Amtrak® ENGINEERING PRACTICES	ORIGINAL ISSUE DATE 7/17/25		NUMBER EP5402
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TITLE **HIGHWAY GRADE CROSSING WARNING TIME AND APPROACH DISTANCE CALCULATION**	RECOMMENDED K Cardolino	DATE 7/14/25	PAGE 1
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SCOPE AND NATURE

The purpose of this Engineering Practice is to provide guidance for calculating warning time and approach distance for highway grade crossing warning systems

SPECIAL REFERENCE

AREMA 3.3.10

MUTCD Section 8

USDOT Highway-Rail Crossing Handbook

FRA Part 234

DEFINITIONS

Crossing Approach	The track circuit(s) which detect a train inbound to highway grade crossing
Crossing Island	The section of track between the edges of highway and/or protected pedestrian path intersecting the railroad track

REPORTING

Results of periodic testing of crossing warning time will be reported by AMT-27 instructions.

RESPONSIBILITY

The Deputy Chief Engineer has overall responsibility for the content and compliance with this Engineering Practice.

Signal Design employees are responsible to perform and document calculations described in this Engineering Practice including obtaining necessary information from design plans and the field and coordination with field personnel to confirm accuracy of calculations.

Maintenance field personnel are responsible to obtain field measurements, data and event recorder downloads to support execution of and verification of calculations described in this Engineering Practice

PROCEDURE

1. Operating parameters

    a. Minimum Warning Time (MWT)

    Highway grade crossing warning systems shall operate for a minimum of 20 seconds for normal operation of through trains.

    b. Buffer Time (BT)

    To accommodate for variations in train handling, track variation and allowable tolerances within locomotive speed measurement apparatus, the Minimum Warning Time will be supplemented with an additional 10 second Buffer Time.

    NOTE: Amtrak's Buffer Time accounts for the up to 10 seconds of clearance time calculated per AREMA 3.3.10. Additional required clearance time will be calculated as described in the Clearance Time section.

    c. Base Warning Time (BWT)

    Unless otherwise specified to be greater by state regulation or diagnostic safety team review, highway grade crossing warning devices shall operate for the 20 second Minimum Warning Time and additional 10 second Buffer for a total Base Warning Time of 30 seconds.

    d. Clearance Time (CT)

    For two-quadrant warning devices, minimum track clearance distance is defined as the length along the highway from the entrance gate to a point 7 ft beyond the far rail of the last track crossed measured perpendicular 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 defined as the length along the highway from the entrance gate to the point clear of the exit gate. Where the exit gate arm is 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.

    Each direction of travel for highway vehicles should be measured and the longer distance used. Where the minimum track clearance distance exceeds 135 ft[1], clearance time is calculated as 1 second for each 10ft over 135 ft.

    NOTE: Additional clearance time may be specific by diagnostic safety team review

    e. 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 arms after the entrance gate arms begin to descend.

[1] The 135 ft distance which is 100 ft greater than the AREMA recommended 35 ft accounts for the 10 second BT included in the BWT to prevent excessive PWT

f. Planned Warning Time (PWT)

For through train movements, Planned Warning Time is the least amount of time active warning devices should operate prior to the arrival of a train at a highway grade crossing. For two quadrant gates, Planned Warning Time is the sum of BWT and CT. For four quadrant gates, Planned Warning Time is the sum of BWT, CT and EGCT.

g. Equipment Response Time (ERT)

Equipment Response Time accounts for operation time of train detection equipment to trigger crossing warning systems. This will typically be 4 seconds as specified by constant warning time device manufacturers, however analysis of the highway crossing detection and warning system must be made to account for operation time for relays, network and communication equipment, and latency with remote starts.

h. Advance Preemption Time (APT)

The period of time specified by a Public Agency for the operation of interconnected highway traffic signals in advance of activation of the highway grade crossing warning system.

i. System Design Time (SDT)

System Design Time is the sum of PWT, ERT and APT

2. Calculation of Approach Distance

Approach Distance will be calculated per section 2a instructions. When the Approach Distance extends through a change in Maximum Authorized Speed, particularly where the change in MAS exceeds 20 mph, calculation per section 2b should be considered.

a. Constant Speed Approach

The Approach Distance (AD) in feet is calculated as the product of the System Design Time and the Maximum Authorized Speed in ft/s. The highest MAS within the crossing approach will be used for the calculation.

AD = SDT x MAS (ft/s)

NOTE: MAS (ft/s) = MAS (mph) x 1.467

Approach distance may need to be calculated for each track and direction separately.

b. Approach with Speed Change

The speed at the crossing island will be referred to as MAS1 and the speed beyond the speed change as MAS2.

i. The distance to the change in MAS from the crossing island must be calculated in feet. Record this value as AD1

ii. The distance in feet from the crossing island to change in MAS will be divided by the MAS1 (ft/s). Record this value as WT-MAS1

iii. Subtract WT-MAS1 calculated in the previous step from SDT. Record this value as WT-MAS2

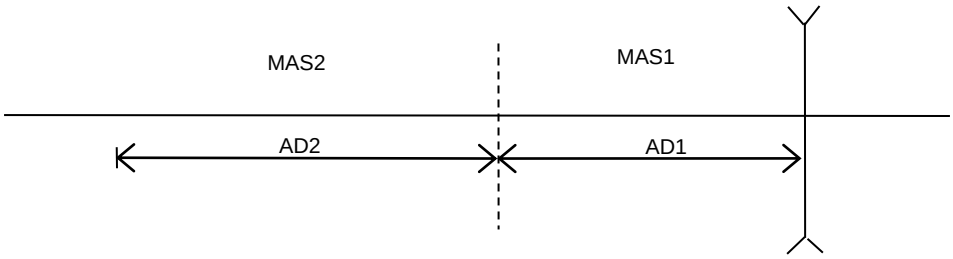
iv. Multiply WT-MAS2 (ft/s) and MAS2 to obtain AD2

v. The total Approach Distance is the sum of AD1 and AD2

NOTE: Where there are multiple changes in MAS in the approach to the highway crossing, the above calculation method may be performed iteratively to obtain the total approach distance.

Approach distance may need to be calculated for each track and direction separately.

Example calculation:



AD1 = 800 ft
MAS1 = 25 mph (36.7 ft/s)
MAS2 = 80 mph (117.4 ft/s)

WT-MAS1 = AD1 / MAS1 = 800 ft / 36.7 ft/s = 21.8 s

WT-MAS2 = SDT – WT-MAS1 = 30 s – 21.8 s = 8.2 s

AD2 = WT-MAS2 x MAS2 = 8.2 s x 117.4 ft/s = 962 ft

AD = AD1 + AD2 = 800 ft + 962 ft = 1762 ft

3. Calculation of Average Maximum Train Speed

The Maximum Train Speed (MTS) used in the highway grade crossing warning time calculation must be listed in the location prints in mph to be referenced during warning time inspection. Where approach distance is calculated per section 2b above, the Maximum Train Speed will be calculated as follows:

MTS (ft/s) = AD / PWT

MTS (mph) = MTS (ft/s) / 1.467