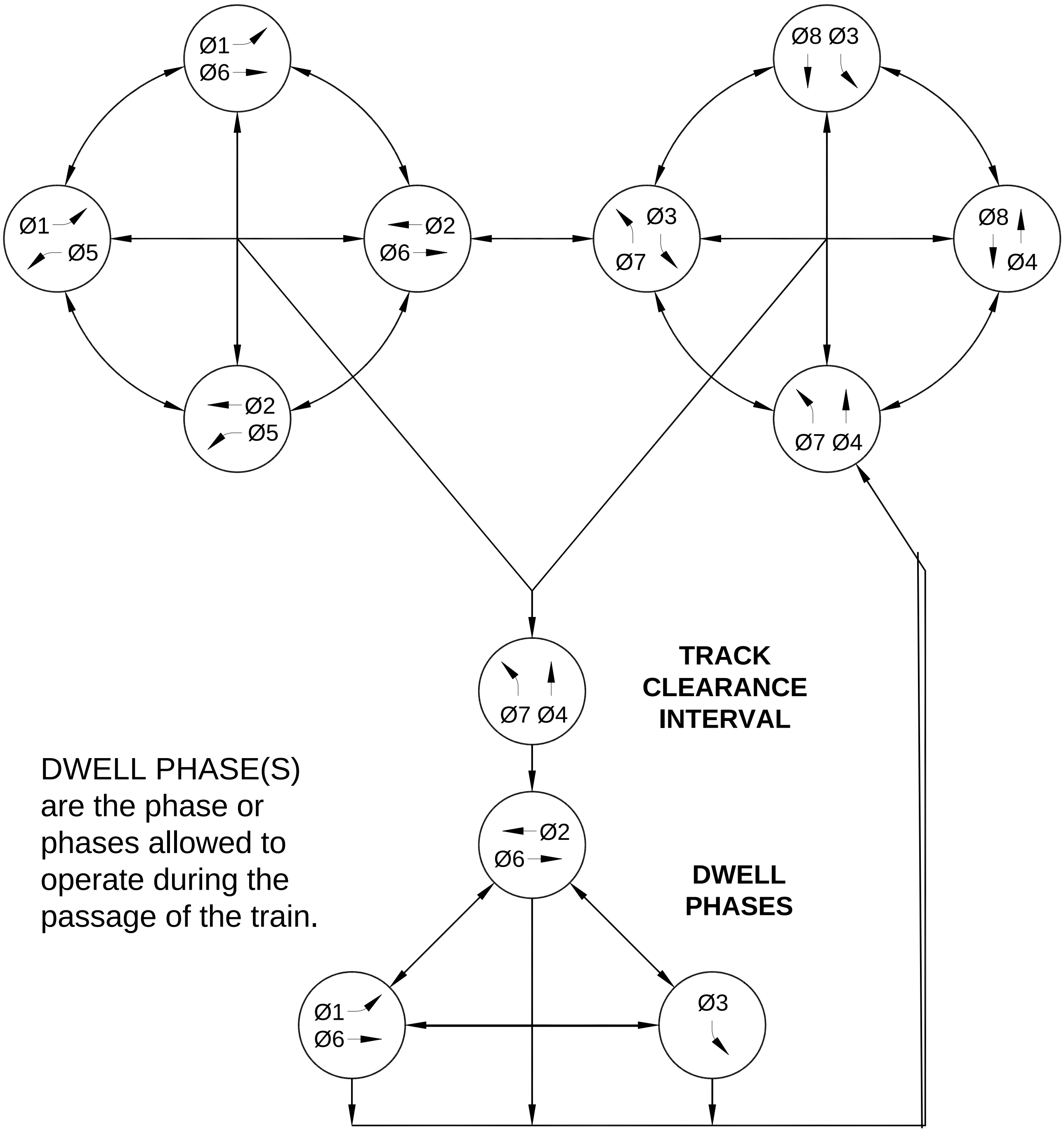
PHASE SEQUENCE

RAILROAD PREEMPT PHASE SEQUENCE



DWELL PHASE(S) are the phase or phases allowed to operate during the passage of the train.

Texas Department of Transportation

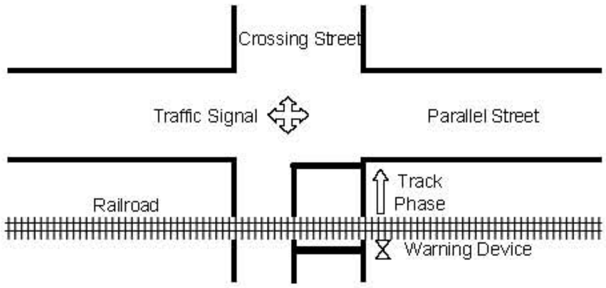
GUIDE FOR DETERMINING TIME REQUIREMENTS FOR TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

City ____________________ Date ____________________

County ____________________ Completed by ____________________

District ____________________ District Approval ____________________

Show North Arrow



Parallel Street Name ____________________

Crossing Street Name ____________________

Railroad ____________________ Railroad Contact ____________________

Crossing DOT# ____________________ Phone ____________________

SECTION 1: RIGHT-OF-WAY TRANSFER TIME CALCULATION

Preempt verification and response time — **Remarks**

1. Preempt delay time (seconds) ………………………… 1. [ ] ____________________
2. Controller response time to preempt (seconds) ………………… 2. [ ] Controller type: __________

3. Preempt verification and response time (seconds): add lines 1 and 2 ………………… 3. [ ]

Worst-case conflicting vehicle time

4. Worst-case conflicting vehicle phase number ………… 4. [ ] — **Remarks**
5. Minimum green time during right-of-way transfer (seconds) ………… 5. [ ] ____________________
6. Other green time during right-of-way transfer (seconds) ………… 6. [ ] ____________________
7. Yellow change time (seconds) ………………………… 7. [ ] ____________________
8. Red clearance time (seconds) ………………………… 8. [ ] ____________________

9. Worst-case conflicting vehicle time (seconds): add lines 5 through 8 ………… 9. [ ]

Worst-case conflicting pedestrian time

10. Worst-case conflicting pedestrian phase number ………… 10. [ ] — **Remarks**
11. Minimum walk time during right-of-way transfer (seconds) ………… 11. [ ] ____________________
12. Pedestrian clearance time during right-of-way transfer (seconds) ………… 12. [ ] ____________________
13. Vehicle yellow change time, if not included on line 12 (seconds) ………… 13. [ ] ____________________
14. Vehicle red clearance time, if not included on line 12 (seconds) ………… 14. [ ] ____________________

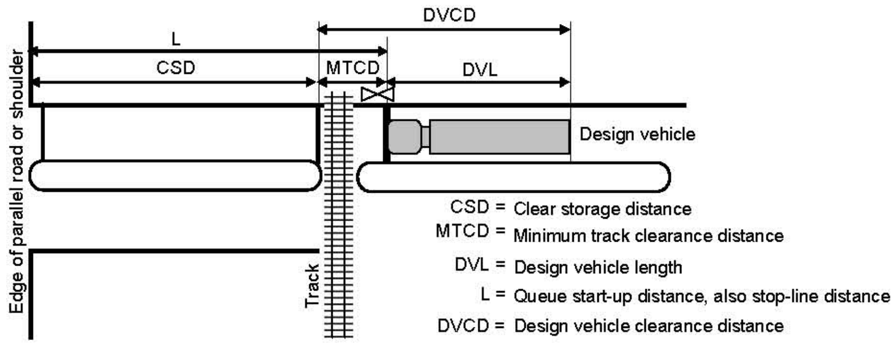
15. Worst-case conflicting pedestrian time (seconds): add lines 11 through 14 ………… 15. [ ]

Worst-case conflicting vehicle or pedestrian time

16. Worst-case conflicting vehicle or pedestrian time (seconds): maximum of lines 9 and 15 ………… 16. [ ]

17. **Right-of-way transfer time (seconds): add lines 3 and 16** ………………………… **17.** [ ]

SECTION 2: QUEUE CLEARANCE TIME CALCULATION



Remarks

18. Clear storage distance (CSD, feet) ………………………….. **18.** [ ] ________

19. Minimum track clearance distance (MTCD, feet) …………… **19.** [ ] ________

20. Design vehicle length (DVL, feet) ……………………………. **20.** [ ] Design vehicle type: ________

21. Queue start-up distance, L (feet): add lines 18 and 19 ……………………… **21.** [ ]

Remarks

22. Time required for design vehicle to start moving (seconds): calculate as 2+(L÷20) ….. **22.** [ ] ________

23. Design vehicle clearance distance, DVCD (feet): add lines 19 and 20 …… **23.** [ ]

24. Time for design vehicle to accelerate through the DVCD (seconds) ………………….. **24.** [ ] Read from Figure 2 in Instructions.

25. Queue clearance time (seconds): add lines 22 and 24 ……………………………………………. 25. [ ]

SECTION 3: MAXIMUM PREEMPTION TIME CALCULATION **Remarks**

26. Right-of-way transfer time (seconds): line 17 …………………………………… **26.** [ ] ________

27. Queue clearance time (seconds): line 25 ……………………………………….. **27.** [ ] ________

28. Desired minimum separation time (seconds) …………………………………… **28.** [4.0] ________

29. Maximum preemption time (seconds): add lines 26 through 28 ………………….…………… 29. [ ]

SECTION 4: SUFFICIENT WARNING TIME CHECK **Remarks**

30. Required minimum time, MT (seconds): per regulations ……. **30.** [ ] ________

31. Clearance time, CT (seconds): get from railroad ……………… **31.** [ ] ________

32. Minimum warning time, MWT (seconds): add lines 30 and 31 ……………. **32.** [ ] Excludes buffer time (BT)

33. Advance preemption time, APT, if provided (seconds): get from railroad … **33.** [ ] ________

34. Warning time provided by the railroad (seconds): add lines 32 and 33 ………………………………… **34.** [ ]

35. Additional warning time required from railroad (seconds): subtract line 34 from line 29, round up to nearest full second, enter 0 if less than 0 ……………………………………..……………………. 35. [ ]

> If the additional warning time required (line 35) is greater than zero, additional warning time has to be requested from the railroad. Alternatively, the maximum preemption time (line 29) may be decreased after performing an engineering study to investigate the possibility of reducing the values on lines 1, 5, 6, 7, 8, 11, 12, 13 and 14.

Remarks: ________

____

____

SECTION 5: TRACK CLEARANCE GREEN TIME CALCULATION (OPTIONAL)

Preempt Trap Check

36. Advance preemption time (APT) provided (seconds): ………. **36.** [ ] Line 33 only valid if line 35 is zero.

37. Multiplier for maximum APT due to train handling ……………. **37.** [ ] See Instructions for details.

38. Maximum APT (seconds): multiply line 36 and 37 ……………………………. **38.** [ ]

39. Minimum duration for the track clearance green interval (seconds) ………. **39.** [15.0]

Remarks

For zero advance preemption time

40. Gates down after start of preemption (seconds): add lines 38 and 39 ………………….. **40.** [ ]

41. Preempt verification and response time (seconds): line 3 …………………. **41.** [ ]

42. Best-case conflicting vehicle or pedestrian time (seconds): usually 0……. **42.** [ ]

Remarks

43. Minimum right-of-way transfer time (seconds): add lines 41 and 42 ……………………. **43.** [ ]

44. Minimum track clearance green time (seconds): subtract line 43 from line 40 ……………………… **44.** [ ]

Clearing of Clear Storage Distance

45. Time required for design vehicle to start moving (seconds), line 22 ……………………. **45.** [ ]

46. Design vehicle clearance distance (DVCD, feet), line 23 …… **46.** [ ]

47. Portion of CSD to clear during track clearance phase (feet) … **47.** [ ]

Remarks

CSD* in Figure 3 in Instructions.

48. Design vehicle relocation distance (DVRD, feet): add lines 46 and 47 …… **48.** [ ]

49. Time required for design vehicle to accelerate through DVRD (seconds) ………………. **49.** [ ] Read from Figure 2 in Instructions.

50. Time to clear portion of clear storage distance (seconds): add lines 45 and 49 ……………………. **50.** [ ]

51. Track clearance green interval (seconds): maximum of lines 44 and 50, round up to nearest full second ….. 51. [ ]

SECTION 6: VEHICLE-GATE INTERACTION CHECK (OPTIONAL)

52. Right-of-way transfer time (seconds): line 17 ……………………………………………… **52.** [ ]

53. Time required for design vehicle to start moving (seconds), line 22 ………………….. **53.** [ ]

54. Time required for design vehicle to accelerate through DVL (on line 20, seconds) …… **54.** [ ] Read from Table 3 in Instructions.

55. Time required for design vehicle to clear descending gate (seconds): add lines 52 though 54 ….. **55.** [ ]

Remarks

56. Duration of flashing lights before gate descent start (seconds): get from railroad ……. **56.** [ ]

Remarks

57. Full gate descent time (seconds): get from railroad …………………………. **57.** [ ]

58. Proportion of non-interaction gate descent time ……………………………… **58.** [ ] Read from Figure 5 in Instructions.

59. Non-interaction gate descent time (seconds): multiply lines 57 and 58 ………………… **59.** [ ]

60. Time available for design vehicle to clear descending gate (seconds): add lines 56 and 59 ……… **60.** [ ]

61. Advance preemption time (APT) required to avoid design vehicle-gate interaction (seconds): subtract line 60 from line 55, round up to nearest full second, enter 0 if less than 0 …………………………… 61. [ ]

INSTRUCTIONS

for the

Texas Department of Transportation

GUIDE FOR DETERMINING TIME REQUIREMENTS FOR TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

USING THESE INSTRUCTIONS

The purpose of these instructions is to assist TxDOT personnel in completing the 2003 Guide For Determining Time Requirements For Traffic Signal Preemption At Highway-Rail Grade Crossings, *also known as the Preemption Worksheet. The main purpose of the Preemption Worksheet is to determine if additional time (advance preemption) is required for the traffic signal to move stationary vehicles out of the crossing before the arrival of the train.*

If you have any questions about completing the Preemption Worksheet, please contact the Mr. David Valdez in the Traffic Operations Division at telephone 512-416-2642 or email DVALDEZ@dot.state.tx.us. For any feedback on the Draft version of the Worksheet or Instructions, please contact Mr. Roelof Engelbrecht from the Texas Transportation Institute at 979-862-3559 or roelof@tamu.edu.

SITE DESCRIPTIVE INFORMATION:

Enter the location for the highway-rail grade crossing including the (nearest) **City**, the **County** in which the crossing is located, and the Texas Department of Transportation (TxDOT) **District** name. When entering the District name, do not use the dated district numbering schema; use the actual district name.

Next, enter the **Date** the analysis was performed, your (the analyst's) name next to "**Completed by**," and the status of the **District Approval** for this crossing.

To complete the reference schematic for this site, place a **North Arrow** in the provided circle to correctly orient the crossing and roadway. Record the name of the **Parallel Street** and the **Crossing Street** in the spaces provided, and remember to include any "street sign"/local name for the streets as well as any state/US/Interstate designation (i.e., "FM 1826," "SH 71," "US 290," "Interstate 35 [frontage]"). You may wish to note other details on the intersection/crossing diagram as well, including the number of lanes and/or turn bays on the intersection approach crossing the tracks and any adjacent land use.

Enter the **Railroad** name, **Railroad Contact** person's name, and **Phone** number for the responsible railroad company and its equipment maintenance and operations contractor (if any). Finally, record the unique 7-character **Crossing DOT#** (6 numeric plus one alphanumeric characters) for the crossing.

Note that this guide for determining (warning) time requirements for traffic signal preemption requires you to input many controller unit timing/phasing values. To preserve the accuracy of these values, record all values to the next highest tenth of a second (i.e., record 5.42 seconds as 5.5 seconds).

SECTION 1: RIGHT-OF-WAY TRANSFER TIME CALCULATION

Preempt Verification and Response Time

Line 1. The **preempt delay time** is the amount of time, in seconds, that the traffic signal controller is programmed to wait from the initial receipt of a preempt call until the call is "verified" and considered a viable request for transfer into preemption mode. Preempt delay time is a value entered into the controller unit for purposes of preempt call validation, and may not be available on all manufacturer's controllers.

Line 2. Unlike preempt delay time (Line 1), which is a value entered into the controller, **controller response time to preempt** is the time that elapses while the controller unit electronically registers the preempt call (i.e., it is the controller's equipment response time for the preempt call). The controller manufacturer should be consulted to find the correct value (in seconds) for use here. For future reference, you may wish to record the controller type in the **Remarks** section to the right of the controller response time to preempt value. However, note that the manufacturer's given response time may be unique for a controller unit's model and software generation; other models and/or software generations may have different response times.

Line 3. The sum of Line 1 and Line 2 is the **preempt verification and response time**, in seconds. It represents the number of seconds between the receipt at the controller unit of a preempt call issued by the railroad's grade crossing warning equipment and the time the controller software actually begins to respond to the preempt call (i.e., by transitioning into preemption mode).

Worst-Case Conflicting Vehicle Time

Line 4. Worst-case conflicting vehicle phase number is the number of the controller unit phase which conflicts with the phase(s) used to clear the tracks—the track clearance phase(s)—that has the longest sum of minimum green (if provided), other (additional) green time (if provided), yellow change interval, and red clearance interval durations that may need to be serviced during the transition into preemption. Note that all of these time elements are for vehicular phases only; pedestrian phase times will be assessed in the next part of the analysis. The worst-case vehicle phase can be any phase that conflicts with the track clearance phase(s); it is not restricted to only the phases serving traffic parallel to the tracks.

Line 5. Minimum green time during right-of-way transfer is the number of seconds that the worst-case vehicle phase (see Line 4 discussion) must display a green indication before the controller unit will terminate the phase through its yellow change and red clearance intervals and transition to the track clearance green interval. The minimum green time during right-of-way transfer may be set to zero to allow as rapid a transition as possible to the track clearance green interval. However, local policies will govern the amount of minimum green time provided during the transition into preemption.

Line 6. If any additional green time is preserved beyond the preempt minimum green time for the worst-case vehicle phase (line 4), it should be entered here as **Other green time during right-of-way transfer**. Given the time-critical nature of the transition to the track clearance green interval during preempted operation, this value is usually zero except in unusual circumstances. One situation where other green time may be present is when a trailing green overlap is used on the worst-case vehicle phase, and the controller unit is set up to time out the trailing green overlap on entry into preemption.

Line 7. Yellow change time is the required yellow change interval time for the worst-case vehicle phase (line 4) given prevailing operating conditions. Yellow change time for the phase under preemption is usually the same value, in seconds, programmed for the phase under normal operating circumstances. Section 4D.13 of the *Texas Manual on Uniform Traffic Control Devices* (*MUTCD*) states that the normal yellow change interval shall not be shortened or omitted during the transition into preemption control. Guidance on setting the yellow change interval can be found in the Institute of Transportation Engineer's *Determining Vehicle Signal Change and Clearance Intervals.*

Line 8. Red clearance time is the required red clearance interval for the worst-case vehicle phase (line 4) given prevailing operating conditions. Red clearance time for the phase under preemption is usually the same value, in seconds, programmed for the phase under normal operating circumstances. Section 4D.13 of the *Texas MUTCD* states that the normal red clearance interval shall not be shortened or omitted during the transition into preemption control. Guidance on setting the red clearance interval can be found in the Institute of Transportation Engineer's *Determining Vehicle Signal Change and Clearance Intervals.*

Line 9. Worst-case conflicting vehicle time is the sum of lines 5 through 8. It will be compared with the worst-case conflicting pedestrian time to determine whether vehicle or pedestrian phase times are the most critical in their impact on warning time requirements during the transition to the track clearance green interval.

Worst-case Conflicting Pedestrian Time

Line 10. Worst-case pedestrian phase number is the pedestrian phase number (referenced as the vehicle phase number that the pedestrian phase is associated with) that has the longest sum of walk time, pedestrian clearance (i.e., flashing don't walk) times, and associated vehicle clearance times that have to be provided during the transition into preemption. The worst-case pedestrian phase is not restricted to pedestrian phases running concurrently with vehicle phases that serve traffic parallel to the tracks. The vehicle phase associated with the worst-case pedestrian phase may even be one of the track clearance phases if the pedestrian phase is not serviced concurrently with the associated track clearance phase.

Line 11. Minimum walk time during right-of-way transfer (seconds) is the minimum pedestrian walk time for the worst-case pedestrian phase (line 10). The *Texas MUTCD* permits the shortening (i.e. truncation) or complete omission of the pedestrian walk interval. A zero value allows for the most rapid transition to the track clearance green interval. However, the minimum pedestrian walk time is typically set based on local policies, which may or may not allow truncation and/or omission.

Line 12. Pedestrian clearance time during right-of-way transfer (seconds) is the clearance (i.e., flashing don't walk) time for the worst-case pedestrian phase. The *Texas MUTCD* permits the shortening (i.e. truncation) or complete omission of the pedestrian clearance interval. A zero value allows for the most rapid transition to the track clearance green interval. However, the pedestrian clearance time is typically set based on local policies, which may or may not allow truncation and/or omission.

Line 13. Enter a **Yellow change time** if the pedestrian clearance interval does not time simultaneously with the yellow change interval of the vehicular phase associated with your worst-case pedestrian phase; enter zero if does. Local policies will determine if this is allowed. Simultaneous timing of the pedestrian clearance interval and the yellow change interval (i.e. a zero value on line 13) allows for the most rapid transition to the track clearance green interval. If a non-zero value is entered, make sure to enter the yellow change time of the vehicular phase associated with your worst-case pedestrian phase. This value may not be the same value you enter on Line 7, since the worst-case pedestrian phase may not be the same as the worst-case vehicular phase.

Line 14. Enter a **Red clearance time** if the pedestrian clearance interval does not time simultaneously with the red clearance interval of the vehicular phase associated with your worst-case pedestrian phase; enter zero if does. Local policies will determine if this is allowed. Also, note than not all traffic signal controllers allow simultaneous timing of the pedestrian clearance interval and the red clearance interval. Simultaneous timing of the pedestrian clearance interval and the red clearance interval (i.e. a zero value on line 14) allows for the most rapid transition to the track clearance green interval. If a non-zero value is entered, make sure to enter the red clearance time of the vehicular phase associated with your worst-case pedestrian phase. This value may not be the same value you enter on Line 8, since the worst-case pedestrian phase may not be the same as the worst-case vehicular phase.

Line 15. Add lines 11 through 14 to calculate your **Worst-case conflicting pedestrian time**. This value will be compared to the worst-case conflicting vehicle time to determine whether vehicle or pedestrian phase times are the most critical in their impact on warning time requirements during the transition to the track clearance green interval.

Worst-case Conflicting Vehicle or Pedestrian Time

Line 16. Record the **Worst-case conflicting vehicle or pedestrian time** (in seconds) by comparing lines 9 and 15 and writing the larger of the two as the entry for line 16.

Line 17. Calculate the **Right-of-way transfer time** by adding lines 3 and 16. The right-of-way transfer time is the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval.

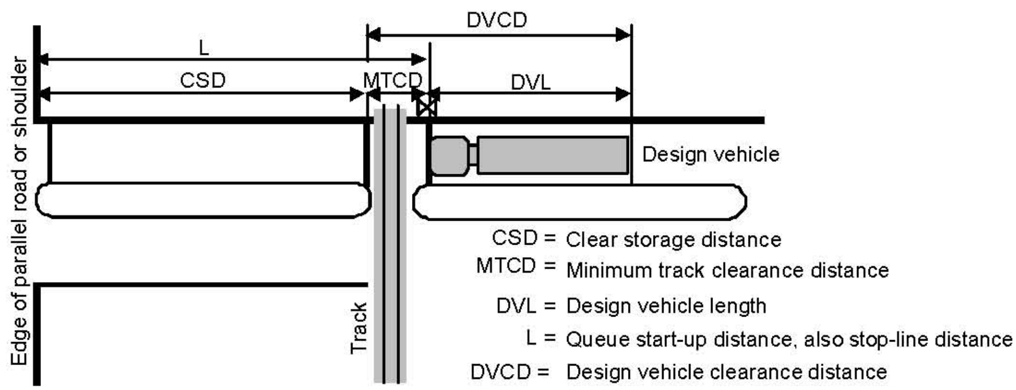


Figure 1 Queue clearance distances.

SECTION 2: QUEUE CLEARANCE TIME CALCULATION

Line 18. Record the **Clear storage distance** (CSD in Figure 1), in feet, as the shortest distance along the crossing street between the edge of the grade crossing nearest the signalized intersection—identified by a line parallel to the rail 6 feet (2 m) from the rail nearest to the intersection—and the edge of the street or shoulder of street that parallels the tracks. If the normal stopping point on the crossing street is significant different from the edge or shoulder of parallel street, measure the distance to the normal stopping point. For angled (i.e., non-perpendicular) railroad crossings, always measure the distance along the inside (centerline) edge of the leftmost lane or the distance along the outside (shoulder) edge of the rightmost lane, as appropriate, to determine the shortest clear storage distance and record that value.

Line 19. Minimum track clearance distance (MTCD in Figure 1), in feet, is the length along the highway at one or more railroad tracks, measured from the railroad crossing stop line, warning device, or 12 feet (4 m) perpendicular to the track centerline—whichever is further away from the tracks, to 6 feet (2 m) beyond the tracks measured perpendicular to the far rail. For angled (i.e., non-perpendicular) railroad crossings, always measure the distance along the inside (centerline) edge of the leftmost lane or the distance along the outside (shoulder) edge of the rightmost lane, as appropriate, to determine the longest minimum track clearance distance and record that value.

Line 20. Design vehicle length (DVL in Figure 1), in feet, is the length of the design vehicle, the longest vehicle permitted by road authority statute on the subject roadway. In the **Remarks** section to the right of the data entry box for Line 20, note the design vehicle type for ease of reference. Some design vehicles from the *AASHTO Green Book (A Policy on Geometric Design of Highways and Streets)* are given in Table 1. Note that Texas legal size and weight limits for non-permit vehicles allow a maximum semitrailer length of 59 feet, resulting in a design vehicle length of 79.5 feet when combined with a conventional long-haul tractor.

Table 1. AASHTO Design vehicle lengths and heights.

Design Vehicle Type	Symbol	Length (ft)
Passenger Car	P	19
Single Unit Truck	SU	30
Large School Bus	S-BUS 40	40
Intermediate Semi-Trailer	WB-50	55

Line 21. Queue start-up distance (L in Figure 1), in feet, is the maximum length over which a queue of vehicles stopped for a red signal indication at an intersection downstream of the crossing must get in motion so that the design vehicle can move out of the railroad crossing prior to the train's arrival. Queue start-up distance is the sum of the clear storage distance (Line 18) and minimum track clearance distance (Line 19).

Line 22. Time required for the design vehicle to start moving (seconds) is the time elapsed between the start of the track clearance green interval and the time the design vehicle, which is located at the edge of the railroad crossing on the opposite side from the signalized intersection, begins to move. This elapsed time is based on a "shock wave" speed of 20 feet per second and a 2 second start-up time (the additional time for the first driver to recognize the signal is green and move his/her foot from the brake to the accelerator). The time required for the design vehicle to start moving is calculated, in seconds, as 2 plus the queue start-up distance, L (Line 21) divided by the wave speed of 20 feet per second. The time required for the design vehicle to start moving is a conservative value taking into account the worst-case vehicle mix in the queue in front of the design vehicle as well as a limited level of drive inattentiveness. This value may be overridden by local observation, but care must be taken to identify the worst-case (longest) time required for the design vehicle to start moving.

Line 23. Design vehicle clearance distance (DVCD in Figure 1) is the length, in feet, which the design vehicle must travel in order to enter and completely pass through the railroad crossing's minimum track clearance distance (MTCD). It is the sum of the minimum track clearance distance (Line 19) and the design vehicle's length (Line 20).

Line 24. The **Time for design vehicle to accelerate through the design vehicle clearance distance (DVCD)** is the amount of time required for the design vehicle to accelerate from a stop and travel the complete design vehicle clearance distance. This time value, in seconds, can be found through local observation or by using by Figure 2. If local observation is used, take care to identify the worst-case (longest) time required for the design vehicle to accelerate through the DVCD. If Figure 2 is used to estimate the time for the design vehicle to accelerate through the DVCD, locate the DVCD from Line 23 on the horizontal axis of Figure 2 and then draw a line straight up until that line intersects the acceleration time performance curve for your design vehicle. Then, draw a horizontal line from this point to the left until it intersects the vertical axis, and record the appropriate acceleration time. Round up to the next higher tenth of a second. For example, with a DVCD of 80 feet and a WB-50 semi-trailer design vehicle on a level surface, the time required for the design vehicle to accelerate through the DVCD will be 12.2 seconds.

If your design vehicle is a WB-50 semi-trailer, large school bus (S-BUS 40), or single unit (SU) vehicle, you may need to apply a correction factor to estimate the effect of grade on the acceleration of the vehicle. Determine the average grade over a distance equal to the design vehicle clearance distance (DVCD), centered around the minimum track clearance distance (MTCD). If the grade is 1% uphill (+1%) or greater, multiply the acceleration time obtained from Figure 2 with the factor obtained from Table 2 and round up to the next higher tenth of a second to get an estimate of the acceleration time on the grade. For example, with a DVCD of 80 feet and a WB-50 semi-trailer design vehicle on a 4% uphill, the (interpolated) factor from Table 2 is 1.30. Therefore, the estimated time required for the design vehicle to accelerate through the DVCD will be 12.2 x 1.30 = 15.86 seconds, or 15.9 seconds rounded up to the next higher tenth of a second.

If you selected a design vehicle different from those listed in Figure 2 and Table 2, you may still be able to use Figure 2 and Table 2 if you can match your design vehicle to the weight, weight-to-power ratio, and power application characteristics of the design vehicles in Figure 2 and Table 2. The WB-50 curve and grade factors are based on an 80,000 lb vehicle with a weight-to-power ratio of 400 lb/hp accelerating at 85% of its maximum power on level grades and at 100% of its maximum power on uphill grades, and may therefore be representative of any heavy tractor-trailer combination with the same characteristics. The school bus curve and grade factors are based on a 27,000 lb vehicle with a weight-to-power ratio of 180 lb/hp accelerating at 70% of its maximum power on level grades and at 85% of its maximum power on uphill grades. The SU curve and grade factors are based on a 34,000 lb vehicle with a weight-to-power ratio of 200 lb/hp accelerating at 75% of its maximum power on level grades and at 90% of its maximum power on uphill grades.

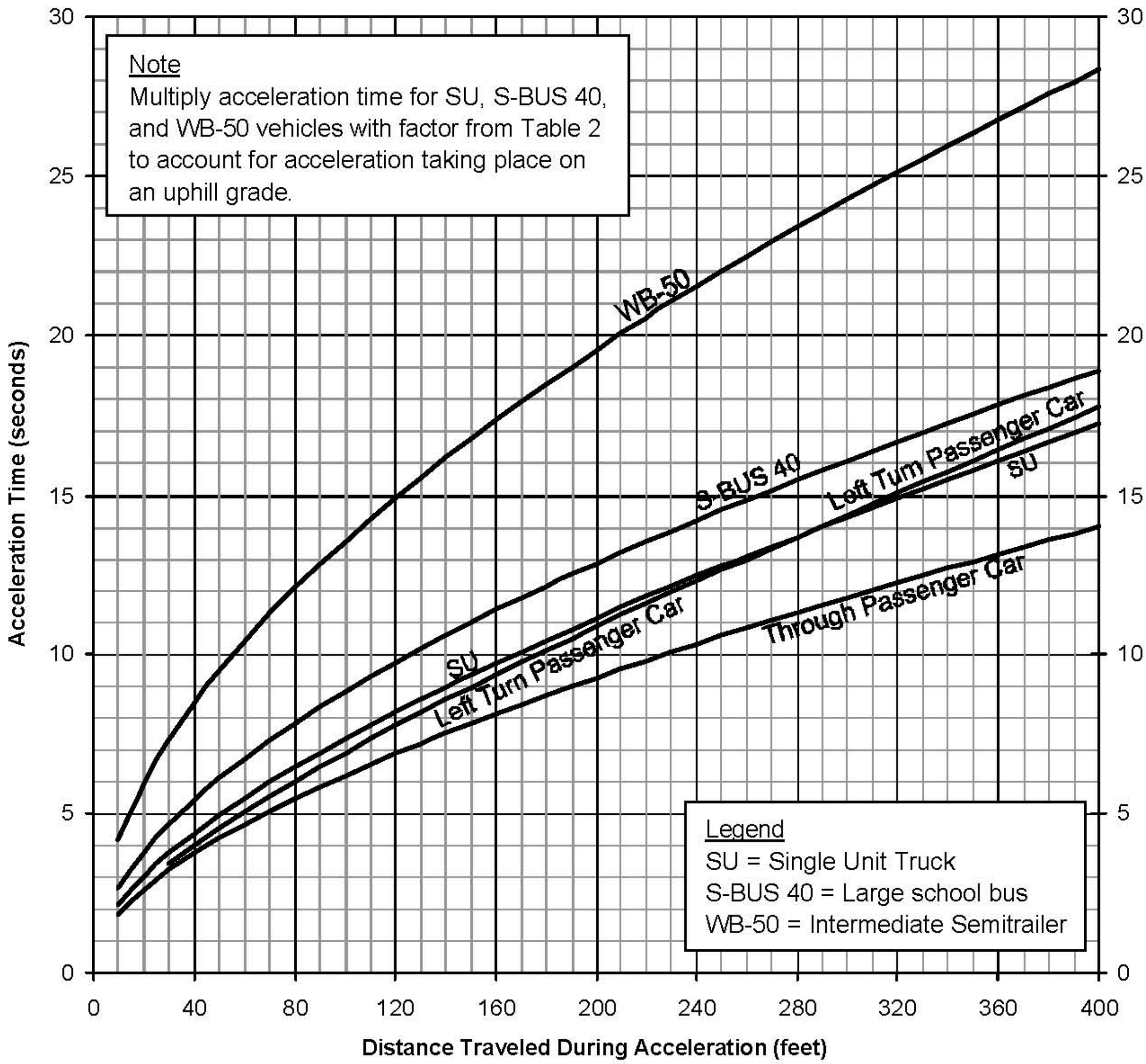


Figure 2 Acceleration time over a fixed distance on a level surface.

Table 2. Factors to account for slower acceleration on uphill grades. Multiply the appropriate factor (depending on the design vehicle, grade, and acceleration distance) with the acceleration time in Figure 2 to obtain the estimated acceleration time on the grade.

Acceleration Distance (ft)	Design Vehicle and Percentage Uphill Grade													
	Single Unit Truck (SU)				Large School Bus (S-BUS 40)					Intermediate Tractor-Trailer (WB-50)				
	0-2%	4%	6%	8%	0-1%	2%	4%	6%	8%	0%	2%	4%	6%	8%
25	1.00	1.06	1.13	1.19	1.00	1.01	1.10	1.19	1.28	1.00	1.09	1.27	1.42	1.55
50	1.00	1.09	1.17	1.25	1.00	1.01	1.12	1.21	1.30	1.00	1.10	1.28	1.44	1.58
75	1.00	1.10	1.19	1.29	1.00	1.02	1.13	1.23	1.33	1.00	1.11	1.30	1.47	1.61
100	1.00	1.11	1.21	1.32	1.00	1.02	1.14	1.25	1.35	1.00	1.11	1.31	1.48	1.64
125	1.00	1.12	1.23	1.34	1.00	1.03	1.15	1.26	1.37	1.00	1.12	1.32	1.50	1.66
150	1.00	1.12	1.24	1.37	1.00	1.03	1.16	1.28	1.40	1.00	1.12	1.33	1.52	1.68
175	1.00	1.13	1.25	1.38	1.00	1.03	1.17	1.29	1.42	1.00	1.12	1.34	1.53	1.70
200	1.00	1.13	1.26	1.40	1.00	1.04	1.17	1.30	1.43	1.00	1.13	1.35	1.54	1.72
225	1.00	1.14	1.27	1.42	1.00	1.04	1.18	1.32	1.45	1.00	1.13	1.35	1.56	1.74
250	1.00	1.14	1.28	1.43	1.00	1.04	1.19	1.33	1.47	1.00	1.13	1.36	1.57	1.76
275	1.00	1.14	1.29	1.44	1.00	1.05	1.20	1.34	1.49	1.00	1.14	1.37	1.58	1.77
300	1.00	1.14	1.30	1.46	1.00	1.05	1.20	1.35	1.50	1.00	1.14	1.37	1.59	1.79
325	1.00	1.15	1.30	1.47	1.00	1.05	1.21	1.36	1.52	1.00	1.14	1.38	1.60	1.81
350	1.00	1.15	1.31	1.48	1.00	1.05	1.22	1.37	1.54	1.00	1.15	1.39	1.61	1.82
375	1.00	1.15	1.31	1.49	1.00	1.06	1.22	1.38	1.55	1.00	1.15	1.39	1.62	1.84
400	1.00	1.15	1.32	1.50	1.00	1.06	1.23	1.40	1.57	1.00	1.15	1.40	1.63	1.85

For design vehicle clearance distances greater than 400 feet, use Equation 1 to estimate the time for the design vehicle to accelerate through the design vehicle clearance distance or any other distance:

$$T = e^{\left[a - b\sqrt{c + \frac{2}{b}\ln\left(\frac{d}{X}\right)}\right]} \tag{1}$$

where

T = time to accelerate through distance X, in seconds;
X = distance over which acceleration takes place, in feet;
ln = natural logarithm function;
e = 2.17828, the base of natural logarithms; and
a, b, c, and d = calibration parameters from Table 3.

Note: To interpolate between grades, do not interpolate the parameters in Table 3. The correct way to interpolate is to calculate the acceleration time T using Equation 1 for the two nearest grades and then interpolate between the two acceleration times.

Line 25. Queue clearance time is the total amount of time required (after the signal has turned green for the approach crossing the tracks) to begin moving a queue of vehicles through the queue start-up distance (L, Line 21) and then move the design vehicle from a stopped position at the far side of the crossing completely through the minimum track clearance distance (MTCD, Line 19). This value is the sum of the time required for design vehicle to start moving (Line 22) and the time for design vehicle to accelerate through the design vehicle clearance distance (Line 24).

Table 3. Parameters to estimate vehicle acceleration times over distances greater than 400 feet using Equation 1.

Design Vehicle	Grade	*a*	*b*	*c*	*d*
Through Passenger Car	Level	7.75	3.252	5.679	2.153
Left Turning Passenger Car	Level	10.29	5.832	3.114	5.090
Single Unit Truck (SU)	Level to 2%	8.16	3.624	5.070	2.018
	4%	10.39	4.865	4.560	1.739
	6%	9.52	4.542	4.393	1.700
	8%	9.38	4.597	4.165	1.668
Large School Bus (S-BUS 40)	Level to 1%	10.02	4.108	5.95	0.885
	2%	11.51	5.254	4.801	1.300
	4%	10.79	5.042	4.577	1.266
	6%	10.61	5.101	4.329	1.253
	8%	11.84	6.198	3.652	1.554
Intermediate Semi-Trailer (WB-50)	Level	17.75	7.984	4.940	0.481
	2%	10.26	4.026	6.500	0.249
	4%	9.39	3.635	6.670	0.193
	6%	9.38	3.732	6.310	0.188
	8%	10.31	4.515	5.219	0.265

SECTION 3: MAXIMUM PREEMPTION TIME CALCULATION

Line 26. Right-of-way transfer time, in seconds, recorded on Line 17. The right-of-way transfer time is the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval.

Line 27. Queue clearance time, in seconds, recorded on Line 25. Queue clearance time starts simultaneously with the track clearance green interval (i.e. after right-of-way transfer), and is the time required for the design vehicle stopped just inside the minimum track clearance distance to start up and move completely out of the minimum track clearance distance.

Line 28. Desired minimum separation time is a time "buffer" between the departure of the last vehicle (the design vehicle) from the railroad crossing (as defined by the minimum track clearance distance) and the arrival of the train. Separation time is added for safety reasons and to avoid driver discomfort. If no separation time is provided, a vehicle could potentially leave the crossing at exactly the same time the train arrives, which would certainly lead to severe driver discomfort and potential unsafe behavior. The recommended value of four (4) seconds is a based on the minimum recommended value found in the Institute of Transportation Engineer's *ITE Journal* (in an article by Marshall and Berg in February 1997).

Line 29. Maximum preemption time is the total amount of time required after the preempt is initiated by the railroad warning equipment to complete right-of-way transfer to the track clearance green interval, initiate the track clearance phase(s), move the design vehicle out of the crossing's minimum track clearance distance, and provide a separation time "buffer" before the train arrives at the crossing. It is the sum of the right-of-way transfer time (Line 26), the queue clearance time (Line 27), and the desired minimum separation time (Line 28).

SECTION 4: SUFFICIENT WARNING TIME CHECK

Line 30. Minimum time (seconds) is the least amount of time active warning devices shall operate prior to the arrival of a train at a highway-rail grade crossing. Section 8D.06 of the *Texas MUTCD* requires that flashing-light signals shall operate for at least 20 seconds before the arrival of any train, except on tracks where all trains operate at less than 32 km/h (20 mph) and where flagging is performed by an employee on the ground.

Line 31. Clearance time (seconds), typically known as CT, is the additional time that may be provided by the railroad to account for longer crossing time at wide (i.e., multi-track crossings) or skewed-angle crossings. You must obtain the clearance time from the railroad responsible for the railroad crossing. In cases where the minimum track clearance distance (Line 19) exceeds 35 feet, the railroads' *AREMA Manual* requires clearance time of one second be provided for each additional 10 feet, or portions thereof, over 35 feet. Additional clearance time may also be provided to account for site-specific needs. Examples of extra clearance time include cases where additional time is provided for simultaneous preemption (where the preemption notification is sent to the signal controller unit simultaneously with the activation of the railroad crossing's active warning devices), instead of providing advance preemption time.

Line 32. Minimum warning time (seconds) is the sum of the minimum time (Line 30) and the clearance time (Line 31). This value is the actual minimum time that active warning devices can be expected to operate at the crossing prior to the arrival of the train under normal, through-train conditions. The term "through-train" refers to the case where trains do not stop or start moving while near or at the crossing. Note that the minimum warning time, does not include buffer time (BT). Buffer time is added by the railroad to ensure that the minimum warning time is always provided despite inherent variations in warning times; however, it is not consistently provided and cannot be relied upon by the traffic engineer for signal preemption and/or warning time calculations.

Line 33. Advance preemption time (seconds), if provided, is the period of time that the notification of an approaching train is forwarded to the highway traffic signal controller unit or assembly prior to activating the railroad active warning devices. Only enter advance preemption time if you can verify from the railroad that advance preemption time is already being provided for your site. If you are determining whether or not you need advance preemption time, enter zero for the advance preemption time in Line 33.

Line 34. Warning time provided by the railroad is the sum of the minimum warning time (Line 32) and the advance preemption time (Line 33), in seconds. This value should be verified with the railroad, and should not include buffer time (BT).

Line 35. Additional warning time required from railroad is the additional time needed (if any), in seconds, that is required to provide safe preemption in the worst case (the maximum preemption time on Line 29), given the warning time provided by the railroad (Line 34). The additional warning time required is calculated by subtracting the warning time provided by the railroad (Line 34) from the maximum preemption time (Line 29). If the result of the subtraction is equal to or less than zero, it means that sufficient warning time is available, and you should enter zero (0) on Line 35. However, keep in mind that highly negative (-10 or less) subtraction results may indicate the potential for operational problems due to insufficient track clearance green time. Section 5 of the worksheet contains a methodology for calculating sufficient track clearance green time.

If the additional warning time is greater than zero (0), it means that the warning time provided by the railroad is insufficient, and additional warning time has to be requested from the railroad to ensure safe operation. The railroad can provide additional warning time either by providing additional clearance time (CT) (Line 30), or by providing or increasing advance preemption time (Line 33).

As an alternative, it may be possible to reduce the maximum preemption time (Line 29). To reduce the maximum preemption time, you can reduce either the preempt delay time (Line 1), if this is possible; reduce preempt minimum green time (Line 5) or other green time (Line 6), as long as you do not violate local policies for signal timing; or, reduce yellow change time (Line 7) or red clearance time (Line 8) as long as adequate and appropriate yellow change and red clearance intervals are provided as per the *Texas MUTCD* Section 4D.10 and applicable guidelines such as the Institute of Transportation Engineers' *Determining Vehicle Signal Change and Clearance Intervals*.

If pedestrian rather than vehicular phasing controls warning time requirements for preemption, it may be possible to reduce the minimum walk time (Line 11) and/or pedestrian clearance time (Line 12) as long as you do not violate local policies for signal timing. You can also let the pedestrian clearance time (flashing don't walk) time simultaneous with vehicular yellow change and red clearance and so reduce the values on Line 13 (yellow change time) and Line 14 (red clearance time) to zero (0). If local policies do not currently allow simultaneous clearance for pedestrian and vehicular phasing, you may want to consider allowing this type of operation to reduce your worst-case conflicting pedestrian time.

Once you have made all of the possible adjustments to the warning time, recompute the totals in Lines 3, 9, 15, 16, 17, 26, 29, and 35. If Line 35 remains greater than zero, then you will have to request additional warning time from the railroad, as described above, to ensure safe preemption of the adjacent signalized intersection.

SECTION 5: TRACK CLEARANCE GREEN TIME CALCULATION (OPTIONAL)

Note: This section is optional and is used to calculate the duration of the track clearance green interval. If this worksheet is only used to determine if additional warning time has to be requested from the railroad, this section need not be completed.

The objective of the section is to calculate the duration of the track clearance green interval to ensure safe and efficient operations at the crossing and adjacent traffic signal.

The Preempt Trap Check section (lines 36 to 44) focuses on safety by calculating the minimum duration of the track clearance green interval to ensure that the track clearance green does not terminate before the gates block access to the crossing. If the gates do not block access to the crossing before the expiration of the track clearance green, it is possible that vehicles can continue to cross the tracks and possibly stop on the tracks. However, the track clearance green interval has already expired and there will be no further opportunity to clear. This potentially hazardous condition is called the "preempt trap" and is described in more detail in TxDOT Project Bulletin 1752-9: The Preempt Trap: How to Make Sure You Do Not Have One.

The Clearing of Clear Storage Distance section (lines 45 to 50) focuses on efficiency by calculating duration of the track clearance green interval that is needed to clear the clear storage distance (CSD in Figure 1), or a specific portion thereof.

Preempt Trap Check

Line 36. Advance preemption time provided is the duration (in seconds) the preempt sequence is active in the highway traffic signal controller before the activation of the railroad active warning devices. If Line 35 is zero (i.e. no additional warning time is required from the railroad), the value on Line 33 can be used. In other cases, use the actual value of the advance preemption time (APT) provided by the railroad. If no APT is provided, enter zero on Line 36.

Line 37. Multiplier for maximum APT due to train handling is a value that relates the maximum duration of the advance preemption time (APT) to the minimum value guaranteed by the railroad. Although the railroad guarantees a minimum duration for the APT, it is probable that in most cases the actual duration of the APT will be longer than the guaranteed duration. This variability in APT occurs due to "train handling", which a term that describes the acceleration and deceleration of trains on their approach to the crossing. If a train accelerates or decelerates while approaching to the crossing, the railroad warning system cannot estimate the arrival time of the train at the crossing accurately, resulting in variation in the actual duration of APT provided. This variation needs to be taken into account to ensure safe operation.

To make sure that the preempt trap does not occur we need to determine the maximum value of the APT so that a sufficiently long track clearance green interval can be provided to ensure that the gates block access to the crossing before the track clearance green ends. The maximum APT can be estimated by multiplying the advance preemption time provided (and guaranteed) by the railroad (Line 36) with the multiplier for maximum APT due to train handling. This value is only significant if the value for APT on Line 36 is non-zero. If APT is zero, continue to line 38.

In the case where APT is provided, the difference between the minimum and maximum values of APT is termed excess APT. Excess APT usually occurs when the train decelerates on the approach to the crossing, or where train handling affects the accuracy of the estimated time of train arrival at the crossing so that the preempt sequence is activated earlier than expected. The amount of excess APT is increased by the following conditions:

- Increased variation in train speeds, since more trains will be speeding up and slowing down;
- Lower train speeds, since a fixed deceleration rate has a greater effect on travel time at low speeds than at higher speeds; and
- Longer warning times, because more time is available for the train to decelerate on the approach to the crossing.

The multiplier for maximum APT can be determined from field measurements as the largest advance preemption time observed (or the 95th percentile, if enough observations are available) divided by the value on Line 36. If no field observations are available, the multiplier for maximum APT can be estimated as 1.60 if warning time variability is high or 1.25 if warning time variability is low. High warning time variability can typically be expected in the vicinity of switching yards, branch lines, or anywhere low-speed switching maneuvers takes place. According to Section 16.30.10 of the *AREMA Signal Manual* the railroad can provide a "timer for constant time between APT and CWT." The effect of such a "not to exceed" timer is to eliminate excess APT, and if provided, the multiplier on Line 37 can be set to 1.0.

Line 38. Maximum APT is largest value (in seconds) of the advance preemption time that can typically be expected, which corresponds to the earliest possible time the preemption sequence in the traffic signal controller will be activated before the activation of the railroad grade crossing warning system (flashing lights and gates). It is the calculated by multiplying the APT provided by the railroad (Line 36) with the multiplier for maximum APT due to train handling (Line 37).

Line 39. Minimum duration for the track clearance green is the minimum duration (in seconds) of the track clearance green interval to ensure that the gates block access to the crossing before the track clearance green expires in the case where no advance preemption time is provided. It is necessary to block access to the crossing before the track clearance green expires to ensure that vehicles do not enter the crossing after the expiration of the track clearance green and so be subject to the preempt trap (described in the introduction to Section 5).

The 15 seconds minimum duration for the track clearance green interval is calculated from Federal regulations and requirements of the *Texas MUTCD*. Section 8D.06 of the *Texas MUTCD* requires that flashing-light signals shall operate for at least 20 seconds before the arrival of any train (with certain exceptions), while Section 8D.04 requires that the gate arm shall reach its horizontal position at least 5 seconds before the arrival of the train. For simultaneous (non-advance) preemption, the preemption sequence starts at the same time as the flashing-light signals, so to ensure that the preempt trap does not occur, a track clearance green interval of at least 15 seconds is required.

Line 40. Gates down after start of preemption is the maximum duration (in seconds) from when the preempt is activated in the highway traffic signal controller until the gates reach a horizontal position. Calculate this value by adding the maximum advance preemption time on Line 38 to the minimum duration for the track clearance green interval on Line 39.

Line 41. Preempt verification and response time, recorded on Line 3, is the number of seconds between the receipt at the controller unit of a preempt call issued by the railroad's grade crossing warning equipment and the time the controller software actually begins to respond to the preempt call.

Line 42. Best-case conflicting vehicle or pedestrian time (in seconds) is the minimum time from when the preempt starts to time in the controller (i.e. after verification and response) until the track clearance green interval can start timing. In most cases, this value is zero, since the controller may already be in the track clearance phase(s) when the preempt starts timing, and therefore the track clearance green interval can start timing immediately. The best-case conflicting vehicle or pedestrian time may be greater than zero if the track clearance green interval contains phases that are not in normal operation (and conflicts with the normal phases), or where another phase or interval always has to terminate before the track clearance green interval can start timing.

Line 43. Minimum right-of-way transfer time is the minimum amount of time needed for the best case condition, prior to display of the track clearance green interval. Calculate the minimum right-of-way transfer time by adding lines 41 and 42.

Line 44. Calculate the M**inimum track clearance green time** by subtracting Line 43 from Line 40. This yields the minimum time that the track clearance green interval has to be active to avoid the preempt trap.

Clearing of Clear Storage Distance

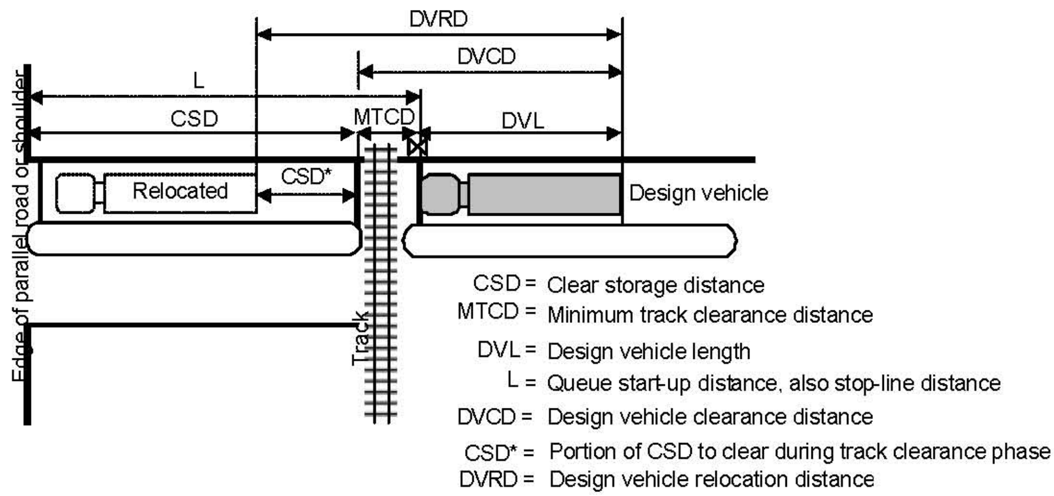


Figure 3 Relocation distances during the track clearance green interval.

Line 45. Time required for design vehicle to start moving, recorded on Line 22, is the number of seconds that elapses between the start of the track clearance green interval and the time the design vehicle, which is located at the edge of the railroad crossing on the opposite side from the signalized intersection, begins to move.

Line 46. Design vehicle clearance distance (DVCD in Figure 3) is the length, in feet, which the design vehicle must travel in order to enter and completely pass through the railroad crossing's minimum track clearance distance (MTCD). This is the same value as recorded on Line 23.

Line 47. Portion of CSD to clear during track clearance, (CSD* in Figure 3) is the portion of the clear storage distance (CSD), in feet, that must be cleared of vehicles before the track clearance green interval ends. For intersections with a CSD greater than approximately 150 feet it is desirable—but not necessary—to clear the full CSD during the track clearance green interval. In other words, it is desirable to set Line 47 to the full value of CSD (Line 18). If the full CSD is not cleared, however, vehicles will be stopped in the CSD during the preempt dwell period, and if not serviced during the preempt dwell period, will be subject to unnecessary delays which may result in unsafe behavior. For CSD values less than 150 feet the full CSD is typically cleared to avoid the driver task of crossing the tracks followed immediately by the decision to stop or go when presented by a yellow signal as the track clearance green interval terminates.

Line 48. Design vehicle relocation distance (DVRD in Figure 3) is the distance, in feet, that the design vehicle must accelerate through during the track clearance green interval. It is the sum of the design vehicle clearance distance (Line 46) and the portion of CSD to clear during the track clearance green interval (Line 47).

Line 49. The **Time required for design vehicle to accelerate through DVRD** is the amount of time required for the design vehicle to accelerate from a stop and travel the complete design vehicle relocation distance (DVRD). This time value, in seconds, can be found by locating your design vehicle relocation distance from Line 48 on the horizontal axis of Figure 2 and then drawing a line straight up until that line intersects the acceleration time performance curve for your design vehicle. For a WB-50 semi-trailer, large school bus (S-BUS 40), or single unit (SU) vehicle, multiply the acceleration time with a correction factor obtained from Table 2 to estimate the effect of grade on the acceleration of the vehicle. Use the average grade over the design vehicle relocation distance. For design vehicle relocation distances greater than 400 feet, use Equation 1 with the appropriate parameters listed in Table 3.

Line 50. Time to clear portion of clear storage distance, in seconds, is the total amount of time required (after the signal has turned green for the approach crossing the tracks) to begin moving a queue of vehicles through the queue start-up distance (L in Figure 3) and then move the design vehicle from a stopped position at the far side of the crossing completely through the portion of clear storage distance that must be cleared (CSD* in Figure 3). This value is the sum of the time required for design vehicle to start moving (Line 45) and the time for the design vehicle to accelerate through the design vehicle relocation distance, DVRD (Line 49).

Line 51. The **Track clearance green interval** is the time required, in seconds, for the track clearance green interval to avoid the occurrence of the preempt trap and to provide enough time for the design vehicle to clear the portion of the clear storage distance specified on Line 47. The track clearance green interval time is the maximum of the minimum track clearance green time (Line 44) and the time required to clear a portion of clear storage distance (Line 50).

SECTION 6: VEHICLE-GATE INTERACTION CHECK (OPTIONAL)

Note: This section is optional and is used to calculate the required advance preemption time to avoid the automatic gates descending on a stationary or slow moving design vehicle as it moves through the minimum track clearance distance (MTCD). If this worksheet is only used to determine if additional warning time has to be requested from the railroad to ensure that vehicles have enough time to clear the crossing before the arrival of the train, this section need not be completed.

Line 52. Right-of-way transfer time, in seconds, recorded on Line 17, is the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval.

Line 53. Time required for design vehicle to start moving, recorded on Line 22, is the time (in seconds) elapsed between the start of the track clearance green interval and the time the design vehicle, which is located at the edge of the railroad crossing on the opposite side from the signalized intersection, begins to move.

Line 54. Time required for design vehicle to accelerate through the design vehicle length, DVL, is the time required for the design vehicle to accelerate through its own length. The design vehicle length is recorded on Line 20. This time value, in seconds, can be read from Figure 2 and Table 2 or looked up in Table 4 for standard design vehicles. For a WB-50 semi-trailer, large school bus, or single unit (SU) truck use the average grade over the design vehicle length at the far side of the crossing.

Line 55. Time required for design vehicle to clear the descending gates, in seconds, is the sum of the right-of-way transfer time on Line 52, the time required for design vehicle to start moving on Line 53, and the time required for design vehicle to accelerate through the design vehicle length on Line 54.

Line 56. Duration of flashing lights before gate descent start, in seconds, is the time the railroad warning lights flash before the gates start to descend. This value typically ranges from 3 to 5 seconds and must be obtained from the railroad. The value obtained from the railroad may be verified using field observation.

Table 4. Time required for the design vehicle to accelerate through the design vehicle length.

Design Vehicle	Design Vehicle Length (feet)	Grade	Acceleration Time (seconds)
Through Passenger Car	19	Level	2.6
Left Turning Passenger Car	19	Level	2.7
Single Unit Truck (SU)	30	Level to 2%	3.8
		4%	4.0
		6%	4.3
		8%	4.6
Large School Bus (S-BUS 40)	40	Level to 1%	5.5
		2%	5.5
		4%	6.1
		6%	6.6
		8%	7.0
Intermediate Semi-Trailer (WB-50)	55	Level	10.0
		2%	11.0
		4%	12.8
		6%	14.4
		8%	15.8

Line 55. Time required for design vehicle to clear the descending gates, in seconds, is the sum of the right-of-way transfer time on Line 52, the time required for design vehicle to start moving on Line 53, and the time required for design vehicle to accelerate through the design vehicle length on Line 54.

Line 56. Duration of flashing lights before gate descent start, in seconds, is the time the railroad warning lights flash before the gates start to descend. This value typically ranges from 3 to 5 seconds and must be obtained from the railroad. The value obtained from the railroad may be verified using field observation.

Line 57. Full gate descent time, in seconds, is the time it takes for the gates to descend to a horizontal position after they start their descent. This value must be obtained from the railroad and may be verified using field observation. In the case where multiple gates descend at different speeds, use the descent time of the gate that reaches the horizontal position first.

Line 58. The **Proportion of non-interaction gate descent time** is the decimal proportion of the full gate descent time on Line 57 during which the gate will <u>not</u> interact with (i.e. not hit) the design vehicle if it is located under the gate. This value depends on the design vehicle height, h, and the distance from the center of the gate mechanism to the nearest side of the design vehicle, d, as shown in Figure 4. Figure 5 can be used to determine the proportion of non-interaction gate descent time. Select the distance from the center of the gate mechanism to the nearest side of the design vehicle, d, on the vertical axis of Figure 5, draw a horizontal line until you reach the curve that represents the design vehicle, and then draw a vertical line down to the horizontal axis and read off the value of the proportion of non-interaction gate descent time.

Line 59. Non-interaction gate descent time is time (in seconds) during gate descent that the gate will <u>not</u> interact with (i.e. not hit) the design vehicle if it is located under the gate. In other words, it is the time that expires after the gate starts to descend until it hits the design vehicle if it is located under the gate. This value is calculated by multiplying the full gate descent time on Line 57 with the proportion of non-interaction gate descent time on Line 58.

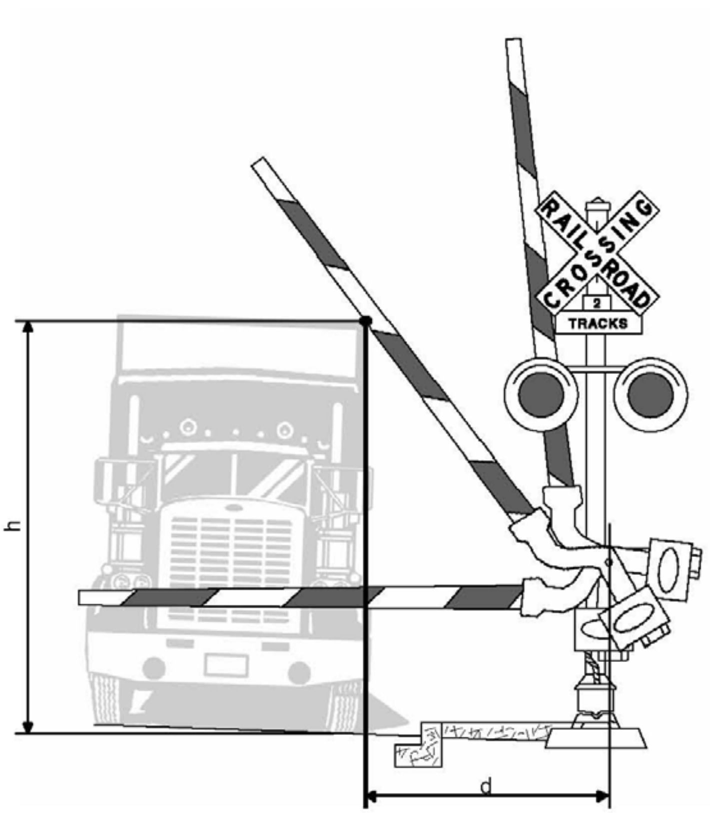


Figure 4 Gate interaction with the design vehicle.

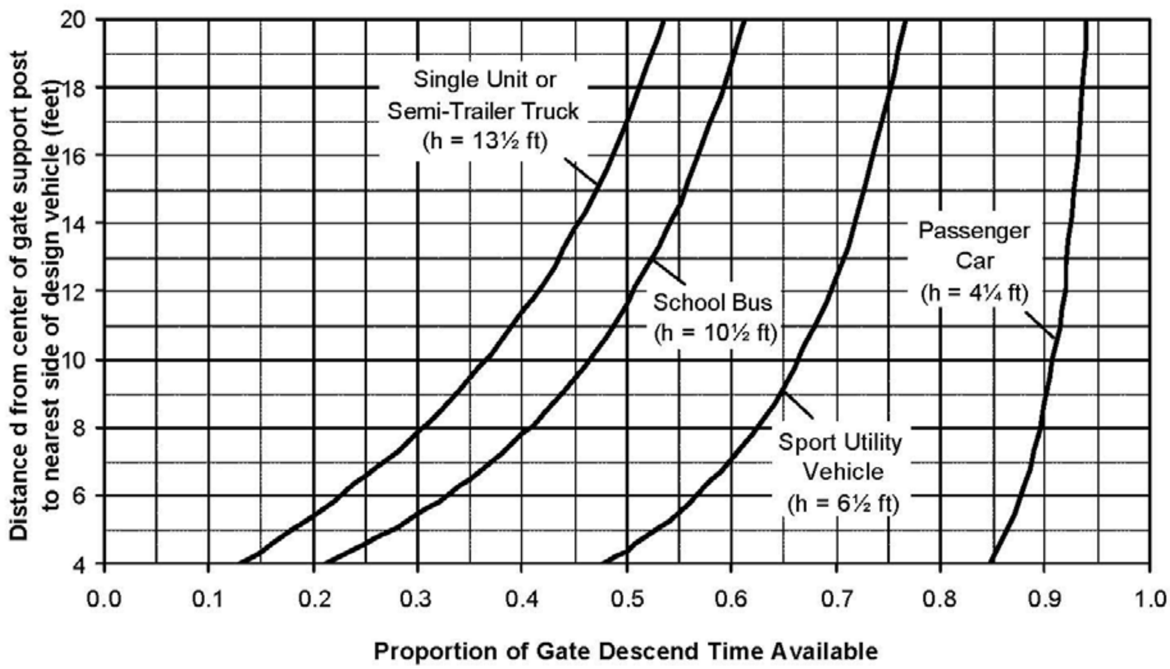


Figure 5 Proportion of gate descent time available as a function of the design vehicle height and the distance from the center of the gate mechanism to the nearest side of the design vehicle.

Line 60. Time available for design vehicle to clear descending gate, in seconds, is the time, after the railroad warning lights start to flash, that is available for the design vehicle to clear the descending gate before the gate hits the vehicle. It is the sum of the duration of the flashing lights before gate descent start (Line 56) and the non-interaction gate descent time (Line 59).

Line 61. Advance preemption time required to avoid design vehicle-gate interaction, in seconds, is calculated by subtracting the time available for the design vehicle to clear descending gate (Line 60) from the time required for the design vehicle to clear descending gate (Line 55). The result is the amount of advance preemption time that is required to avoid the gates descending on a stationary or slow-moving design vehicle. If the result of the subtraction is equal to or less than zero, it means that sufficient time is available, and you should enter zero (0) on Line 61. If the result is greater than the amount of advance preemption time provided by the railroad, as given on Line 36, there is a possibility that the gates could descend on a stationary or slow-moving design vehicle. To avoid this situation, additional advance preemption time should be requested from the railroad.

It should be kept in mind that on its own, gates descending on a vehicle is not a critical safety failure, because enough time still exists to clear the crossing before the arrival of the train, if the advance preemption time on Line 36 is provided. Therefore, local policies may vary on whether additional advance preemption time (over and above that on Line 36) should be requested solely for the purpose of prohibiting gates descending on vehicles.

If additional advance preemption time is provided to avoid design vehicle-gate interaction, Line 33 of this Worksheet has to updated, and Lines 34 and 35 recomputed. Section 5 also needs to be recomputed to calculate the track clearance green time.

REFERENCES

The following references were used in the development of the *2003 Guide For Determining Time Requirements For Traffic Signal Preemption At Highway-Rail Grade Crossings* and these accompanying Instructions.

Texas Department of Transportation. *Texas Manual on Uniform Traffic Control Devices (MUTCD).* 2003. On the Internet at http://www.dot.state.tx.us/TRF/mutcd.htm. Link valid May 2003.

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Vehicles Dynamics for Computing Track Clearance Phase Detection

Vehicles Dynamics when Accelerating from a Stopped Position								
Time (s) to start moving for the Nth vehicle								
Vehicle N	Fast Car	Average Thru Car	Average Left T. Car	Slow Car	Average SU	Average WB-15	Slow WB-15	Average School Bus
1.0	2.0	2.2	2.0	2.5	2.5	4.0	4.6	2.7
2.0	3.0	3.4	2.9	3.9	3.9	7.0	8.2	4.5
3.0	4.0	4.5	3.9	5.4	5.4	10.0	11.7	6.2
4.0	5.0	5.7	4.9	6.8	6.9	12.9	15.3	8.0
5.0	6.0	6.9	5.8	8.3	8.3	15.9	18.9	9.7
6.0	7.0	8.1	6.8	9.8	9.8	18.9	22.5	11.5
7.0	8.0	9.3	7.8	11.2	11.2	21.9	26.1	13.2
8.0	9.0	10.5	8.7	12.7	12.7	24.9	29.6	15.0
9.0	10.0	11.6	9.7	14.1	14.2	27.9	33.2	16.7
10.0	11.0	12.8	10.7	15.6	15.6	30.8	36.8	18.5

Methodology from: Modeling Queued Driver Behavior At Signalized Junctions
By Jim Bonneson
Transportation Research Record. 1992 (1365) pp99-107

Numbers from: 1. Acceleration Characteristics of Starting Vehicles
By Gary Long, University of Florida
TRB 2000 Preprint Paper No. 00-0980
2. School Bus Acceleration and Sight Distance
J.L. Gattis, S.H. Nelson, and J.D. Tubbs
Paper Submission to ASCE

Assumptions: 1 seconds initial perception-reaction time (Bonneson's tau)
The following saturation flows and vehicle queue spacing:

	Sat. Flow (vphgpl)	Queue space (ft/veh)
Fast Car	2600	25
Average Thru Car	2200	25
Average Left T. Car	2000	25
Slow Car	1800	25
Average SU	1500	36
Average WB-15	900	61
Slow WB-15	750	61
Average School Bus	1500	46

Vehicles Dynamics when Accelerating from a Stopped Position								
Distance traveled (ft) in time T from a stopped position								
Time T (s)	Fast Car	Average Thru Car	Average Left T. Car	Slow Car	Average SU	Average WB-15	Slow WB-15	Average School Bus
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5	0.9	0.8	0.8	0.7	0.6	0.1	0.1	0.8
1.0	3.5	3.2	3.1	2.9	2.4	0.6	0.2	3.1
1.5	7.7	7.0	6.7	6.3	5.3	1.3	0.6	6.8
2.0	13.4	12.2	11.5	11.0	9.2	2.4	1.0	12.0
2.5	20.6	18.7	17.3	16.9	14.1	3.7	1.5	18.5
3.0	29.1	26.4	24.1	23.8	19.8	5.3	2.2	26.2
3.5	38.9	35.3	31.8	31.8	26.5	7.2	3.0	35.2
4.0	50.0	45.3	40.2	40.7	33.9	9.3	3.9	45.3
4.5	62.2	56.3	49.3	50.5	42.0	11.8	5.0	56.5
5.0	75.5	68.2	59.0	61.1	50.9	14.5	6.1	68.8
5.5	89.9	81.1	69.3	72.5	60.4	17.5	7.4	82.1
6.0	105.2	94.8	80.1	84.6	70.5	20.8	8.8	96.4
6.5	121.5	109.3	91.3	97.5	81.2	24.3	10.3	111.6
7.0	138.7	124.5	102.9	111.0	92.5	28.1	12.0	127.7
7.5	156.6	140.5	114.8	125.0	104.2	32.1	13.7	144.6
8.0	175.4	157.2	127.1	139.7	116.4	36.4	15.6	162.3
8.5	194.9	174.4	139.7	154.9	129.1	41.0	17.6	180.9
9.0	215.2	192.3	152.5	170.5	142.1	45.8	19.7	200.1
9.5	236.0	210.8	165.5	186.7	155.6	50.9	21.9	220.1
10.0	257.6	229.7	178.7	203.3	169.4	56.2	24.2	240.7
10.5	279.7	249.2	192.2	220.3	183.5	61.8	26.6	262.0
11.0	302.4	269.1	205.8	237.6	198.0	67.6	29.2	283.9
11.5	325.6	289.5	219.5	255.4	212.8	73.6	31.8	306.4
12.0	349.4	310.3	233.4	273.4	227.9	79.9	34.6	329.5
12.5	373.6	331.4	247.4	291.8	243.2	86.4	37.5	353.1
13.0	398.3	353.0	261.4	310.5	258.7	93.2	40.5	377.2
13.5	423.4	374.9	275.6	329.4	274.5	100.1	43.6	401.8
14.0	448.9	397.1	289.9	348.6	290.5	107.4	46.8	426.9
14.5	474.8	419.6	304.3	368.1	306.8	114.8	50.1	452.4
15.0	501.1	442.4	318.7	387.8	323.2	122.5	53.5	478.4

Methodology from: Modeling Queued Driver Behavior At Signalized Junctions
By Jim Bonneson
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Numbers from: 1. Acceleration Characteristics of Starting Vehicles
By Gary Long, University of Florida
TRB 2000 Preprint Paper No. 00-0980
2. School Bus Acceleration and Sight Distance
J.L. Gattis, S.H. Nelson, and J.D. Tubbs
Paper Submission to ASCE

RIGHT-OF-WAY TRANSFER TIMING CALCULATION
TO SUPPORT TX DOT GUIDE FOR DETERMINING TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

IN ORDER TO DETERMINE THE PROPER RIGHT-OF-WAY TRANSFER TIME (RWTT), IT IS NECESSARY TO UNDERSTAND HOW THE CONTROLLER UNIT RESPONDS TO A CALL FOR RAILROAD PREEMPTION. NEWER EQUIPMENT GENERALLY ALLOWS CERTAIN TIME INTERVALS SUCH AS MINIMUM GREEN, PEDESTRIAN WALK & PEDESTRIAN CHANGE TO BE SHORTENED OR ELIMINATED WHEN THE RAILROAD PREEMPTION CALL IS RECEIVED. SOME CONTROLLER UNITS ALLOW THE SOME OR ALL OF THESE SETTINGS TO BE MADE GLOBALLY (ONE SETTING FOR ALL PHASES), PER RING (ONE SETTING PER RING) OR PER PHASE (ONE SETTING PER PHASE). OLDER EQUIPMENT MAY NOT PROVIDE THE ABILITY TO SHORTEN OR ELIMINATE ANY TIME INTERVALS. IN SOME INSTANCES, SUCH AS AT FREEWAY INTERCHANGES OR WHERE “STOP AHEAD WHEN FLASHING” SIGNS ARE USED, A SECOND OR ADDITIONAL GREEN INTERVAL IS USED WHICH CAN BE SHORTENED OR ABBREVIATED. ANY ADDITIONAL GREEN TIME MUST BE IDENTIFIED AND INSERTED IN THE FORM.

FOR THE PRUPOSES OF DETERMINING PROPER VALUES TO INSERT INTO THE PREEMPTION TIMING FORM, YOU MUST FIRST TEST AND EVALUATE HOW THE MINIMUM TIMES ARE TREATED WITH THE SPECIFIC HARDWARE AND FIRMWARE. THIS CAN BE ACCOMPLISHED THROUGH A NUMBER OF METHODS SUCH AS REFERRING TO MANUFACTURER PRODUCT MANUALS OR LITERATURE, BY INSPECTION OF A TIMING SHEET PROVIDED BY THE SUPPLIER OF THE FIRMWARE OR BY SIMULATING A PREEMPTION CALL IN EACH PHASE AND INTERVAL IN ORDER TO DETERMINE HOW THE EQUIPMENT FUNCTIONS. IF THERE IS ANY UNCERTAINTY AS TO HOW THE EQUIPMENT OPERATES, IT IS MANDATORY TO PERMORM OPERATIONAL TESTING TO VALIDATE THE PROPER OPERATION.

IT IS ALSO NECESSARY TO DETERMINE IF THE CONTROLLER UNIT PERMITS THE PEDESTRIAN CHANGE INTERVAL TO TIME CONCURRENTLY WITH THE YELLOW CHANGE OR THE RED CLEARANCE INTERVAL. AGAIN, THIS FUNCTION IS SPECIFIC TO THE FIRMWARE VERSION INSTALLED IN THE HARDWARE.

THE PURPOSE OF RWTT IS TO DETERMINE HOW MUCH TIME IS REQUIRED IN ORDER TO LEAVE THE MINIMUM GREEN, PEDESTRIAN WALK AND THE PEDESTRIAN CHANGE INTERVALS FOR EVERY NON-TRACK PHASE. A NON-TRACK PHASE IS ANY PHASE WHICH, IF GREEN WHEN THE PREEMPTION CALL IS RECEIVED, MAY REMAIN GREEN WITHOUT THE NEED TO CHANGE TO RED. THESE ARE GENERALLY THE PHASES WHICH CONTROL MOVEMENTS CROSSING THE TRACK, BUT THIS MAY NOT ALWAYS BE TRUE, ESPECIALLY IF “YELLOW TRAP” SEQUENCING IS UTILIZED.

VEHICULAR RWTT DATA

PHASE	1	2	3	4	5	6	7	8
MIN GREEN								
ADDL GREEN								
YELLOW CH								
RED CLEAR								
VEH RWTT								

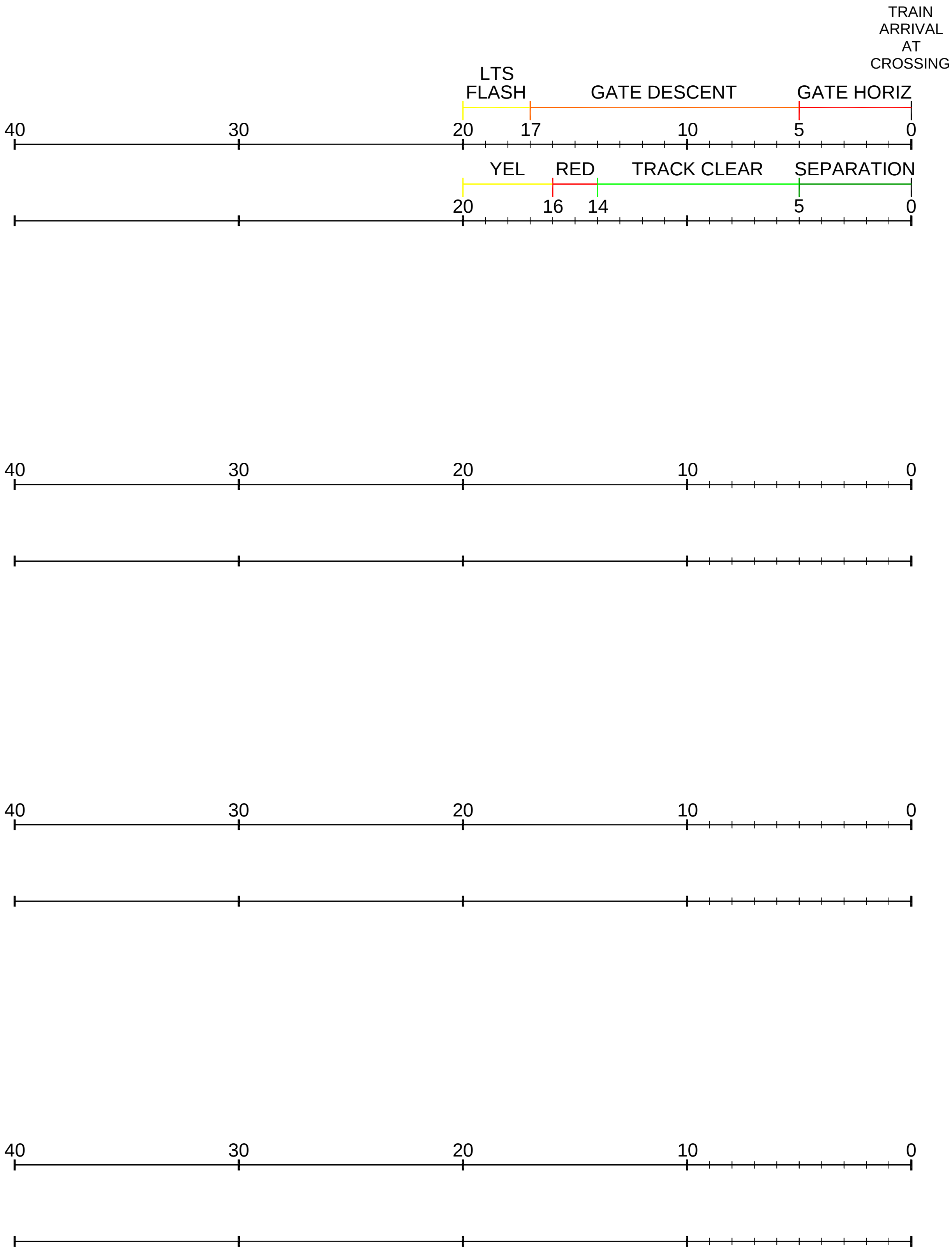
THE GREATEST VALUE FOR THE VEHICULAR RWTT FOR THE NON-TRACK PHASES IS INSERTED INTO LINE 9 OF THE FORM.

PEDESTRIAN RWTT

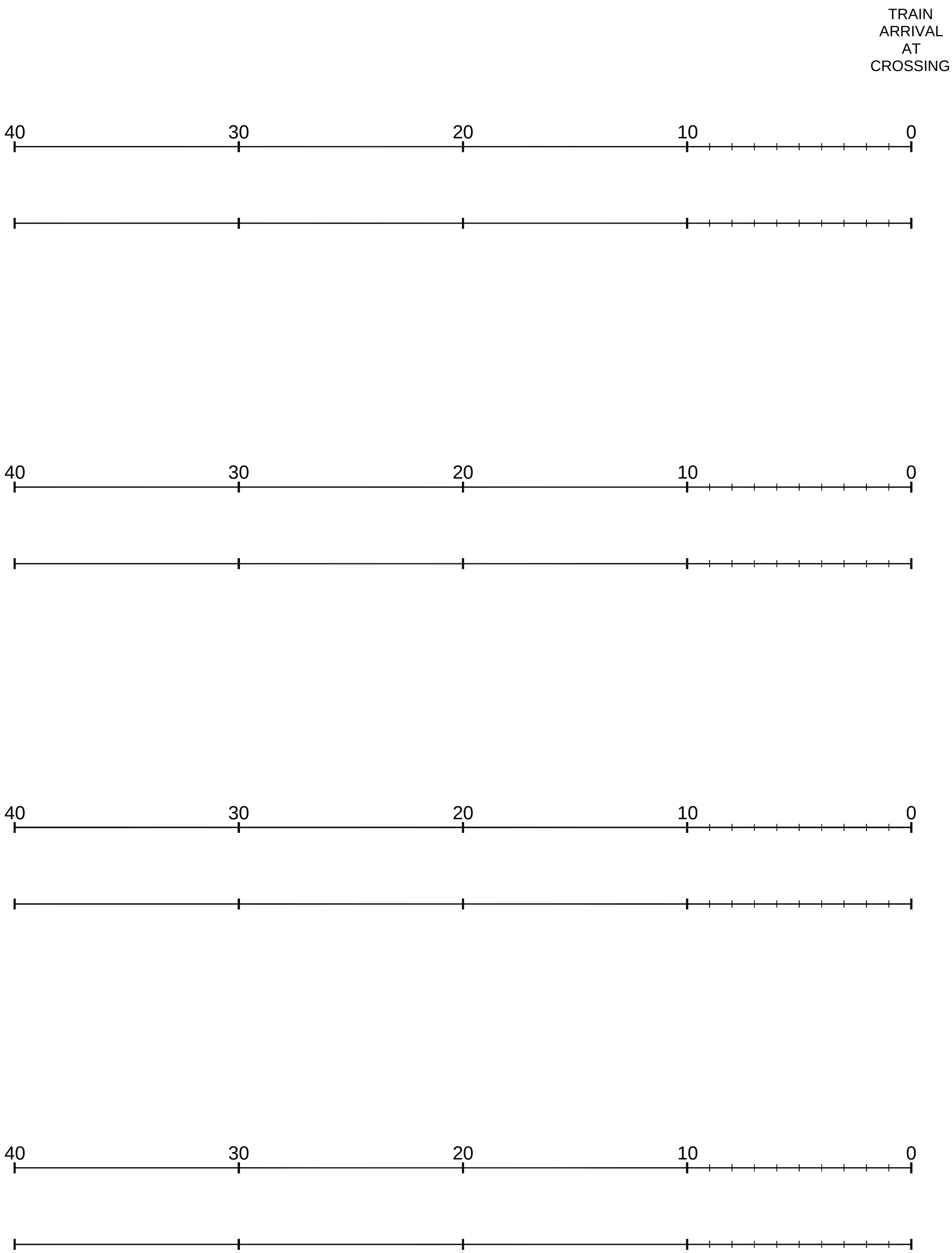
PHASE	1	2	3	4	5	6	7	8
WALK								
PED CHG								
YELLOW								
RED CLR								
PED RWTT								

THE GREATEST VALUE FOR THE PEDESTRIAN RWTT FOR THE NON-TRACK PHASES IS INSERTED INTO LINE 15 OF THE FORM.

Basic Preempt Time Line



Preempt Time Line



CASE STUDIES

WAS FOX RIVER GROVE AN ANOMALY?

SURELY THIS ISN'T AS BIG A PROBLEM AS YOU MAKE IT OUT TO BE. IS IT?

CASE STUDY

State Street and 68th Avenue in Wauwatosa, Wisconsin

AREA'S PRE-EMPTIVE RAILROAD CROSSINGS CALLED SAFE

The Milwaukee Journal Sentinel
Nov 1, 1995
by LARRY SANDLER

At least three area railroad crossings have signal systems similar to the one under study in a fatal Illinois bus-train collision, but authorities say they're all working safely.

The National Transportation Safety Board last week urged local transportation officials to inspect crossings near intersections, where traffic signals are governed by so-called pre-emption systems. The systems are supposed to prevent cars and buses from being trapped on the tracks in the path of an oncoming train.

Signal problems have been cited as a possible contributor to last week's crash in a Chicago suburb in which seven students on a school bus were killed and dozens of others injured.

Pre-emption systems at crossings parallel to W. State St., at N. 68th and 70th streets in Wauwatosa, were checked Friday and were working properly, said City Engineer S. Howard Young.

A crossing in Elm Grove, near Watertown Plank Road and Legion Drive was checked less than two years ago and found to be working properly, Police Chief Jeffrey Haig said.

TRUCK TRAPPED IN TRAFFIC HIT BY TRAIN IN WAUWATOSA

The Milwaukee Journal Sentinel
Oct 6, 2005
by ANNYSA JOHNSON

No charges are expected to be filed in a train-truck collision that sent two people to the hospital with minor injuries Wednesday.

Wauwatosa Police called the accident at N. 68th and W. State streets "a fluke" caused by a traffic backup and the timing of the street lights. But the state Railroad Commission ranks the intersection in the bottom 2% of its 4,167 non-bridge crossings in terms of safety. And nearby residents raised concern.

"I've timed it, and you have only 7 to 10 seconds to get off those tracks," said Pat Johnson of N. 68th St., just north of the intersection. "There are always people turning left off of those tracks, and sometimes there's nowhere to go."

The driver of a Dorshak Family Tree Service truck escaped serious injury about 10:20 a.m. when his vehicle was broadsided by the westbound train.

According to police, the driver had the green light and started north over the tracks but became stuck when traffic in front of him failed to move and the crossing's gates went down in front of and behind him.

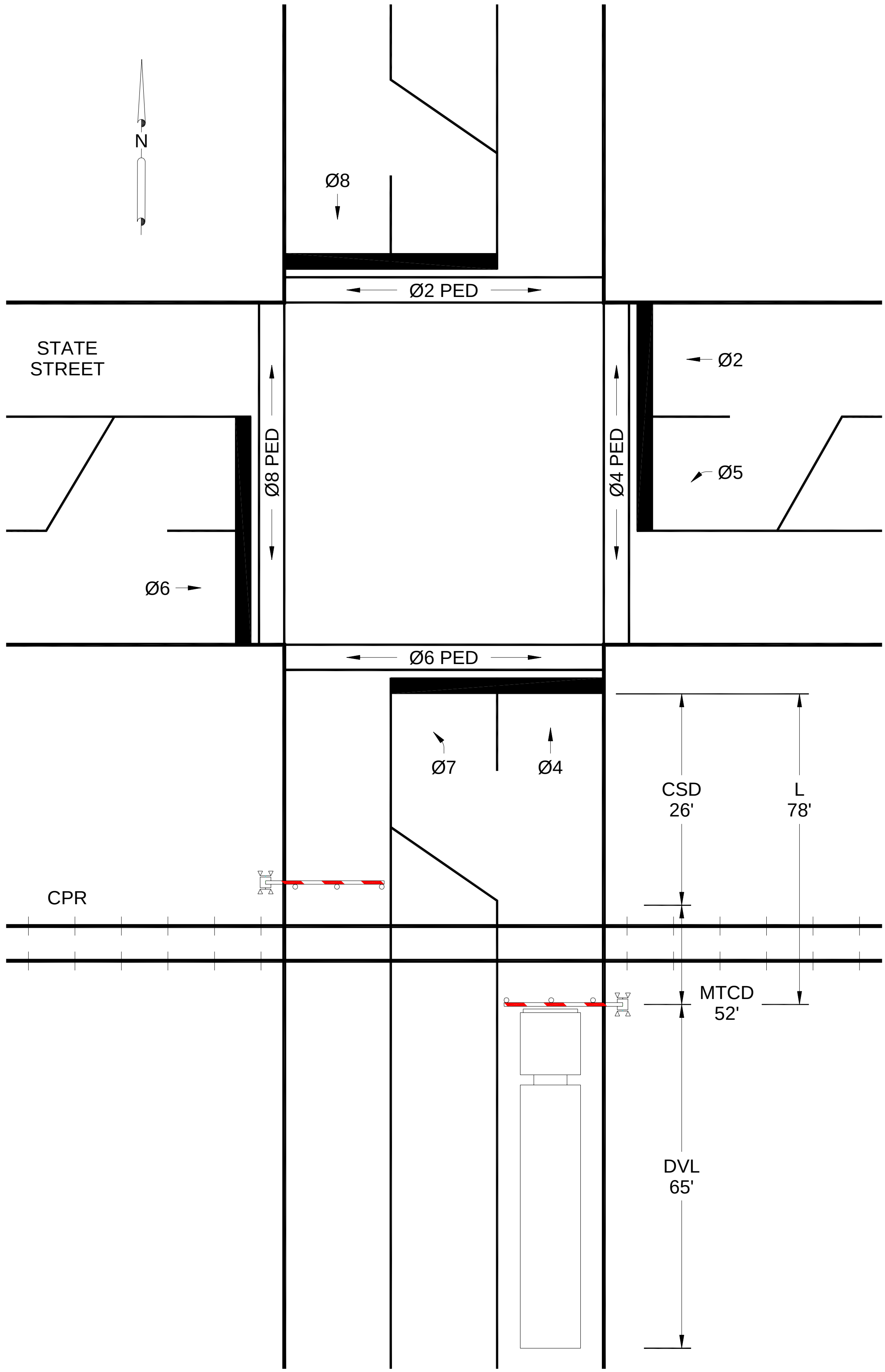
Police said the train was traveling about 40 mph when the engineer saw the truck on the tracks and hit the brakes. Police accident investigator Lynn Kavelaris estimated the train was going about 35 mph at impact.

A 21-year-old Milwaukee woman waiting for a bus at the intersection was sprayed with liquid fertilizer that spewed from a 200-gallon container in the back of the vehicle. Both were treated and released from a local hospital, said police, who refused to identify either person Wednesday.

"It could have been a lot worse," Kavelaris said of the accident's outcome.

The impact from the train mangled the back half of the truck, downed electric power lines and sent gasoline and about 175 gallons of the nitrogen-based fertilizer into the street, said Wauwatosa Fire Department Deputy Chief Michael Carberry.


RAILROAD CROSSING
2 TRACKS
NO TURN ON RED
DO NOT STOP ON TRACKS
ONE LANE ROAD AHEAD
Cousins



W. STATE ST. & N. 68th ST.
WAUWATOSA, WI.

Version 6-10-04

Texas Department of Transportation

GUIDE FOR DETERMINING TIME REQUIREMENTS FOR TRAFFIC SIGNAL PREEMPTION AT HIGHWAY-RAIL GRADE CROSSINGS

City Wauwatosa, WI

County

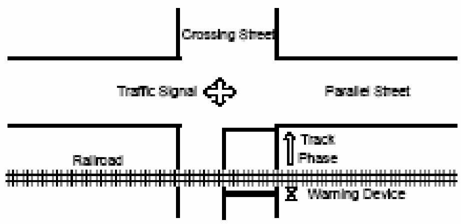
District

Date

Completed by

District Approval

Show North Arrow



Parallel Street Name

W State Street

Crossing Street Name

N 68th Street

Railroad CP Railway

Crossing DOT# 390 501D

Railroad Contact

Phone

SECTION 1: RIGHT-OF-WAY TRANSFER TIME CALCULATION

Preempt verification and response time

			Remarks
1. Preempt delay time (seconds)	1.	0.0	
2. Controller response time to preempt (seconds)	2.	0.0	Controller type:
3. Preempt verification and response time (seconds): add lines 1 and 2	3.	0.0	

Worst-case conflicting vehicle time

			Remarks
4. Worst-case conflicting vehicle phase number	4.		
5. Minimum green time during right-of-way transfer (seconds)	5.	7.0	
6. Other green time during right-of-way transfer (seconds)	6.	0.0	
7. Yellow change time (seconds)	7.	4.0	
8. Red clearance time (seconds)	8.	1.6	
9. Worst-case conflicting vehicle time (seconds): add lines 5 through 8	9.	12.6	

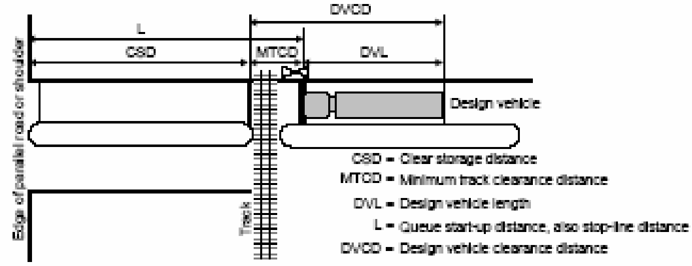
Worst-case conflicting pedestrian time

			Remarks
10. Worst-case conflicting pedestrian phase number	10.		
11. Minimum walk time during right-of-way transfer (seconds)	11.	0.0	Ped Clear continues thru
12. Pedestrian clearance time during right-of-way transfer (seconds)	12.	15.0	yellow change and red
13. Vehicle yellow change time, if not included on line 12 (seconds)	13.	4.0	clearance intervals
14. Vehicle red clearance time, if not included on line 12 (seconds)	14.	1.6	
15. Worst-case conflicting pedestrian time (seconds): add lines 11 through 14	15.	20.6	

Worst-case conflicting vehicle or pedestrian time

16. Worst-case conflicting vehicle or pedestrian time (seconds): maximum of lines 9 and 15	16.	20.6
17. Right-of-way transfer time (seconds): add lines 3 and 16	17.	20.6

SECTION 2: QUEUE CLEARANCE TIME CALCULATION



			Remarks
18.	Clear storage distance (CSD, feet)	26	
19.	Minimum track clearance distance (MTCD, feet)	52	
20.	Design vehicle length (DVL, feet)	65	Design vehicle type: WB-50
21.	Queue start-up distance, L (feet): add lines 18 and 19	78	
22.	Time required for design vehicle to start moving (seconds): calculate as 2+(L÷20)	5.9	
23.	Design vehicle clearance distance, DVCD (feet): add lines 19 and 20	117	
24.	Time for design vehicle to accelerate through the DVCD (seconds)	15.0	Read from Figure 2 in instructions.
25.	**Queue clearance time (seconds): add lines 22 and 24**	20.9	

SECTION 3: MAXIMUM PREEMPTION TIME CALCULATION

			Remarks
26.	Right-of-way transfer time (seconds): line 17	20.6	
27.	Queue clearance time (seconds): line 25	20.9	
28.	Desired minimum separation time (seconds)	4.0	
29.	**Maximum preemption time (seconds): add lines 26 through 28**	45.5	

SECTION 4: SUFFICIENT WARNING TIME CHECK

			Remarks
30.	Required minimum time, MT (seconds): per regulations	20.0	
31.	Clearance time, CT (seconds): get from railroad	2.0	
32.	Minimum warning time, MWT (seconds): add lines 30 and 31	22.0	Excludes buffer time (BT)
33.	Advance preemption time, APT, if provided (seconds): get from railroad		
34.	Warning time provided by the railroad (seconds): add lines 32 and 33	22.0	
35.	**Additional warning time required from railroad (seconds): subtract line 34 from line 29, round up to nearest full second, enter 0 if less than 0**	24	

> If the additional warning time required (line 35) is greater than zero, additional warning time has to be requested from the railroad. Alternatively, the maximum preemption time (line 29) may be decreased after performing an engineering study to investigate the possibility of reducing the values on lines 1, 5, 6, 7, 8, 11, 12, 13 and 14.

Remarks: ____________________

SECTION 5: TRACK CLEARANCE GREEN TIME CALCULATION (OPTIONAL)

Preempt Trap Check

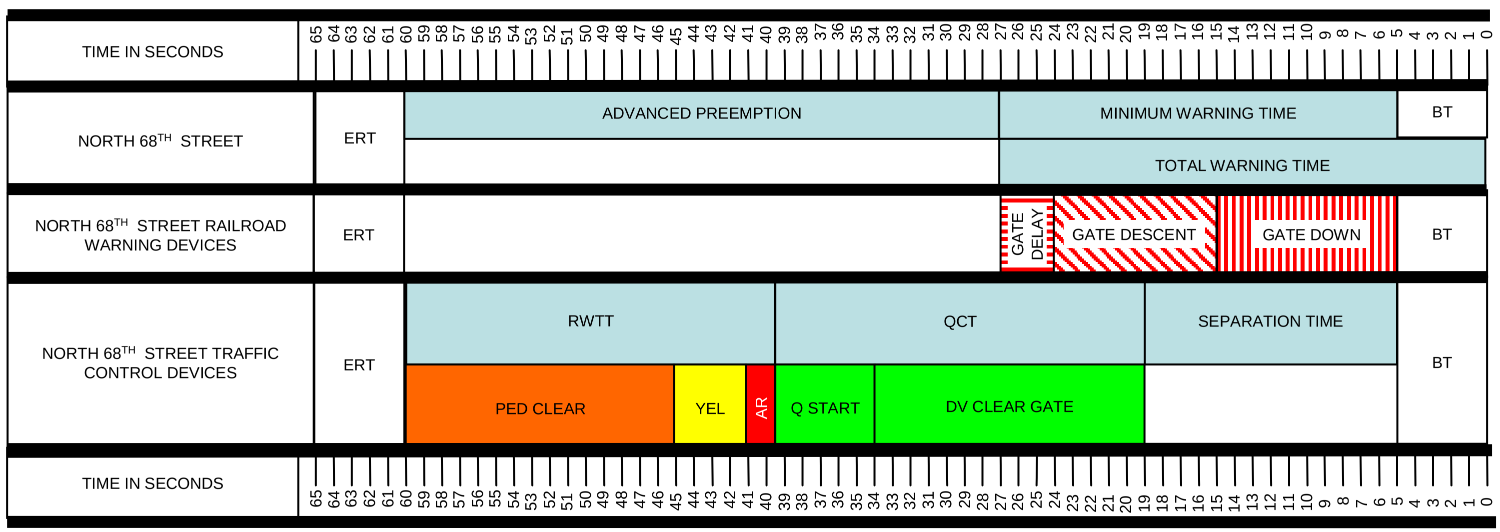
36.	Advance preemption time (APT) provided (seconds):		Line 33 only valid if line 36 is zero.
37.	Multiplier for maximum APT due to train handling		See instructions for details.
38.	Maximum APT (seconds): multiply line 36 and 37	0.0	Remarks
39.	Minimum duration for the track clearance green interval (seconds)	15.0	For zero advance preemption time
40.	Gates down after start of preemption (seconds): add lines 38 and 39	15.0	
41.	Preempt verification and response time (seconds): line 3	0.0	Remarks
42.	Best-case conflicting vehicle or pedestrian time (seconds): usually 0		
43.	Minimum right-of-way transfer time (seconds): add lines 41 and 42	0.0	
44.	Minimum track clearance green time (seconds): subtract line 43 from line 40	15.0	

Clearing of Clear Storage Distance

45.	Time required for design vehicle to start moving (seconds), line 22	5.9	
46.	Design vehicle clearance distance (DVCD, feet), line 23	117	Remarks
47.	Portion of CSD to clear during track clearance phase (feet)		CSD* in Figure 3 in instructions.
48.	Design vehicle relocation distance (DVRD, feet): add lines 46 and 47	117	
49.	Time required for design vehicle to accelerate through DVRD (seconds)		Read from Figure 2 in instructions.
50.	Time to clear portion of clear storage distance (seconds): add lines 45 and 49	5.9	
51.	**Track clearance green interval (seconds): maximum of lines 44 and 50, round up to nearest full second**	**15**	

SECTION 6: VEHICLE-GATE INTERACTION CHECK (OPTIONAL)

52.	Right-of-way transfer time (seconds): line 17	20.6	
53.	Time required for design vehicle to start moving (seconds), line 22	5.9	
54.	Time required for design vehicle to accelerate through DVL (on line 20, seconds)	11.0	Read from Table 3 in instructions.
55.	Time required for design vehicle to clear descending gate (seconds): add lines 52 though 54	37.5	Remarks
56.	Duration of flashing lights before gate descent start (seconds): get from railroad	3.0	Remarks
57.	Full gate descent time (seconds): get from railroad	9.0	
58.	Proportion of non-interaction gate descent time	0.22	Read from Figure 5 in instructions.
59.	Non-interaction gate descent time (seconds): multiply lines 57 and 58	2.0	
60.	Time available for design vehicle to clear descending gate (seconds): add lines 56 and 59	5.0	
61.	**Advance preemption time (APT) required to avoid design vehicle-gate interaction (seconds): subtract line 60 from line 55, round up to nearest full second, enter 0 if less than 0**	**33**	



NORTH 68TH STREET CROSSING

Indicator of Problems?

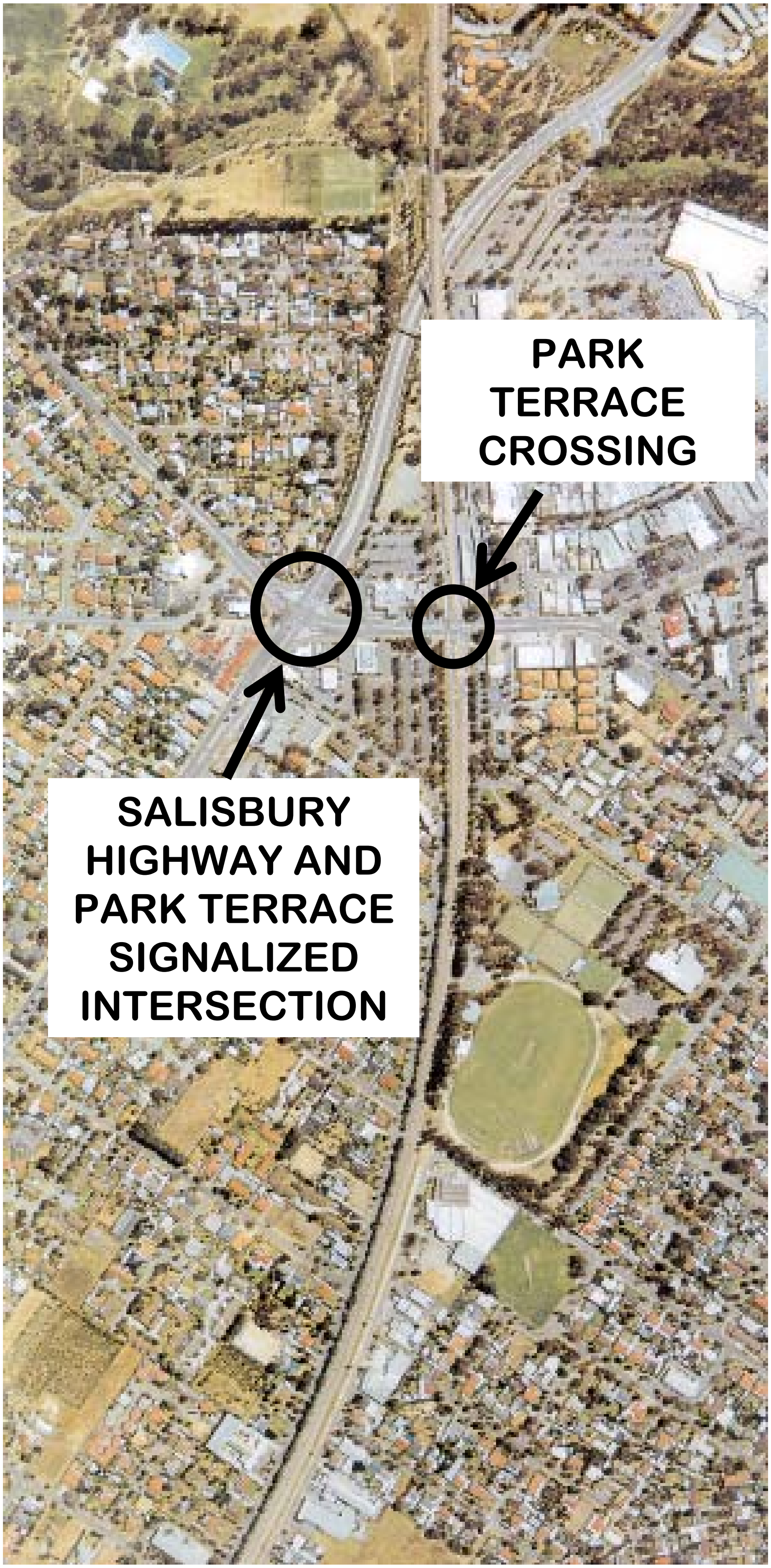
http://www.atsb.gov.au/publications/investigation_reports/2002/RAIR/pdf/rair2002002_001.pdf

Australian Government
Australian Transport Safety Bureau

At 15:33:01 on 24 October 2002 passenger train 5AL8 collided with a car and scheduled bus on the Salisbury Interchange controlled level crossing on Park Terrace. As a result of the accident 4 people were killed and 26 injured. A small sedan car and the bus were effectively destroyed. In addition two other road vehicles were damaged. The locomotive and the first vehicle of the consist sustained minor damage. There was no derailment of any rail vehicles.

The report details 13 key conclusions:

The immediate cause of the collision between train 5AL8, the white Nova Holden WOJ 601 and Serco bus number 246 (VYV 786) was that the drivers of the road vehicles entered the level crossing, in contravention of the Australian Road Rules, at a time when they were unable to drive through the crossing and were blocked by other vehicles.


PARK
TERRACE
CROSSING
SALISBURY
HIGHWAY AND
PARK TERRACE
SIGNALIZED
INTERSECTION

The driver and co-driver of locomotive NR 34, reacted promptly in sounding a warning of train 5AL8, applying emergency brakes and returning the throttle to idle. Neither the driver nor the co-driver could have taken any action that would have prevented the collision with the white Holden Nova or Serco bus number 246 (VYV 786) operating the 401 service.

Locomotive NR 34 and the 25 vehicles of the consist comprising train 5AL8 were in working order, were properly maintained and were fit for purpose. There were no deficiencies in the consist that contributed to the collision.

The railway infrastructure (track circuitry, signals, level crossing warning signals and the boom barrier) worked as designed within standard time limits.

Following the collision, the on train staff servicing the passenger vehicles of train 5AL8 acted promptly to assist the injured at the scene of the accident until they were able to relinquish care to the emergency services.

The response of the emergency services was timely.

The road traffic lights at the junction of Park Terrace, Gawler Street, North Lane and the Bus Interchange and the link with the level crossing warning signals worked as designed.

The road traffic signals at the Salisbury Highway/Park terrace intersection did not work as designed or as recommended by Australian Standard AS1742.14, in that the link with the railway crossing had been broken at some time and the special queue-clearing phase was not operational. There was no effective maintenance or checking system in place to monitor the continuing operation of the queuing phase of the lights and the links with the traffic Control Centre. The non-operation of the special queuing phase was probably not a significant factor in the collision of 24 October.

The road traffic on the western side of the level crossing for traffic crossing Salisbury Highway or turning onto Salisbury Highway was halted at the traffic signals causing traffic to back-up over the level crossing.

The backing up of westbound traffic across some part of the level crossing was not unusual and had become an accepted factor of driving in Park Terrace.

The complexity of the Park Terrace road system over a distance of 175 m from the bus interchange turning just east of the level crossing to the stop line at Salisbury Highway, increased the probability of road vehicles backing up to the level crossing in that:

- Road vehicles exiting or entering the Station car park and crossing or from the outside westbound lane, right turn lane, or attempting to enter the eastbound lane potentially restrict traffic flow.

- Road vehicles exiting or entering the Eureka Tavern car park across the traffic.

- Heavy traffic southbound on the Salisbury Highway restricts the opportunity for traffic in the left turn lane to join the Salisbury Highway.

Based on observed behaviour of road vehicle drivers, a collision between traffic queued at Park Terrace and a train was foreseeable. However, the absence of any specific reports of near miss incidents or accidents between trains and vehicles at Park Terrace had led to a belief that there was no significant risk.

The lack of initial site control following the collision and during the immediate emergency phase increased the risk of pedestrian onlookers being struck by trains, either through any possible movement of train 5AL8 or the TransAdelaide services.

7.2. If a traffic signal installation is located close to a railway level crossing, special provision shall be made to ensure that queues generated by the traffic signals will not extend across the railway tracks. This may be achieved by treatments such as warning signs, escape routes, additional road widening and queue detectors.

Consideration should be given to providing a queue clearance phase or any other special phase that would avoid queue formation across the crossing before the arrival of the train. This will require traffic signal linking with the railway level crossing to enable a special phase to be initiated at a predetermined time before the train is due to arrive at the crossing. Once the queue-clearing phase has terminated, no phases or turning movements which would have traffic cross the railway line can be introduced until the train has cleared the crossing. It may be necessary to provide for additional storage of these vehicles while the railway level crossing is closed.

In some situations, it may be possible to include the railway level crossing within the vehicular conflict area. In this case, the train movement may be treated as a priority phase.

8. PROXIMITY TO OTHER TRAFFIC CONTROL DEVICES

The following should be considered before installing traffic control devices in the vicinity of a railway level crossing –

(a) the effect that the device may have upon the operation of the railway level crossing, e.g. vehicles queuing over the crossing; and

(b) the effect that the normal operation of the railway level crossing may have upon the effectiveness of the traffic control devices, e.g. vehicles at the railway crossing queuing through an intersection, thus affecting the flow of traffic not using the crossing.

The general principles of operation are:

Upon receipt of the early call signal from the rail crossing control system the traffic signal controller shall move to the clearance phase (where required). The early call will remain active until after receipt of the late call.

Upon receipt of the late call signal from the rail crossing control system (which activates the flashing red signals and the boomgates) the traffic signal controller shall move to the railway phase. The late call will remain active until after the train has cleared the crossing. Upon removal of both the early and late call signals the traffic signal controller shall resume normal operation.

Liaison with the rail authority will be required to determine the time difference between the two signals supplied by the rail crossing control system.

The minimum time between the early and late call signals shall be such as to allow safe termination of any phase under the most adverse conditions (e.g. just started green or walk) and then running the clearance phase long enough to clear any vehicles possibly stored across the rail tracks. Potential vehicle numbers, types, lengths and acceleration performances shall be taken into account.

The maximum time between the early and late call signals shall be such that the traffic signals are not held in the clearance phase for excessive times prior to the railway phase, as this typically leads to deliberate disregard of the red traffic signals. This should generally not exceed the minimum time (as determined above) by more than 10 seconds.

Where the late call only is received without an early call, the traffic signal controller shall move to the clearance phase followed by the railway phase.

Where the early call only is received without a late call the traffic signal controller shall move to the clearance phase and remain there until the call is removed.

Unless otherwise approved by Main Roads the railway phase shall not operate until the flashing red signals and boomgates are activated. This is to ensure that no vehicles approaching the rail crossing from any direction will be stopped over the rail tracks.

Rose Avenue – Oxnard, CA

Gasper Medina told The Associated Press that he set up the cameras at the intersection to document the danger at the rail crossing.

STEVE LOPEZ/Staff Artist

Cause for concern?

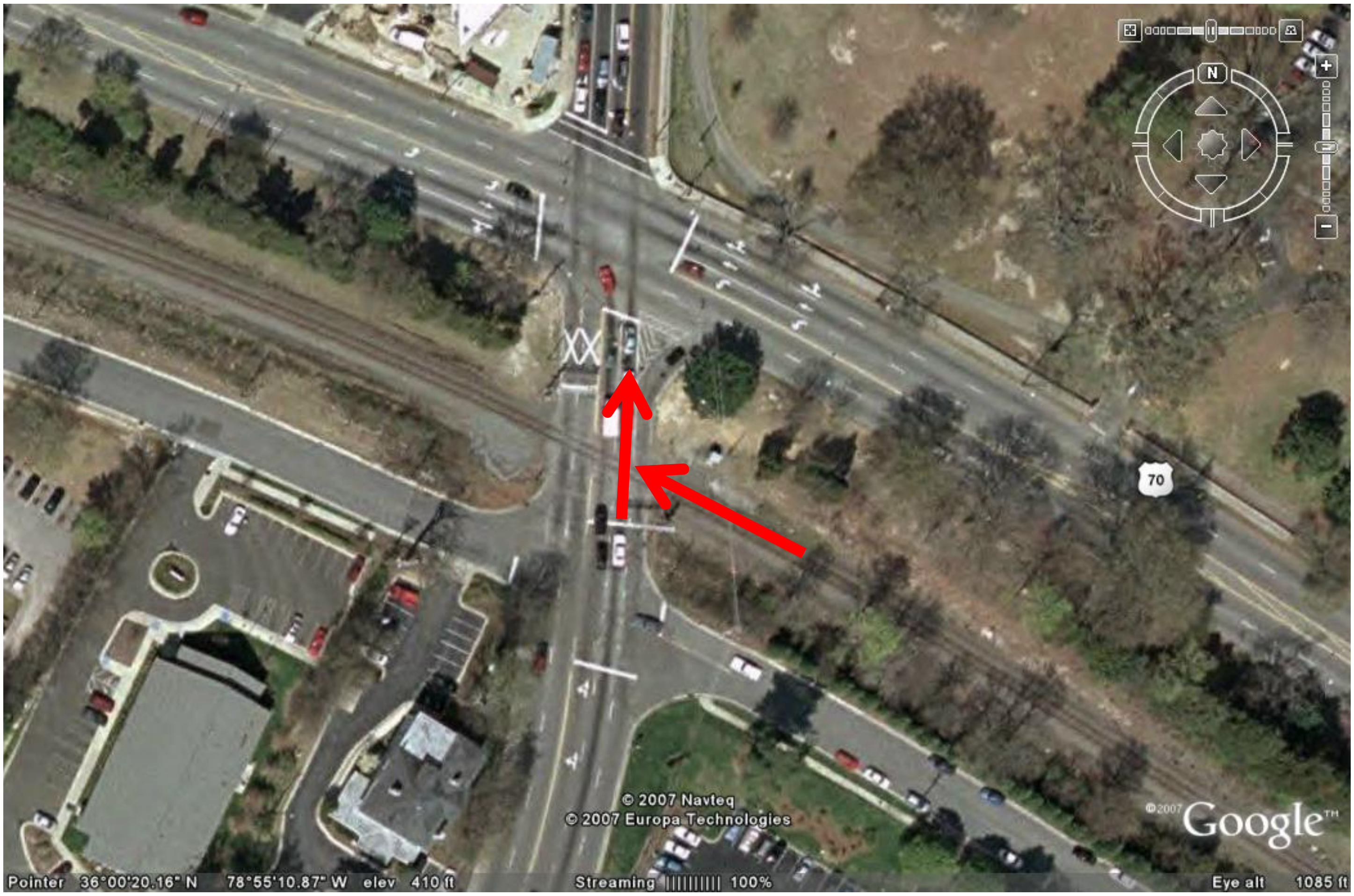
Worth looking into.

Riviera Beach, FL

Woman Unhurt When Train Hits Car

May 15, 2007

DURHAM, NC - The southbound Carolinian passenger train was delayed about two hours Monday evening after striking an automobile at Swift Avenue. There were no injuries. **Johnnie Humphrey of Durham said she was stopped for a Main Street traffic light at the crossing when a crossing gate came down across the rear of her Chevrolet Lumina. Unable to back up, she panicked, she said, and was trying to turn away from the track when the train hit the passenger side of the car.** Humphrey was unhurt but said the car was probably a total loss. She was not charged. The accident happened at 6:42 p.m., according to Amtrak headquarters in Washington, D.C. The northbound Piedmont train was also held up near Greensboro due to the delay, Amtrak said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© 2007 Navteq
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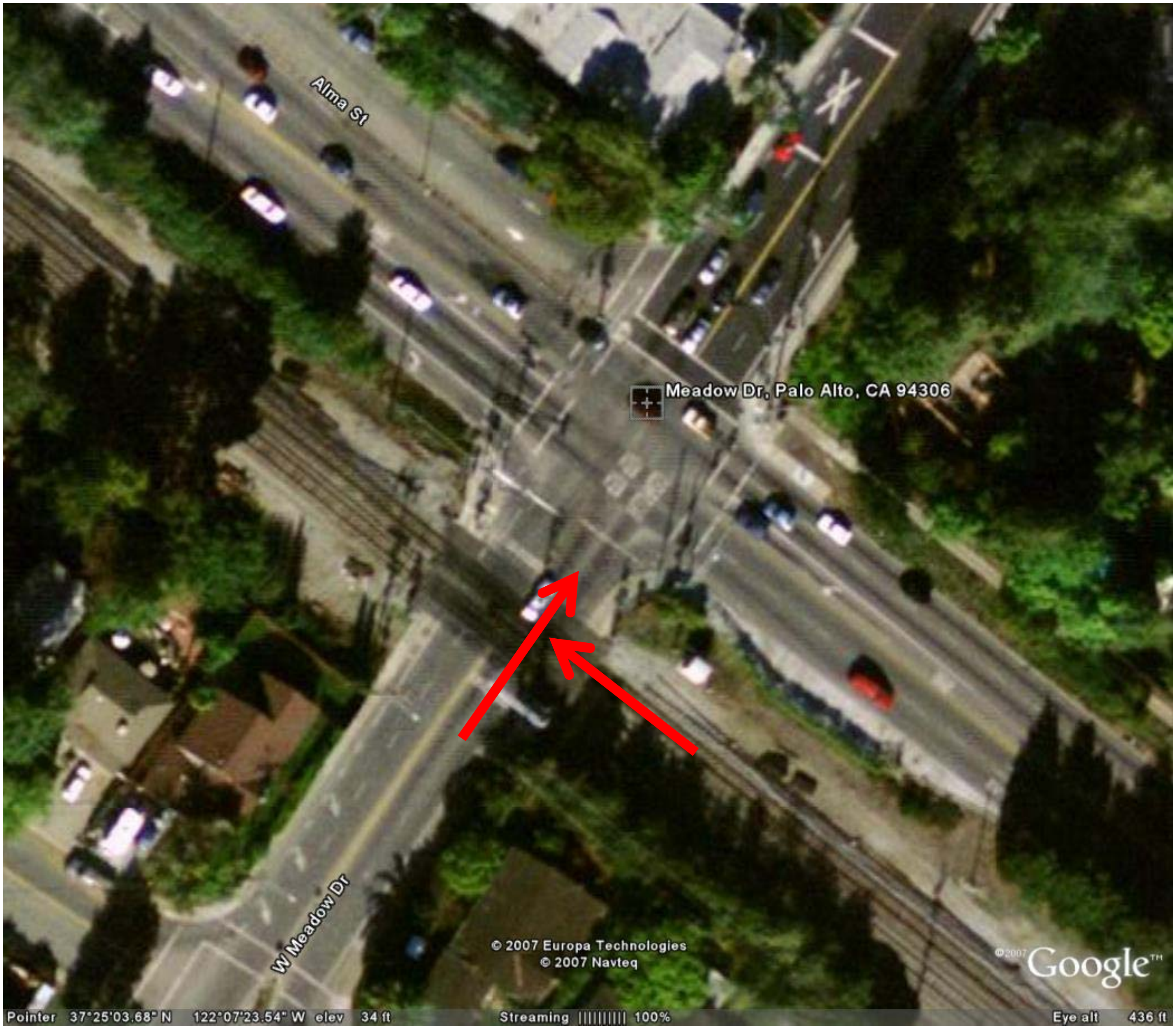
Woman Killed When Express Train Hits Her Stopped Car. Witnesses Say She Didn't Try to Get Out
Jun 28, 2007

PALO ALTO, CA - A woman was killed Thursday afternoon in Palo Alto when a northbound Caltrain express train struck her car and dragged it underneath for about half a mile, according to police. Around 4:45 p.m., a "Baby Bullet" train struck the woman's maroon Toyota Camry, which was stopped on the tracks at East Meadow Drive. South Palo Alto resident John O'Neill said he witnessed the crash. O'Neill said he was driving his daughter and a friend back from the video store when he stopped at a red light on East Meadow Drive immediately past the tracks. The Camry behind him stopped squarely on the tracks, he said. His daughter, Oona O'Neill, 14, said when she glanced back she saw the train barrier come down on the middle of the car's roof. "I told my dad what I saw and then we heard the crash," she said. John O'Neill said he had just turned left when he heard "a sickening crash.“ "By the time she asked why they were on the tracks and the light turned green and us leaving, it was like bang - so fast," he said.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Four Killed When Train Hits Car In Lakeland
July 16, 2007

LAKELAND, FL -- Four people were killed when an Amtrak train struck the car they were in Monday afternoon, police said. Witnesses said the car drove around the crossing gate, but police would not confirm that account. "The car is totally demolished," Lakeland police spokesman Jack Gillen said. "We're still not sure what happened yet... We're focused on the recovery of the victims and notification of the families at this point."The eastbound Amtrak train struck the car at an intersection a little more than a mile south of Interstate 4 in the central Florida town about 3:20 p.m., Gillen said. No information on the cause of the crash was immediately available. The train had stopped in Tampa before the accident.

MBTA Train Hits Truck Stuck in Crossing

July 26, 2007

BRAINTREE , MA – A commuter rail train carrying about 75 passengers slammed into a Stop & Shop delivery truck that was stuck in a railroad crossing. The truck was twisted from the impact and metal paneling was peeled off the back of it. Bottles of water had spilled onto the street. The truck's driver, whom police would not identify, was turning left from Washington Street onto Plain Street when the gates came down around the truck at about 1:40 p.m. Wednesday , Fire Chief Kenneth McHugh said. No one was hurt. Police are investigating the accident and said the gates and lights at the crossing were working properly. The driver could be charged if he's found to have been at fault, O'Connor said


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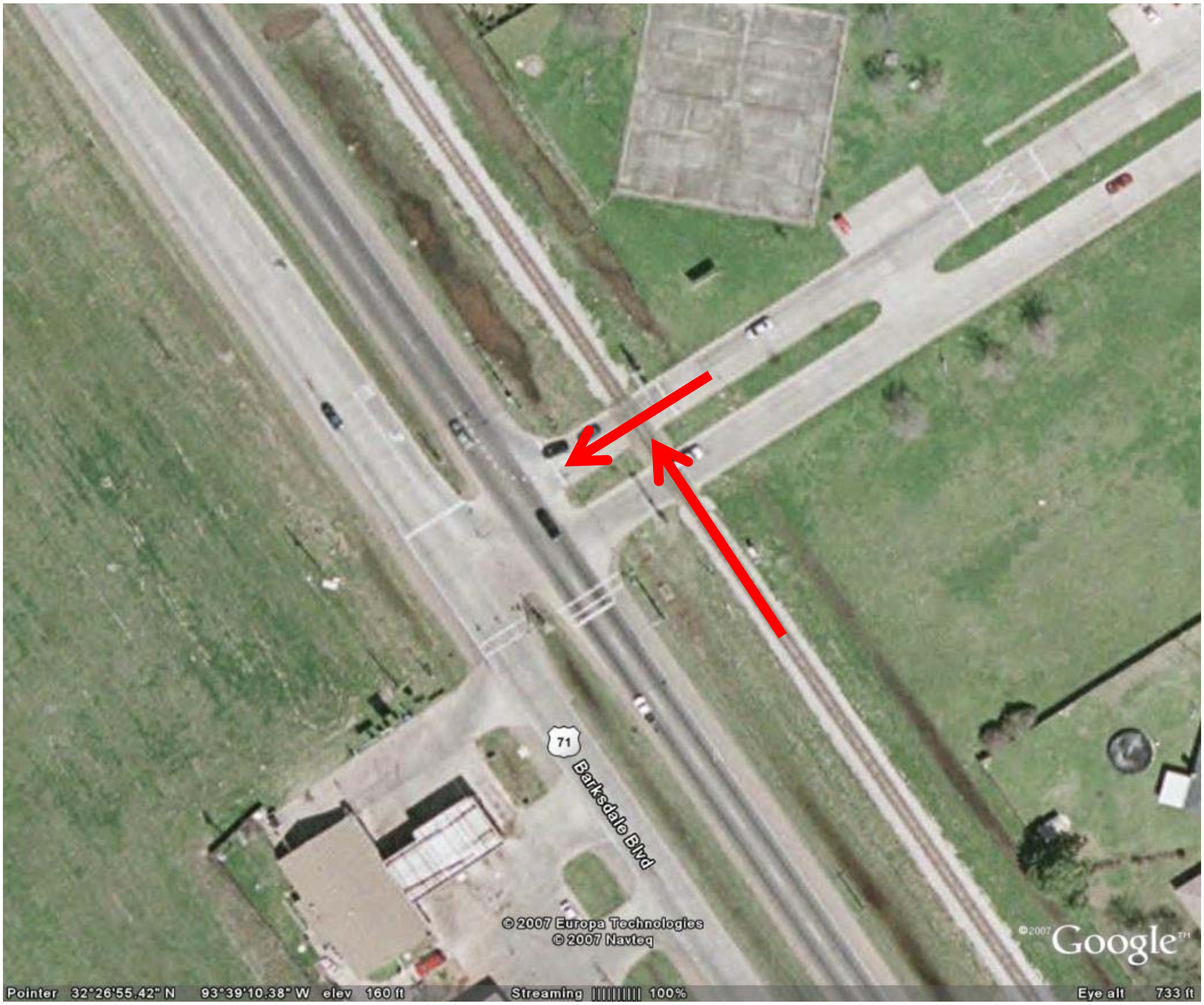
Car, Train Collide in South Bossier City
August 7, 2007

BOSSIER CITY, LA - A Bossier City man was being treated Monday night at LSU Hospital after a train hit the sedan he was driving. The collision happened about 7:45 p.m. at the crossing on Golden Meadows Drive near its intersection with Barksdale Boulevard. Witnesses told police they saw a 2003 Chevrolet Monte Carlo heading west on Golden Meadows, approaching a northbound train, police spokesman Mark Natale said. "As it approached the crossing, the car came to a slow crawl and then proceeded through the crossing," Natale said. Witnesses said the train smashed into the car's driver side while the conductor blew the horn. Crossing lights and bells appear to have been working. The 54-year-old Monte Carlo driver was not seriously injured but was flown to the hospital because of a previously existing medical condition, Natale said. No one was has been charged in the crash.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© 2007 Europa Technologies
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©2007 Google
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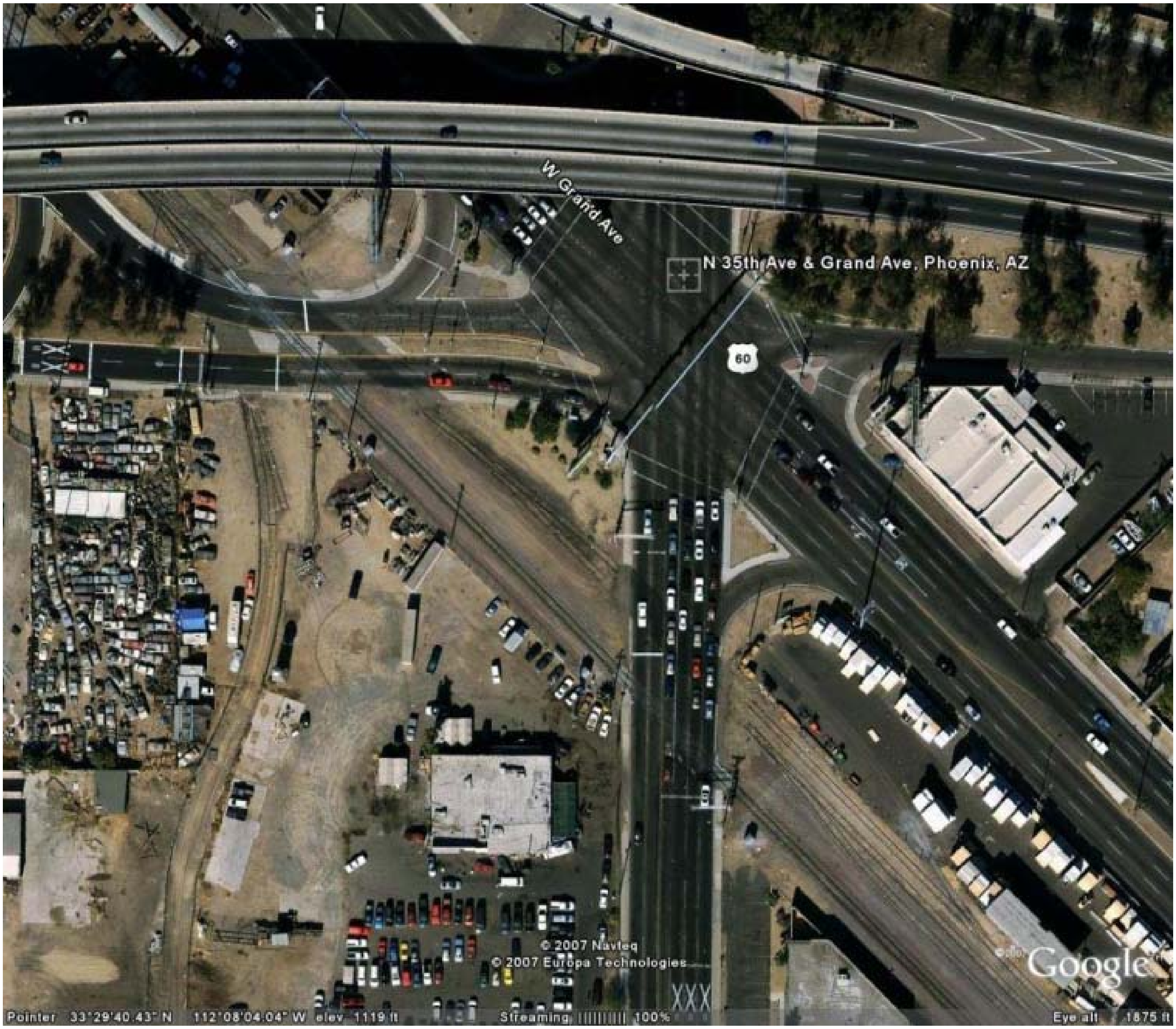
Eye alt 733 ft

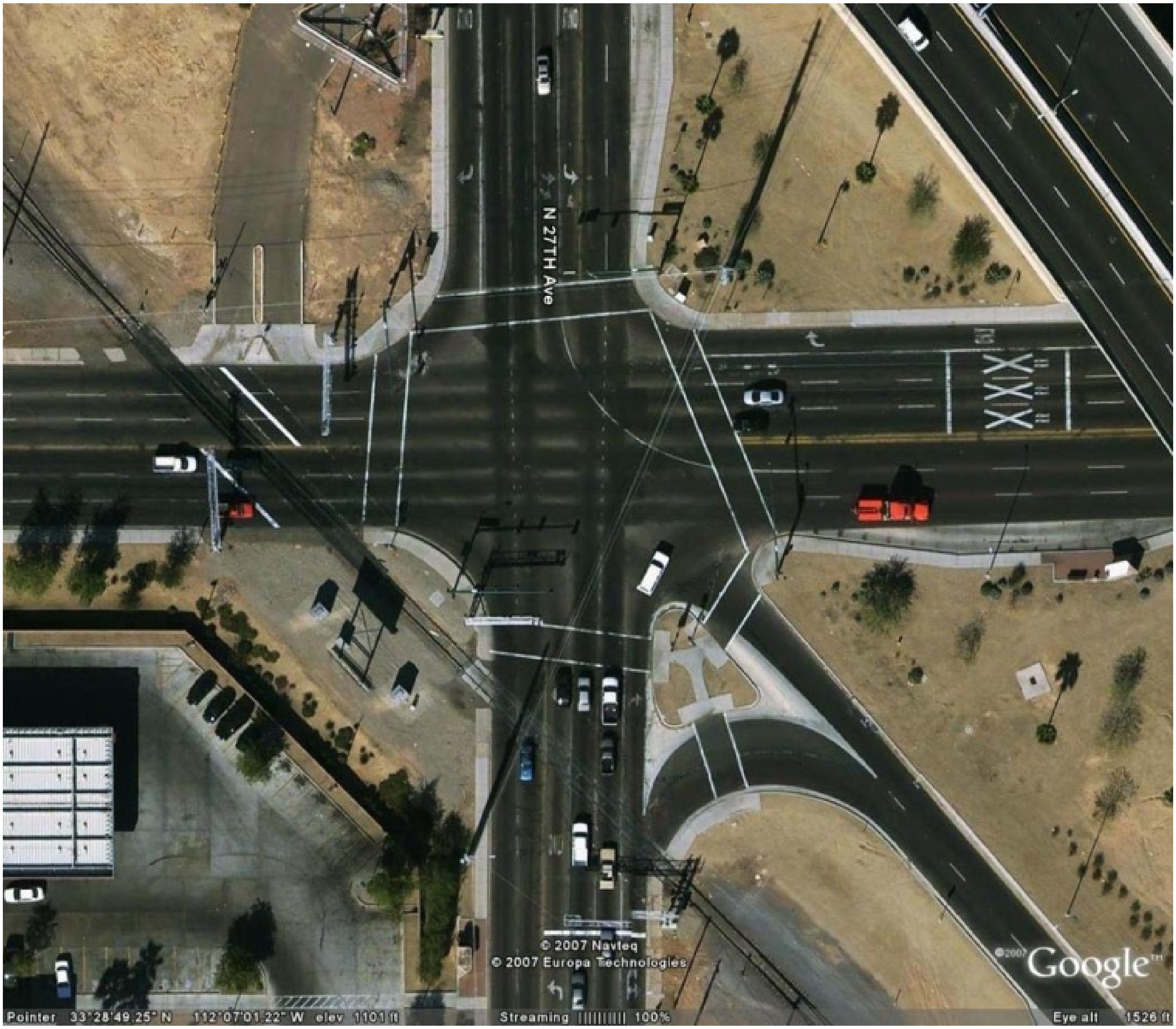
Phoenix Area Tops the List for Railroad Crossing Crashes
Wednesday
August 8, 2007

PHOENIX (AP) -- Crossing a railroad track in the Phoenix area can be a dangerous experience. **A west Phoenix crossing tops the list of the most dangerous railroad crossings in the U.S.** Two other metropolitan Phoenix crossings ranked in the top five, according to a report released Tuesday by the University of Louisville and Citizens for Rail Safety. Some of the accidents involved injuries; none were fatal. **A five-year study found the worst railroad crossing intersection at 35th Avenue near Grand Avenue in west Phoenix. It logged 20 crashes between cars and trains. Two locations tied for fifth place nationally with 12 accidents each at Thomas Road and 27th Avenue** and another just to the east of 27th Avenue, south of Jackson Street. "The Phoenix area is the area in the country where most of the accidents are happening," said Patricia Abbate, executive director for the rail-safety group. **"Unfortunately, almost always it's driver behavior or some facet of traffic that causes the accidents," Murphy said. "People are edging forward, winding up on the tracks and panicking. People are trying to race the gates.“**



25th & Grand Avenue

Phoenix, AZ



27th & Thomas Road

Phoenix, AZ

Railroad barriers functional at crash. Autopsy reveals no obvious medical issues for man killed by train.
August 14, 2007

FORT COLLINS, CO - Investigators say they may never know why a local man drove his car into the path of an oncoming freight train Sunday afternoon. William J. Lofink, 85, died about 3 p.m. at the intersection of the tracks and Horsetooth Road, next to McClelland Drive, according to the Larimer County Coroner's Office, which ruled his death an accident. The autopsy revealed no obvious medical conditions, such as heart attack or stroke, which may have contributed to the accident, said Dianne Fairman, chief investigator with the Coroner's Office. Fairman said toxicology results are pending. Lofink was hard of hearing, and a hearing aid was recovered from his car, said Fairman, whose investigation is continuing. Railway officials say the crossing gates and warning lights were working properly when Lofink drove his Lincoln Town Car eastbound into the path of the southbound 89-car train. Railway officials say the freight train was traveling between 22 and 25 mph at the time of the crash.


30
© 2007 Microsoft Corporation Image courtesy of

Metra Train Hits Van
August 15, 2007

CHICAGO, IL - A motorist was seriously injured Wednesday night when his van was struck by a Metra train in the Beverly neighborhood on Chicago's South Side. The accident occurred about 5:45 p.m. at 103rd Street and Beverly Avenue, Chicago Fire Department spokeswoman Eve Rodriguez said. Rock Island District train No. 415, which had left downtown Chicago at 5:20 p.m. and was headed to Joliet, hit the van at a street-level crossing, Metra spokesman Tom Miller said. **He said it was not immediately clear why the van was on the tracks**. The driver of the van was taken in serious condition to Little Company of Mary Hospital in Evergreen Park, Rodriguez said. Miller said the train was delayed at the scene for about 30 minutes, which caused delays of up to 30 minutes for several following trains. Metra police were investigating.

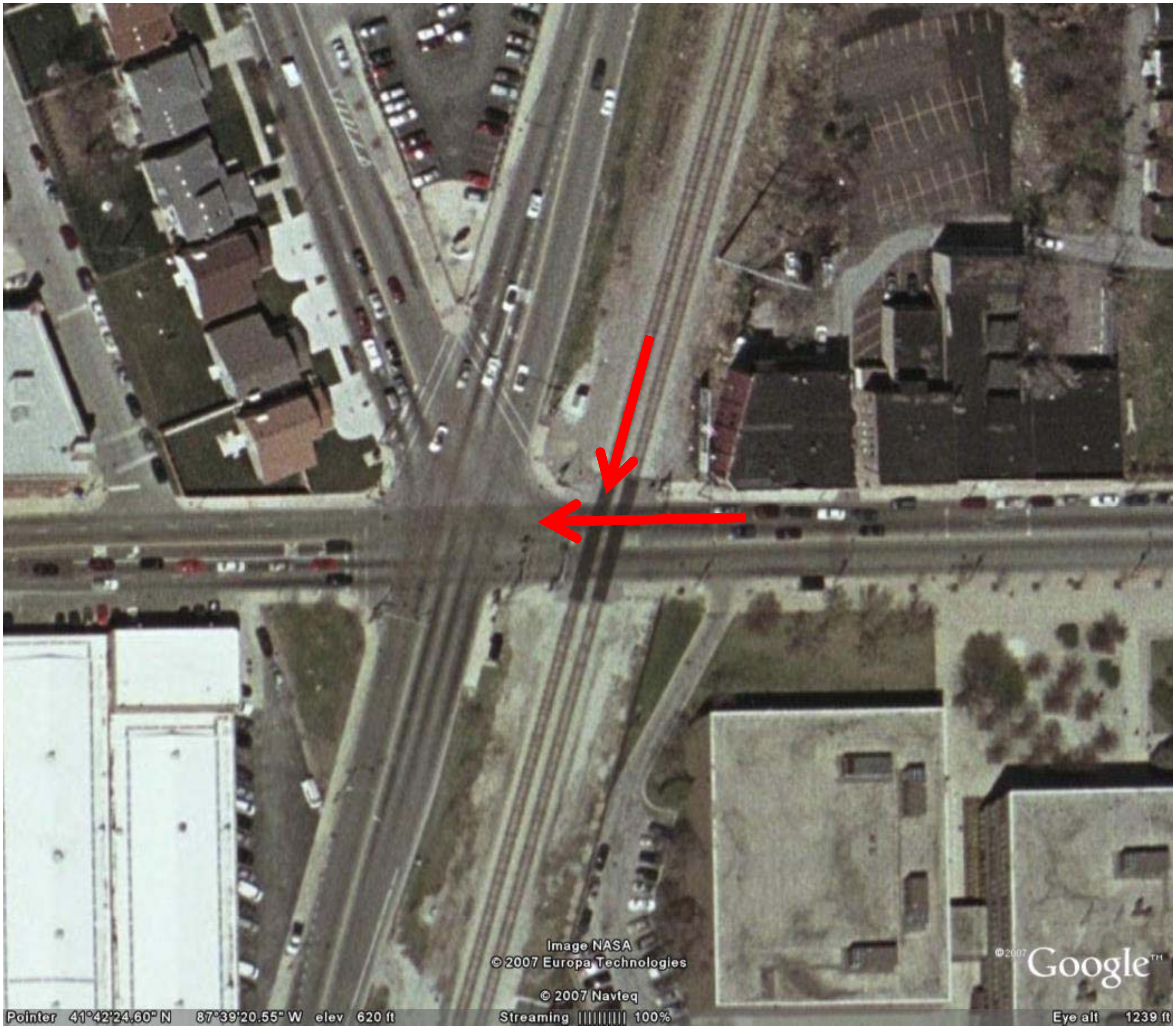
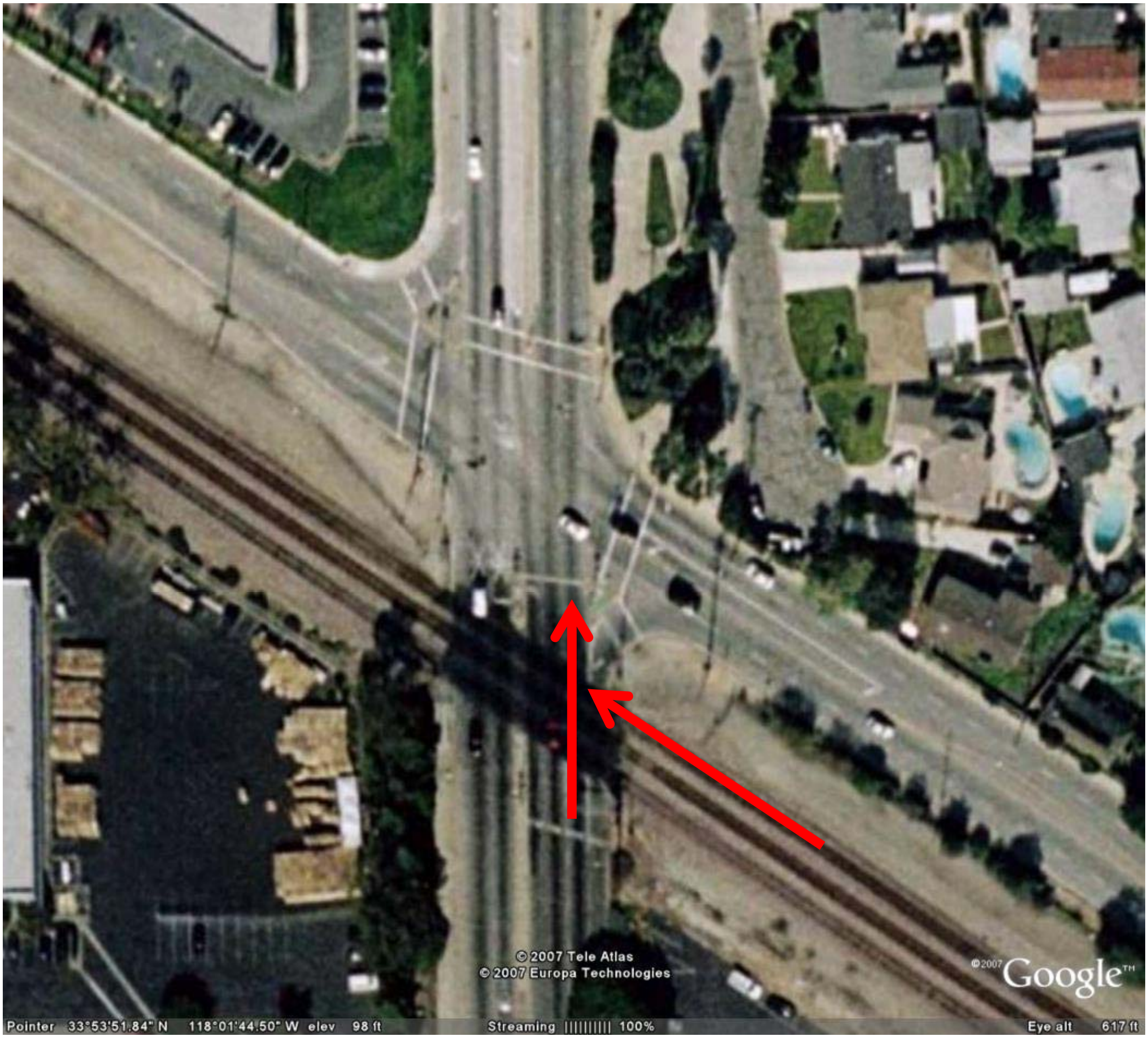


Image NASA
© 2007 Europa Technologies
© 2007 Navteq
Pointer 41°42'24.60" N 87°39'20.55" W elev 620 ft
Streaming |||||||||| 100%
Eye alt 1239 ft
©2007 Google™

Metrolink Train Hits Truck in La Mirada
September 20, 2007

LA MIRADA , CA – A Metrolink train heading from Riverside to Union Station in Los Angeles hit a truck today in La Mirada, but no one was hurt, authorities said. The accident occurred about 6:30 a.m. at Valley View Boulevard and Stage Road. One Orange County resident reported being on the train during the incident. "I was in the front car about 50 feet back from the front of the train," wrote Bill Contresceri, who was riding into L.A. from Buena Park, in an e-mail. "Basically, I heard air brakes sound off followed by a sharp jolt and a loud burst." He said a semi-tractor-trailer hadn't cleared the tracks when it was struck. "Apparently, a semi-truck was crossing the track and hit a red light which is a very short distance from the tracks, " Contresceri said. "The semi-truck was very long and the tail end of it wasn't able to clear the tracks.


© 2007 Tele Atlas
© 2007 Europa Technologies
©2007 Google™
Pointer 33°53'51.84" N 118°01'44.50" W elev 98 ft
Streaming |||||||||| 100%
Eye alt 617 ft

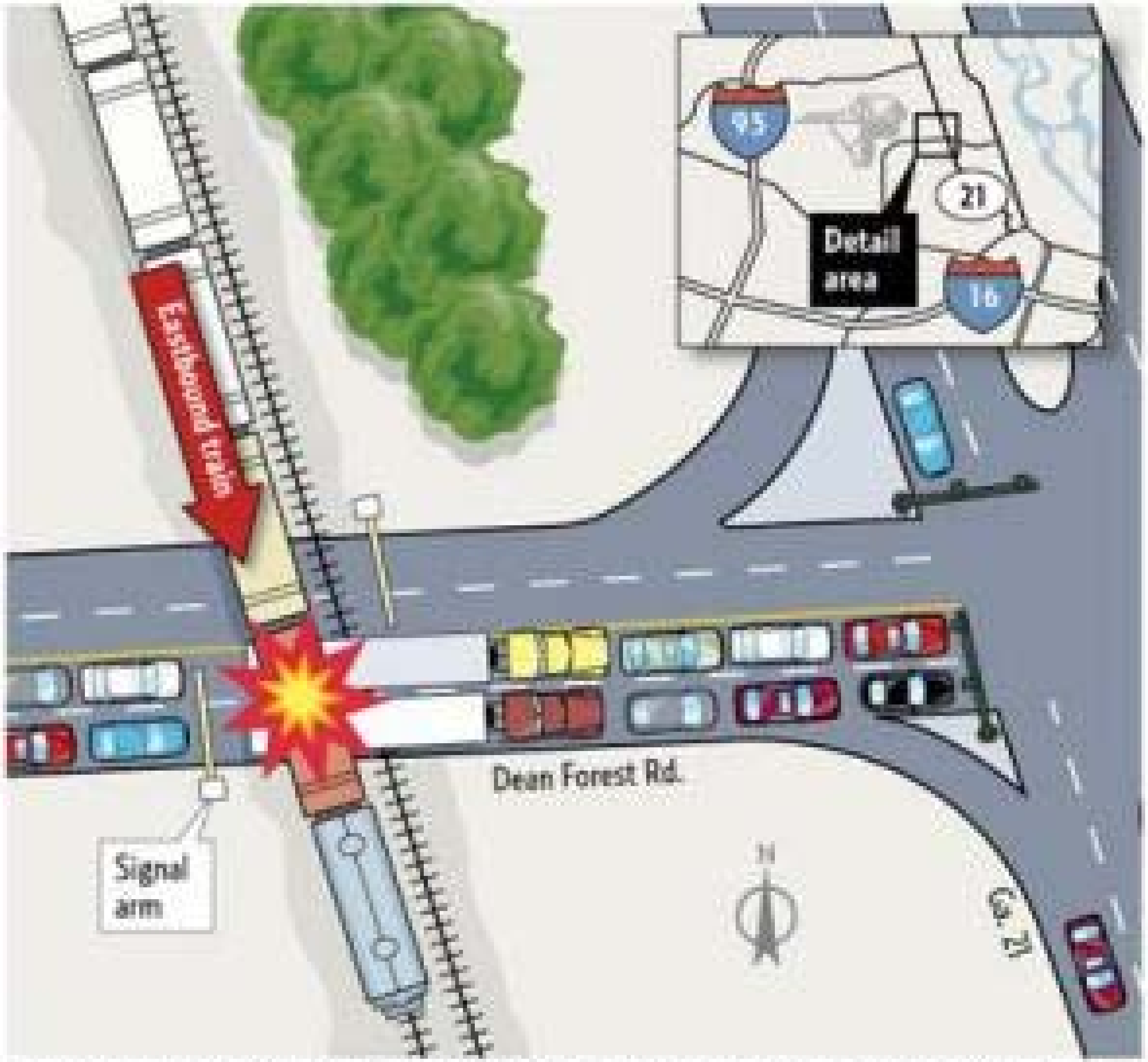
Train-Truck Crash Closes Dean Forest for Hours
October 20, 2007

For the fourth time in just over a month, rescue crews converged at a railroad crossing Friday to remove mangled wreckage and restore order.
About 9 a.m., a 40-car CSX freight train crashed into two tractor-trailers stopped on the tracks on Dean Forest Road at Ga. 21.
Savannah-Chatham police investigators determined the two trucks, advancing side-by-side slowly in heavy traffic, had pulled into the railroad crossing and stopped. Once their trailers cleared the crossing arms, however, the trucks could not advance because of the traffic backup. Their loads extended over the tracks by an estimated six feet.
"They were stuck in a position where they had nowhere to go," he said. "Their actions precipitated the whole situation."

On October 3, 2007, a truck driver was injured when his vehicle was hit at Dean Forest and Ga. 21 by an Amtrak train. Garden City police think that driver went around the crossing arms.

HOW IT HAPPENED

Investigators have determined that two tractor-trailers were improperly stopped on the railroad tracks after the signal arm came down. The trucks were in a line of traffic on Dean Forest Road waiting for the traffic light at Ga. 21 to change. The eastbound freight train struck the trucks before they were able to clear from the tracks.



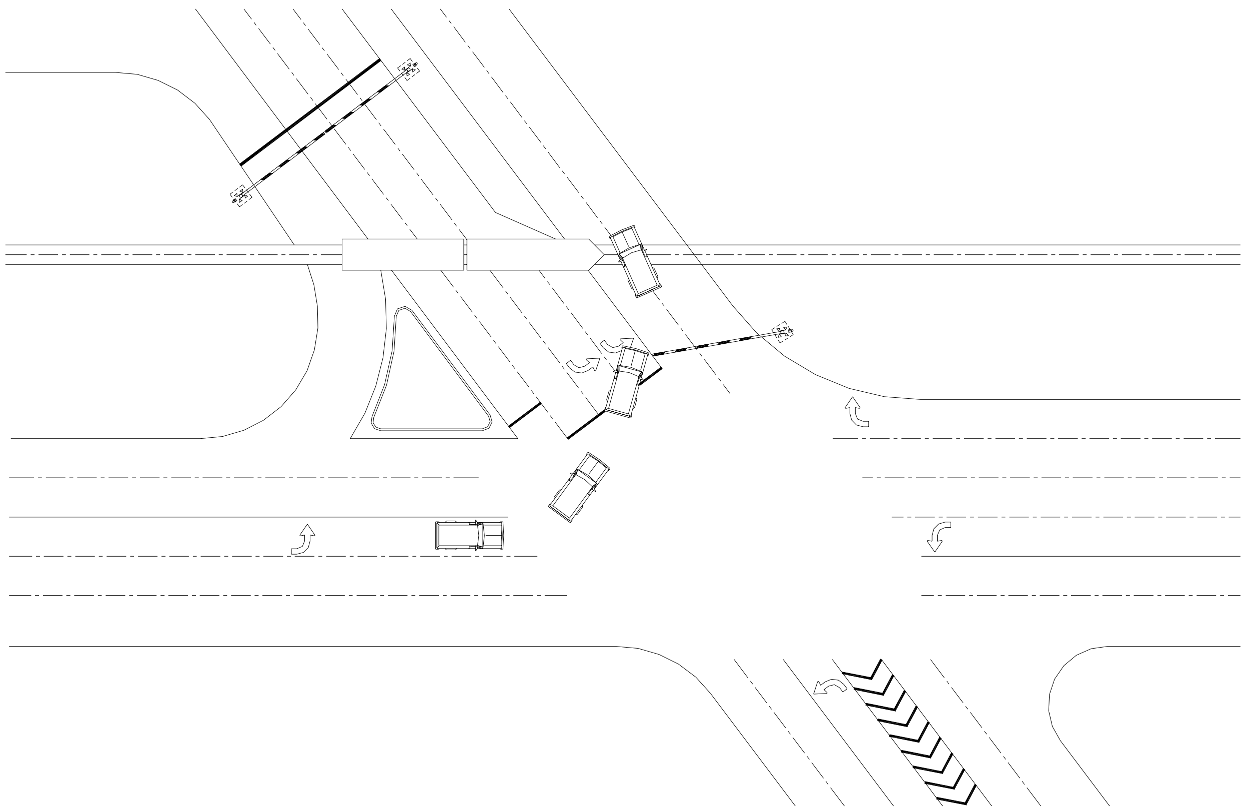
Source: Savannah-Chatham Metropolitan Police Terrence Horan/Savannah Morning News

Train-truck accident injures man in north Harris County
Nov. 9, 2007

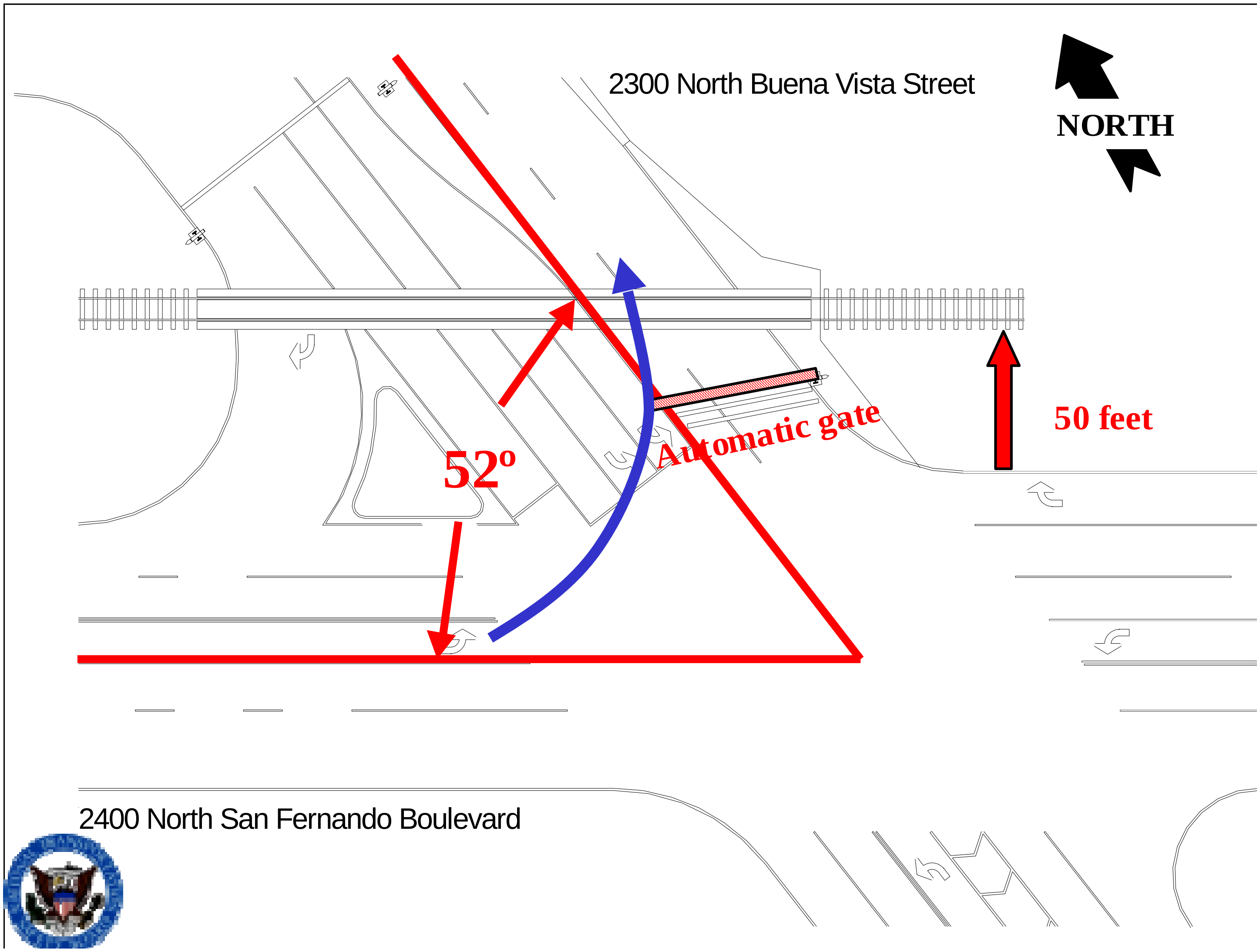
HOUSTON, TX - A man was injured this morning after the truck he was driving was struck by a train in north Harris County, sheriff deputies said. Witnesses said the truck was traveling eastbound on East Richey when it stopped on a railroad crossing near the Hardy Toll Road about 9 a.m. The crossing arms had come down shortly before the train struck the trailer of the large delivery truck. The truck landed in a nearby ditch while the train dragged the trailer about a quarter-mile before stopping. Sheriff's deputies said the driver was taken to an area hospital with injuries to his legs. The intersection at East Richey between the toll road and Imperial Valley remains closed.

East Richey Road
Inez Road/East Richey Road

Special Geometric Conditions Must Always be Considered



Burbank, CA
San Fernando Road and Buena Vista Street



MUTCD

Section 8B.06 Turn Restrictions During Preemption

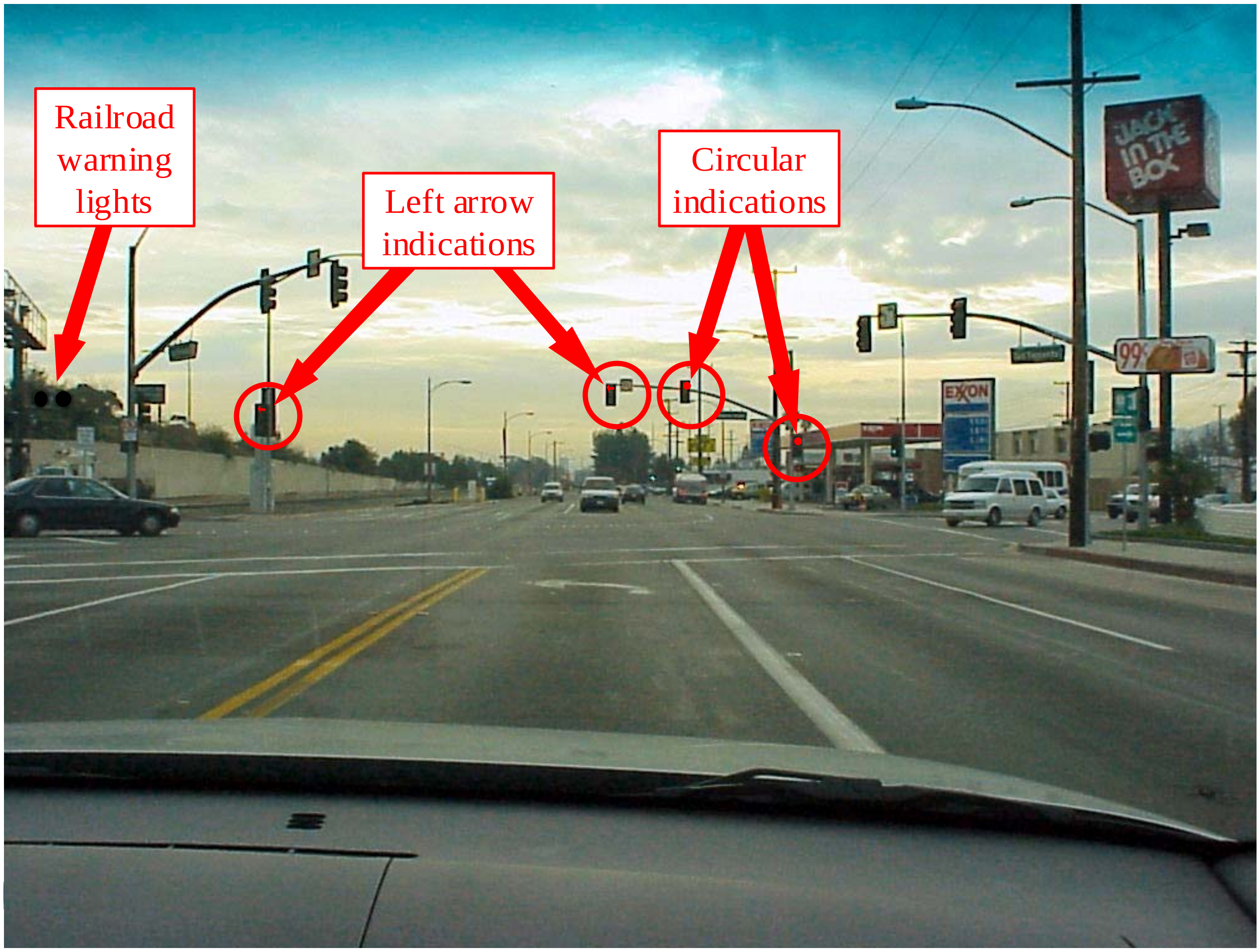
- Guidance:
  At a signalized intersection that is located within 60 m (200 ft) of a highway-rail grade crossing, measured from the edge of the track to the edge of the roadway, where the intersection traffic control signals are preempted by the approach of a train, all existing turning movements toward the highway-rail grade crossing should be prohibited during the signal preemption sequences.

- Option:
  A blank-out or changeable message sign and/or appropriate highway traffic signal indication or other similar type sign may be used to prohibit turning movements toward the highway-rail grade crossing during preemption. The R3-1a and R3-2a signs shown in Figure 8B-3 may be used for this purpose.

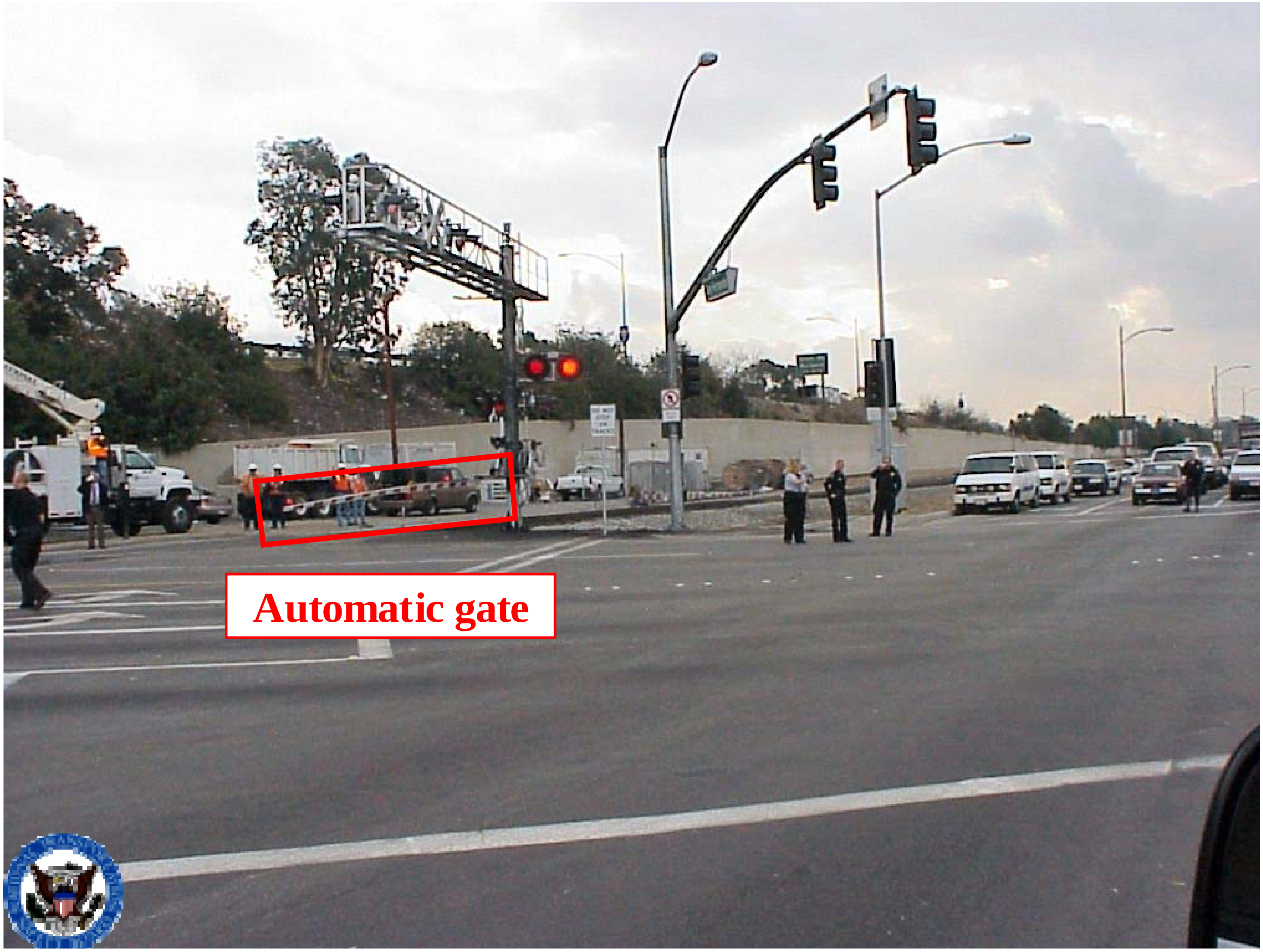
Burbank, CA

Driver Perspective

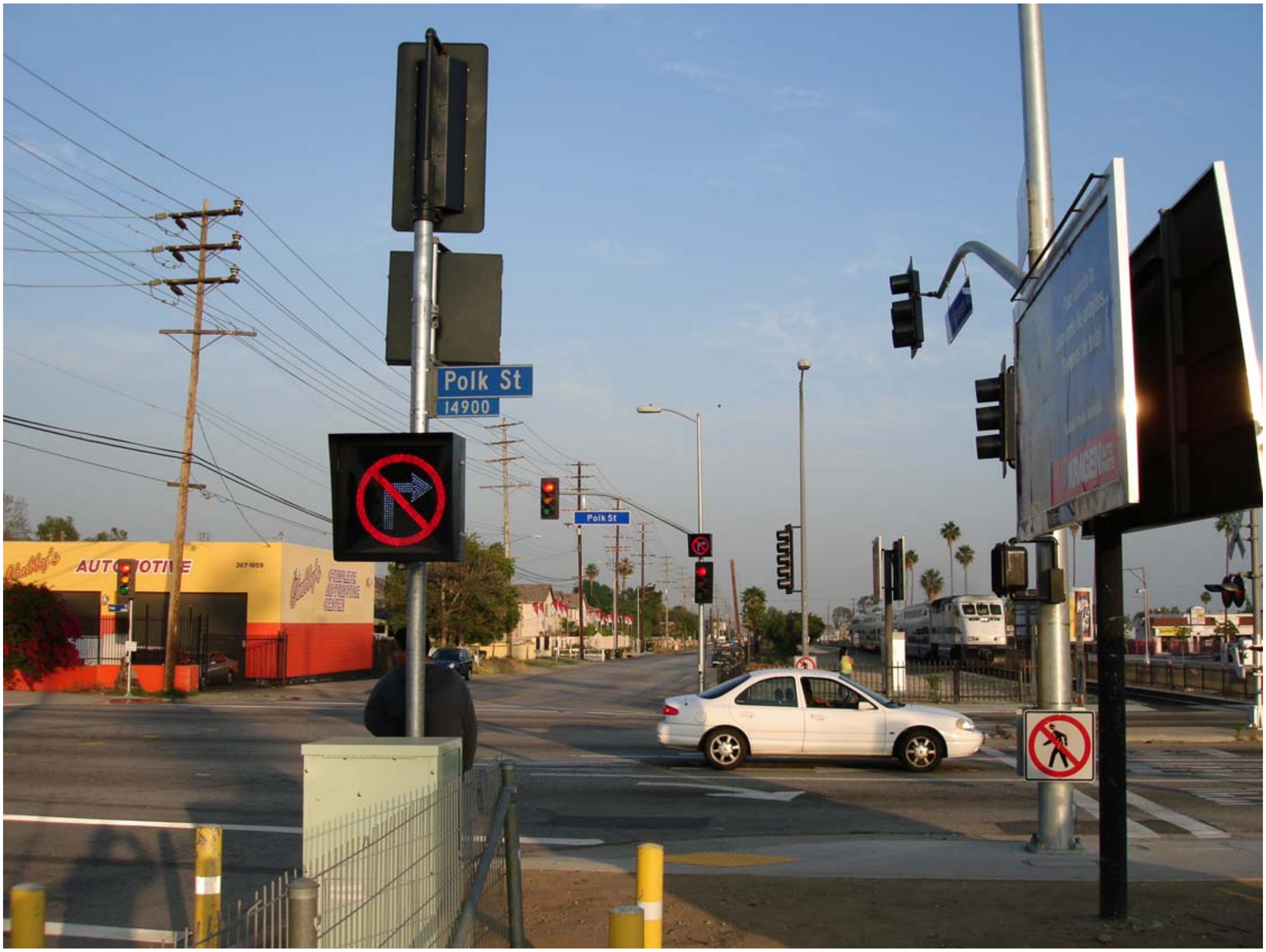
View Looking East



Burbank, CA
Driver View of Railroad Warning Devices

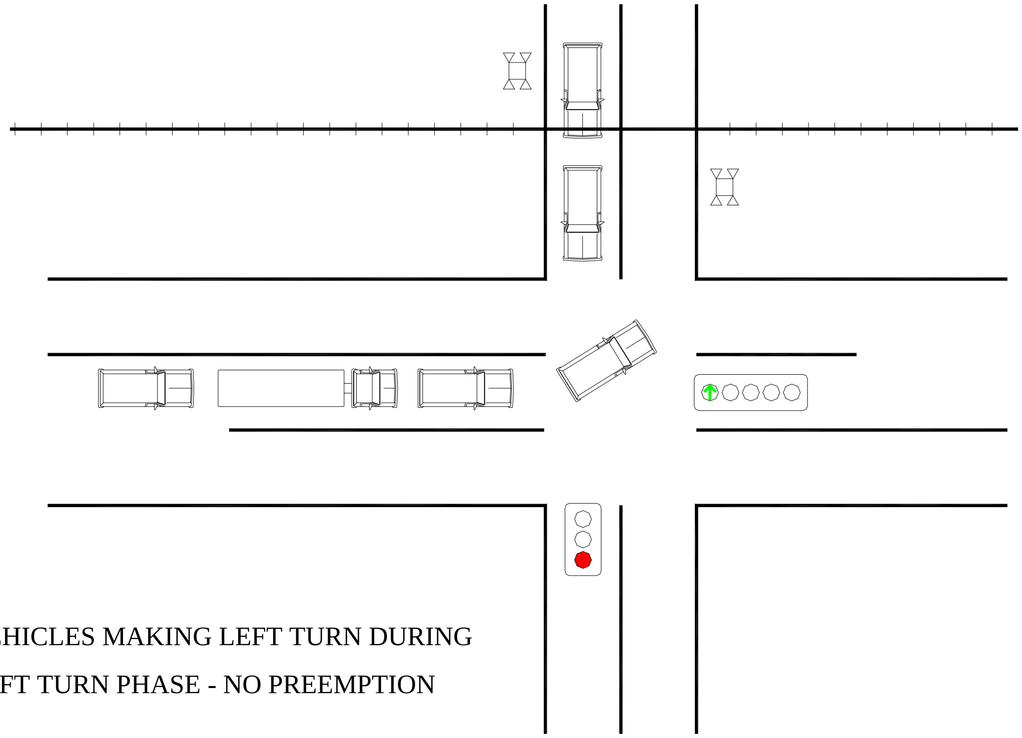


“NO LEFT TURN” SYMBOLIC BLANK OUT SIGN



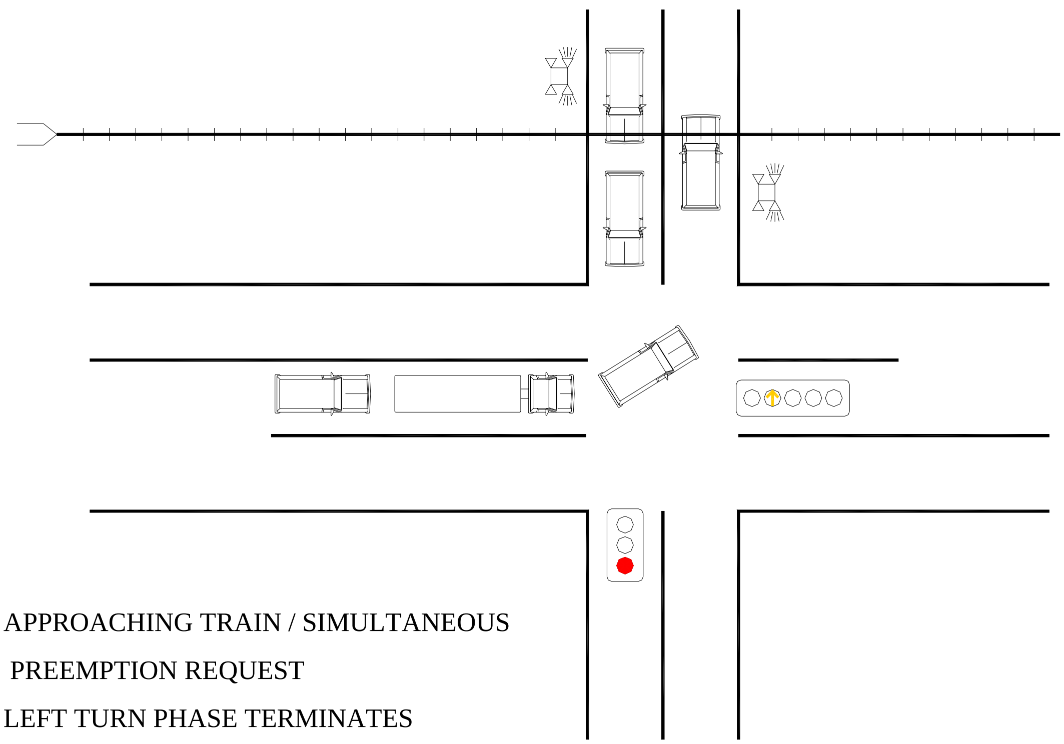
Polk St
14900
Polk St
AUTO OTIVE


SALEM ST
NO
RIGHT
TURN
TRAIN



VEHICLES MAKING LEFT TURN DURING

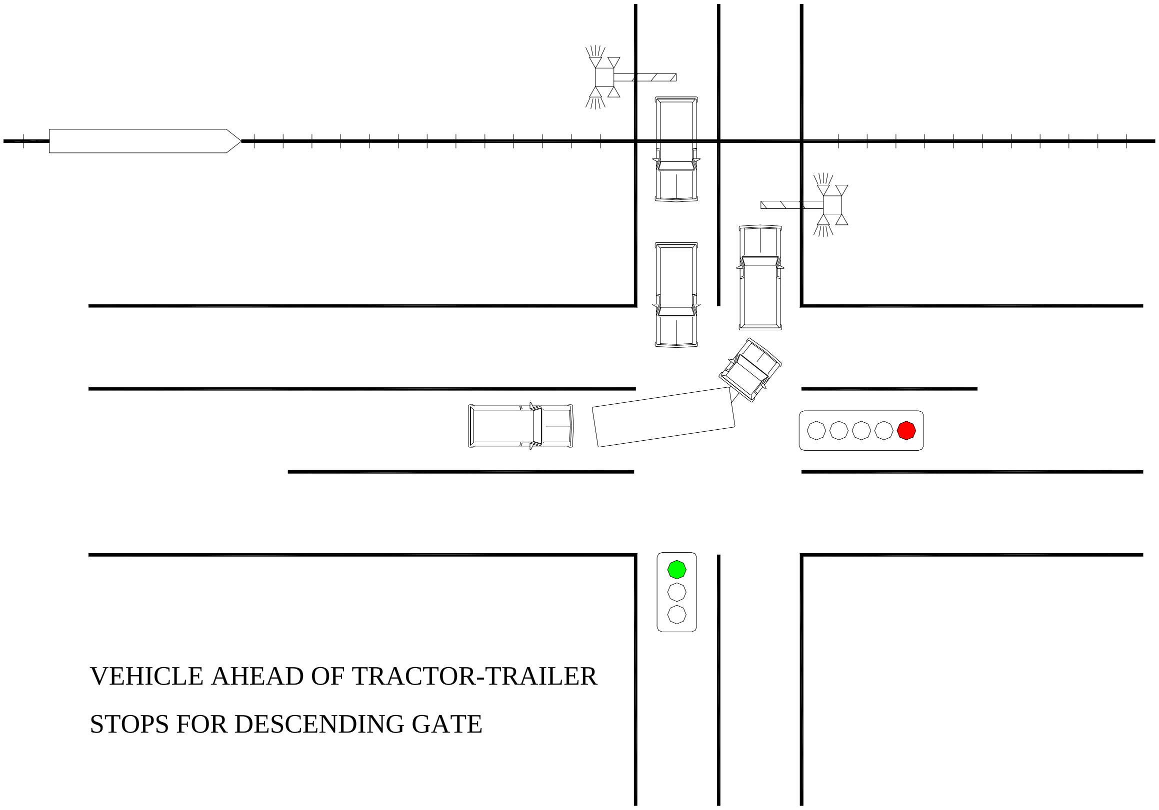
LEFT TURN PHASE - NO PREEMPTION

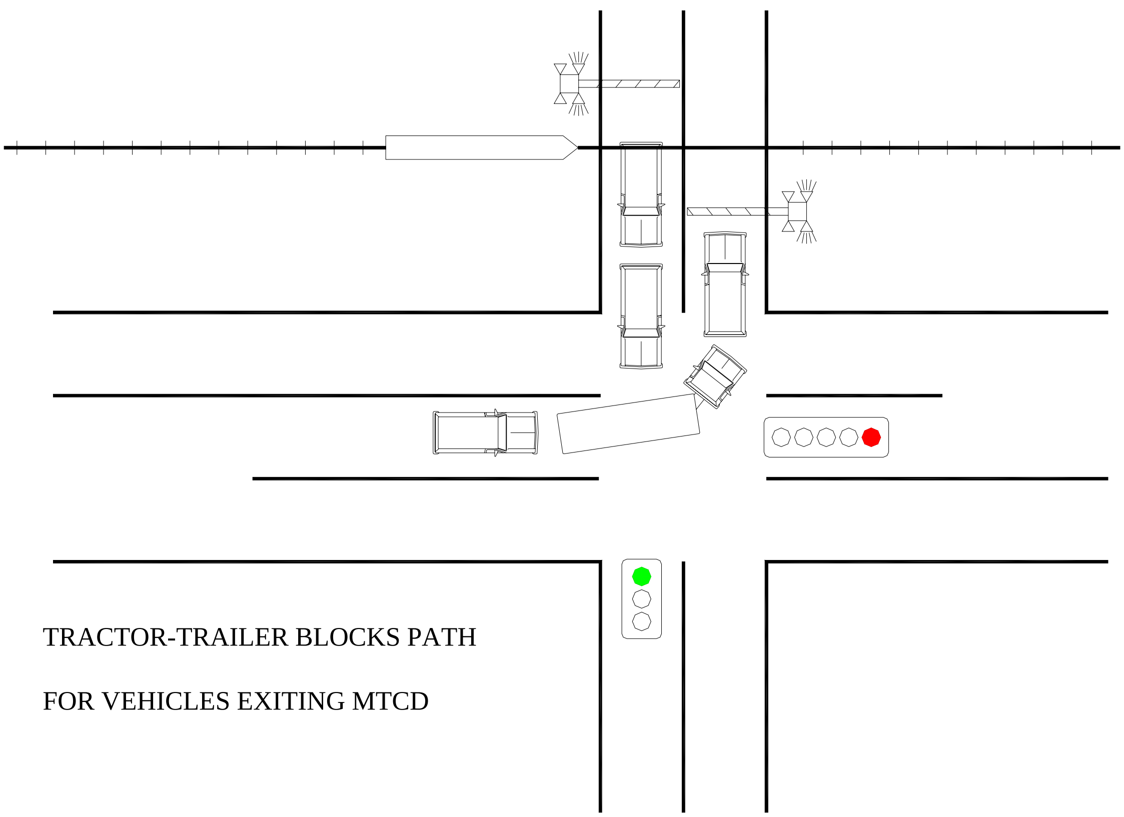


APPROACHING TRAIN / SIMULTANEOUS

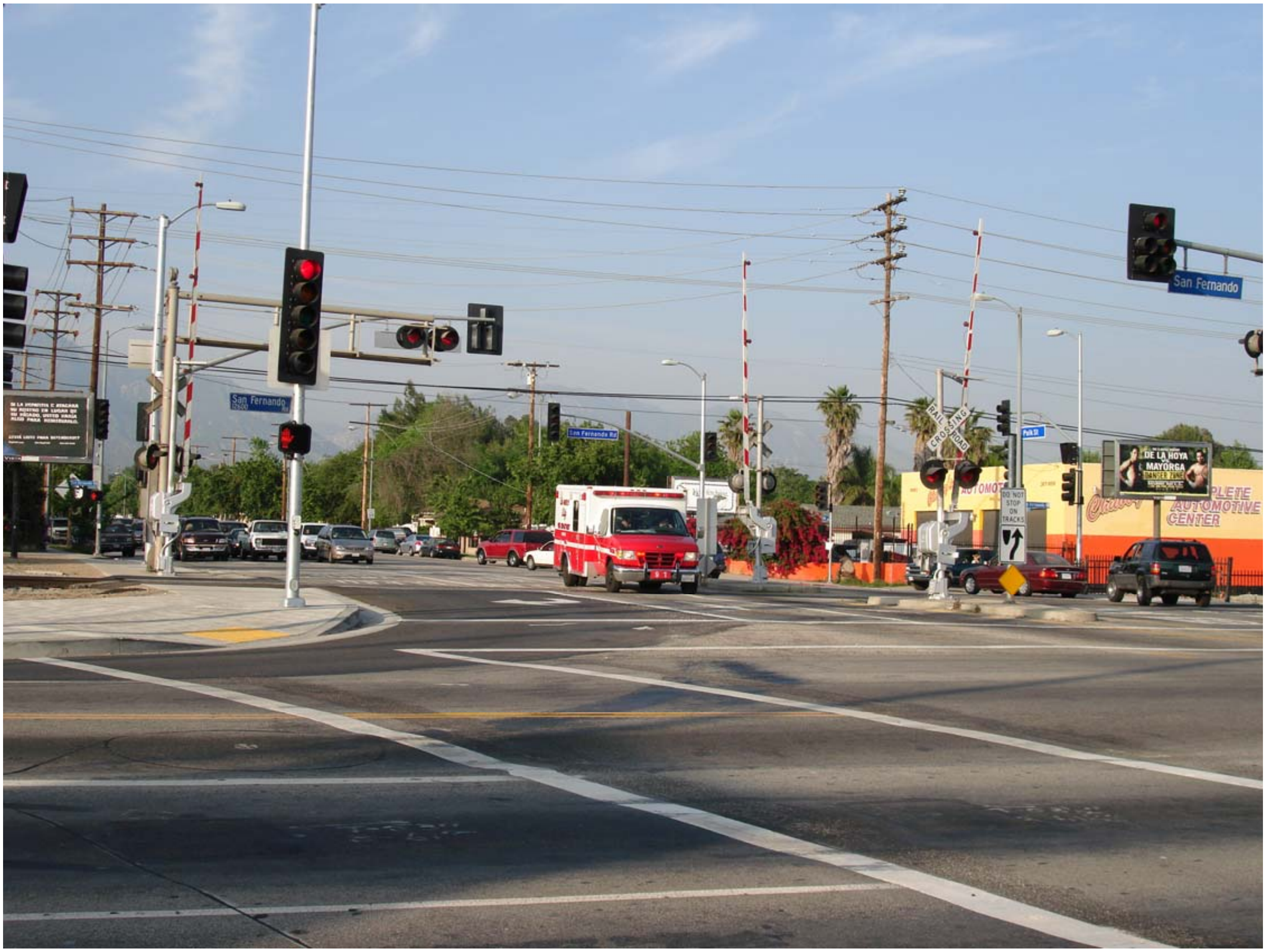
PREEMPTION REQUEST

LEFT TURN PHASE TERMINATES


VEHICLE AHEAD OF TRACTOR-TRAILER
STOPS FOR DESCENDING GATE


TRACTOR-TRAILER BLOCKS PATH
FOR VEHICLES EXITING MTCD

OBSTRUCTED ROADWAY DUE TO APPROACHING TRAIN


San Fernando
San Fernando Rd
DE LA HOYA
MAYORGA
AUTOMOTIVE
CENTER

WARNING!

Highway-Rail Grade Crossing Warning System and Highway Traffic Signals are Interconnected.

BEFORE MODIFICATION is made to any operation which connects to or controls the timing of an active railroad warning system and/or timing and phasing of a traffic signal the appropriate party(ies) shall be notified and, if necessary, a joint inspection conducted.

U.S. DOT/AAR Crossing Number: ____________________

1. Highway Agency: ____________________

   Phone Number: ____________________

2. Railroad: ____________________

   Phone Number: ____________________

3. Other: ____________________

   Phone Number: ____________________

U.S. Department of Transportation
Federal Railroad Administration
Federal Highway Administration
Federal Transit Administration
National Highway Traffic Safety Administration

Presignal Applications at

Highway-Rail Grade Crossings

- **MUTCD Application of Presignals**
- **Institute of Transportation Engineers**
- **When is a Presignal not a Presignal?**

MUTCD Application
of Presignals

Part 8 Traffic Controls for Highway-Rail Grade Crossings

Section 8D.07 Traffic Control Signals at or Near Highway-Rail Grade Crossings

Standard:

If a pre-signal is installed at an interconnected highway-rail grade crossing near a signalized intersection, a STOP HERE ON RED (R10-6) sign shall be installed near the pre-signal or at the stop line if used. If there is a nearby signalized intersection with insufficient clear storage distance for a design vehicle, or the highway-rail grade crossing does not have gates, a NO TURN ON RED (R10-11) sign shall be installed for the approach that crosses the railroad track.

Other MUTCD Parts Relating Indirectly to Presignals

Part 4 Highway Traffic Signals
Section 4D.15 Size, Number and Location of Signal Faces by Approach

Standard:

The signal faces for each approach to an intersection or a midblock location shall be provided as follows:

A. A minimum of two signal faces shall be provided for the major movement on the approach, even if the major movement is a turning movement.

1. A signal face installed to satisfy the distance requirements as described in Paragraphs B and C in the first Standard of this Section, and at least one and preferably both of the signal faces required by Paragraph A in this Standard shall be located:

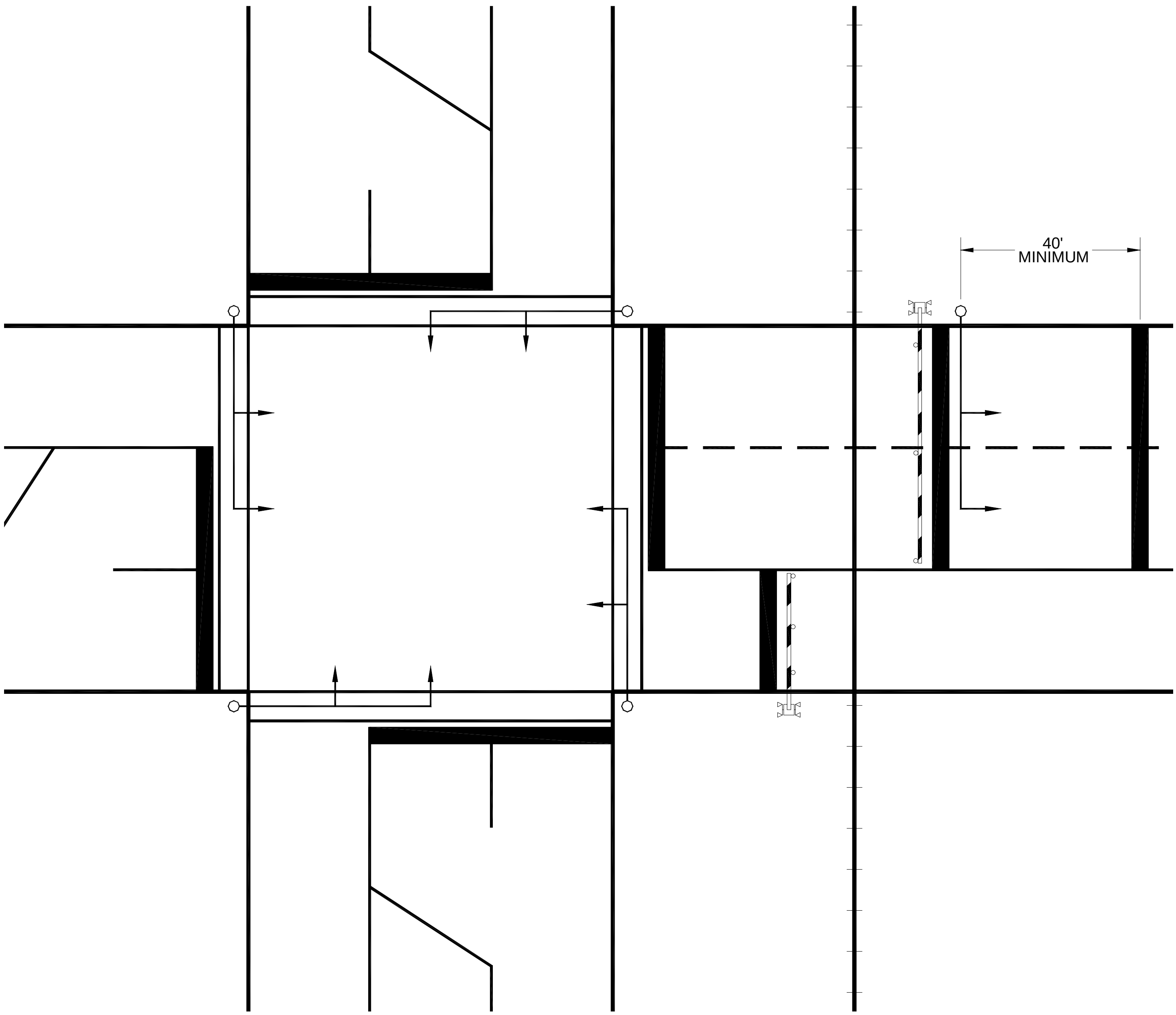
(a) Not less than 12 m (40 ft) beyond the stop line.

Institute of Transportation Engineers

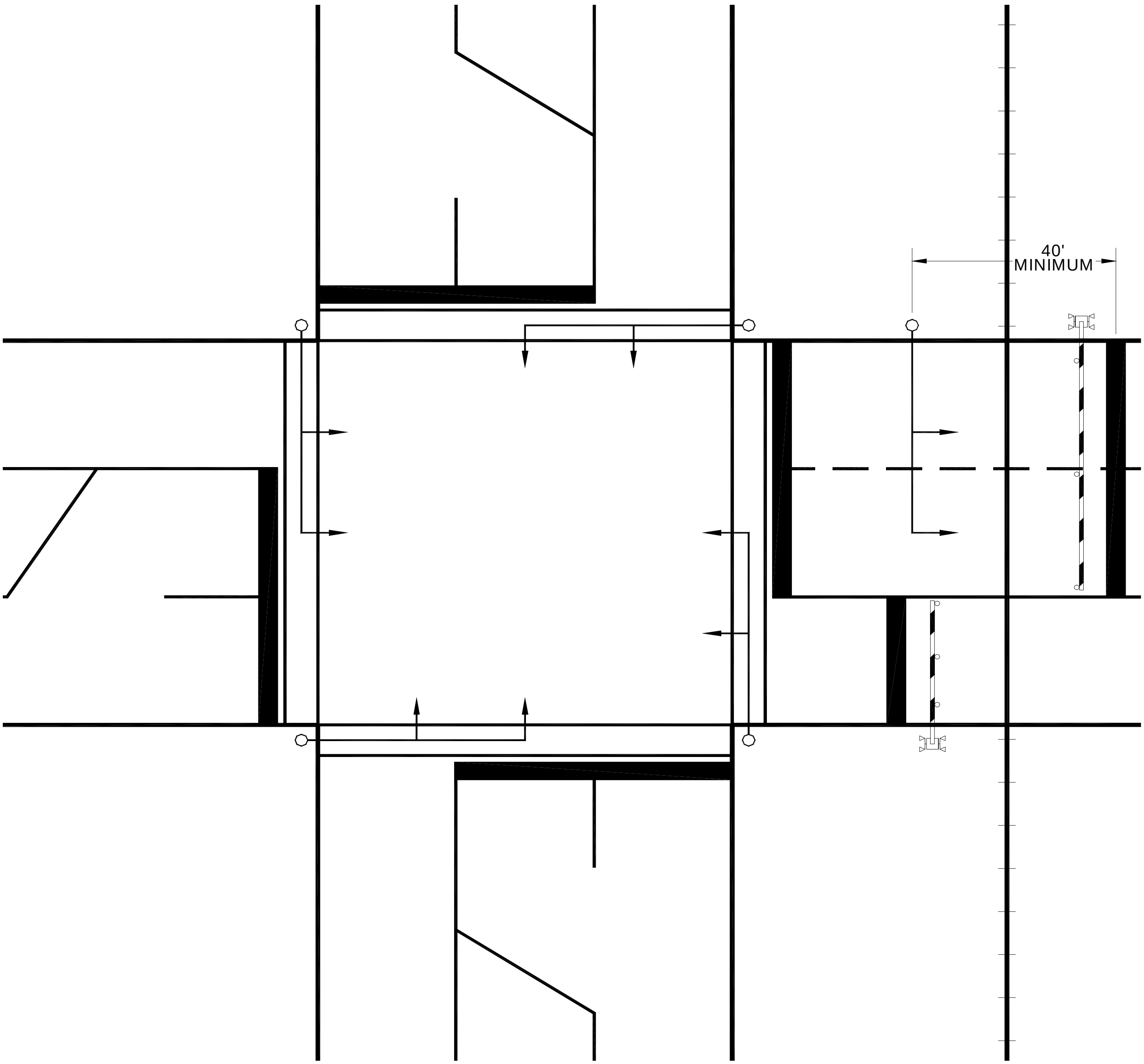
PREEMPTION OF TRAFFIC SIGNALS NEAR RAILROAD CROSSINGS

Pre-signal mast arm poles can be located upstream or downstream from the railroad crossing. In all cases, pre-signal poles must be located to maintain visibility of the railroad flashing lights. If an existing railroad cantilever exists and upstream pre-signals are used, they should be mounted on the cantilever if permitted by the railroad or regulatory agency.

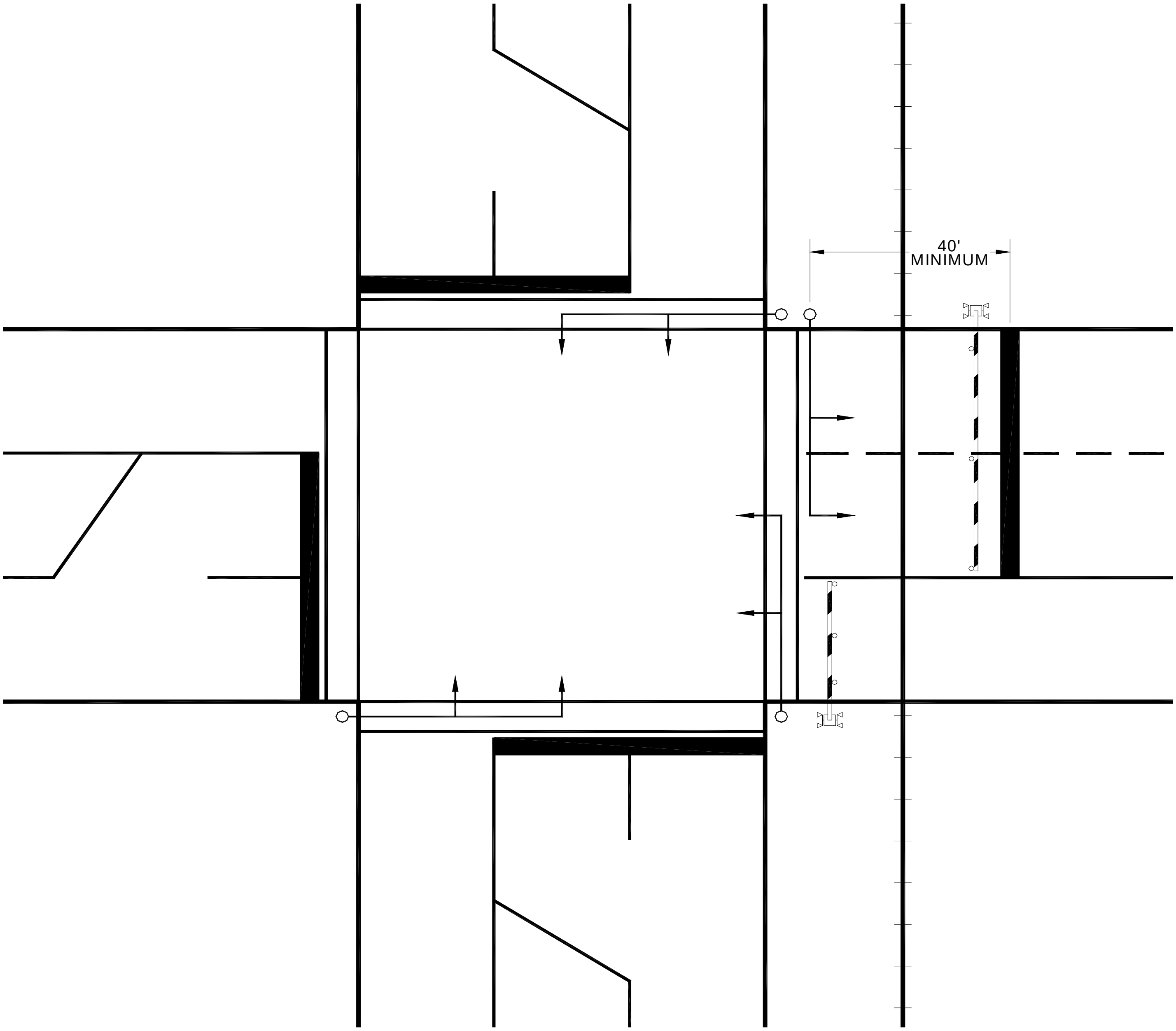
Presignal Upstream



Presignal Downstream



Presignal Downstream-
Minimum CSD
Near Side of Intersection




DO NOT STOP ON TRACKS
REX
SALE LEASE
JUL 17 2001


E45n
O 2
O 1

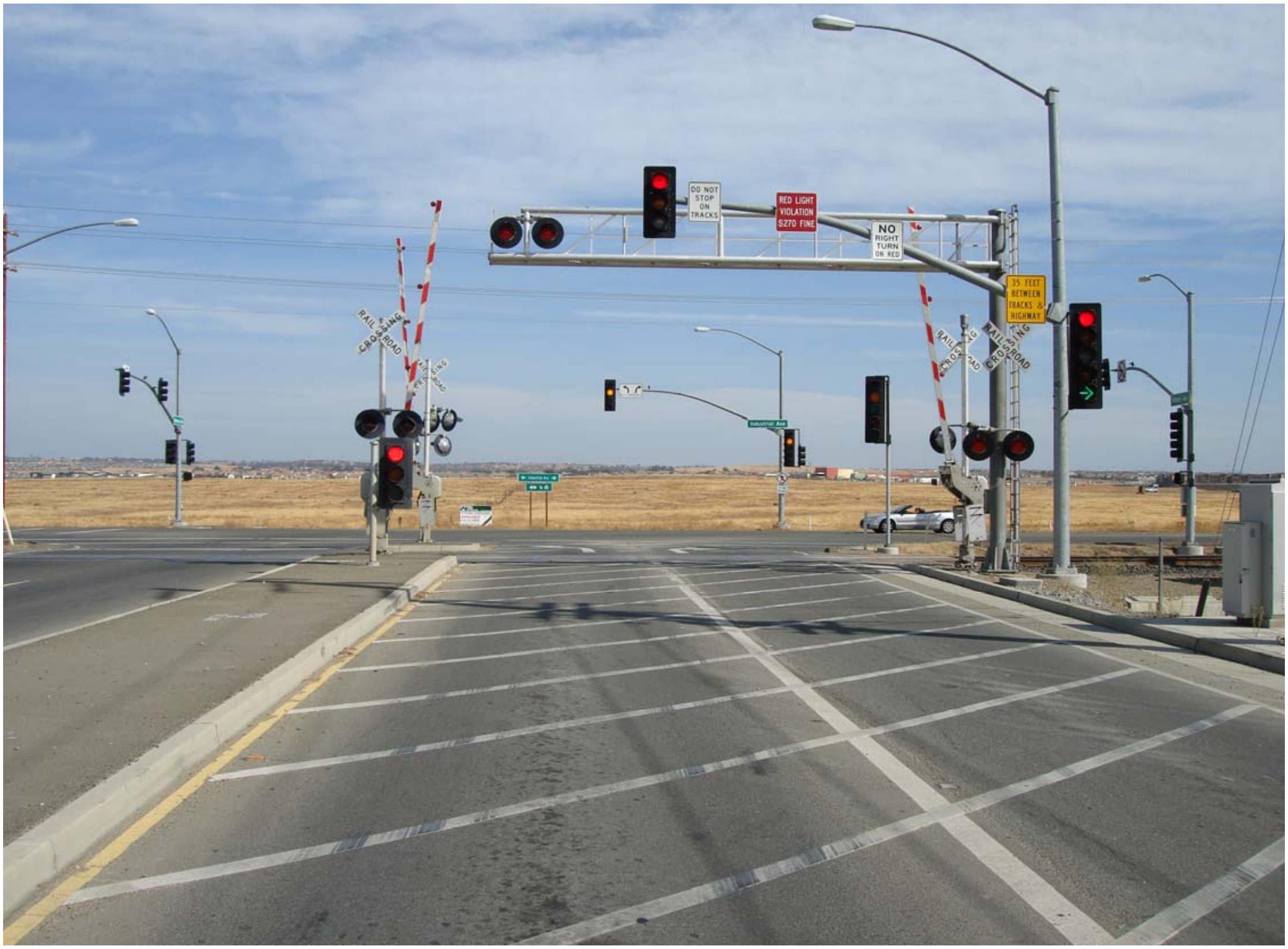
Indiana & Ohio Railroad

Galbraith Road
Presignal

Indiana & Ohio Railroad

Galbraith Road
Presignal


RXR
RXR


DO NOT STOP ON TRACKS
RED LIGHT VIOLATION $270 FINE
NO RIGHT TURN ON RED
35 FEET BETWEEN TRACKS & HIGHWAY
RAILROAD CROSSING

CROSS ROAD
2
TRACKS
FOR TRAFFIC SIGNAL
STOP
HERE ON
RED
DO NOT
STOP
ON
TRACKS
NO
TURN
ON RED
WARNING
$500 FINE
FOR ANY MOTORIST
OR PEDESTRIAN
WHO VIOLATES R.R.
WARNING DEVICES
FOX
PANTRY

Maryland MTA

MD 170 & Aviation Blvd.
Presignal

Indiana & Ohio Railroad

US 42 & Tylersville Road
Presignal?

Institute of Transportation Engineers

PREEMPTION OF TRAFFIC SIGNALS NEAR RAILROAD CROSSINGS

Pre-signals or queue-cutter signals should also be used wherever railroad warning devices consist only of flashing light signals. However, this can result in conflicting signal indications between the flashing red lights at the crossing and a display of track clearance green beyond the crossing. To eliminate this conflict, the installation of gates may be necessary.

Institute of Transportation Engineers

PREEMPTION OF TRAFFIC SIGNALS NEAR RAILROAD CROSSINGS

Pre-Signal Phasing and Operation

The pre-signal intervals should be progressively timed with the downstream signal intervals to provide a delay adequate to clear vehicles from the track area and the downstream intersection. Vehicles that are required to make a mandatory stop such as school buses, vehicles hauling hazardous materials, etc., should be considered when determining the delay time to ensure that they will not be stopped within the minimum track clearance distance (see Appendix C).

Institute of Transportation Engineers

PREEMPTION OF TRAFFIC SIGNALS NEAR RAILROAD CROSSINGS

Pre-Signal Phasing and Operation

Where the clear storage distance is inadequate to store a design vehicle clear of the minimum track clearance distance and crossing gates are present, consideration should be given to installation of vehicle detection within the clear storage distance to prevent vehicles from being trapped within the minimum track clearance distance by extending the clear track green interval.

Mustang Court Grapevine, TX
FWWR

When is a Presignal not a Presignal?

When it’s a Queue-Cutter Signal!

- Looks like a presignal.
- Located at the crossing like a presignal.
- When Clear Storage Distance is greater than 120’.

When is a Presignal not a Presignal?

Queue Cutter Signal

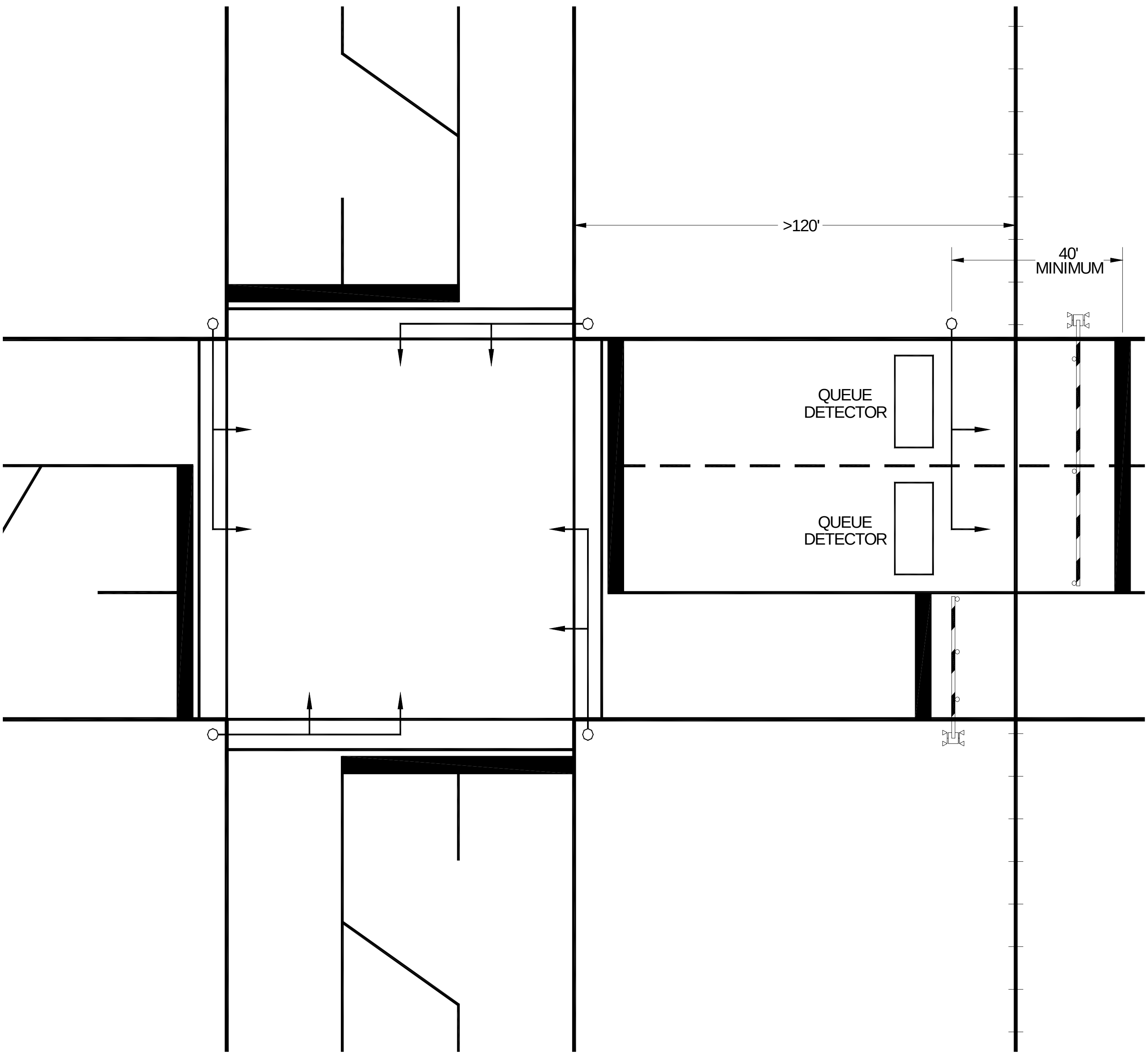
- Interconnected for simultaneous preemption.
- May or may not function as a part of the downstream intersection signals.
- Utilizes downstream vehicle detection to change to red to prevent standing vehicles within MTCD.

Institute of Transportation
Engineers

PREEMPTION OF TRAFFIC SIGNALS NEAR RAILROAD CROSSINGS

If the clear storage distance is greater than 120 ft (37 m), any traffic signal heads located at a railroad crossing should be considered to be a separate mid-block crossing (a “queue-cutter” signal), and not a pre-signal. However, coordination with the intersection signals may still be appropriate.

Queue Cutter Signal
and
Downstream Detector




THE TRAGIC ACCIDENT THAT OCCURRED
ON THIS SPOT
OCTOBER 25, 1995
WILL SERVE AS A REMINDER TO ALL
THAT THE FUTURE CAN BE CHANGED IN
AN INSTANT AND THAT THE PAST HOLDS
MEMORIES OF INSPIRATION,
HOPE AND LOVE
IN REMEMBRANCE OF
JEFFREY CLARK
STEPHANIE FULHAM
SUSANNA GUZMAN
MICHAEL HOFFMAN
JOE KALTE
SHAWN ROBINSON
TIFFANY SCHNEIDER