NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH

EXPLANATION OF THE INVESTIGATIVE INDEX FORMULA AS USED IN THE RAILROAD-HIGHWAY GRADE CROSSING SIGNAL PROJECT SELECTION PROCESS

I. GENERAL

The Investigative Index (I.I.) formula used in the selection process for railroad-highway grade crossing signal projects is attached. This formula has evolved since the early 1970's into its present form. In the early 1970's the N.C.D.O.T. used what was called a "hazard index" formula considering only the basic elements present at crossings. The present I.I. formula includes all the critical operational and safety factors existing at crossings.

The I.I. formula is divided into three parts:

A.	"Exposure"	(PF) (ADT) (TV) (TSF) (TF)
B.	Accident history	A/Y
C.	Sight distance	SDF

As originally developed, the formula was to give equal weight to each of these factors with the "typical" crossing to have an index value of approximately 100. Constants were introduced to give each individual part a value of approximately 33, e.g., the 160 denominator in the "exposure" part of the formula. Through experience, it was found this original gave too little weight to those locations which were experiencing several accidents in the 10 year study period. It was decided to greater emphasize the accident factor by "squaring it". Likewise, we found that an earlier version included too many locations which already had signals, so the "protection factor" for signals was lowered to further discount those locations.

II. EXPLANATION OF FACTORS

A. PF = Protection Factor

This is a means of discounting those locations which already have some form of active protection. The "No Protection" item is listed because it is an element of the national crossing inventory. In actuality, all crossings should have "crossbucks" unless very special conditions exist. The "traffic signal preemption" item refers to locations where only traffic signal preemption exists without crossing signals.

B. ADT = Average Daily Traffic

The ADT is adjusted for three other conditions: school bus traffic, hazardous cargo, and passenger trains.

1. School Buses - Assuming the average automobile occupancy to be 1.2 persons, we equate the number of school bus passengers to an equivalent number of automobiles and add this to the ADT. The number of school bus passengers is derived from data supplied by each county school system.

2. Hazardous Cargo and Passenger Trains - The ADT factor is increased by 20% when either hazardous cargo or passenger trains are known to be present. Hazardous cargo is considered present if it is obvious during the field inspection phase of our investigation, such as when a crossing is located near a gasoline tank farm.

C. TV = Train Volume

This is based on the number of train moves per day, both through and switching. This information is furnished by the railroads.

D. TSF = Train Speed Factor

Considers the maximum train speed through the crossing as reported by the railroad.

E. TF = Train Factor

The Train Factor (TF) is used to establish relative danger between combinations of through and switching tracks. For instance, the factor is 3.0 for a four track crossing where all the tracks are mainline or "thru" tracks. The factor is only 2.0 if all but one of the four tracks are sidings.

F. AY = Accidents per Year

We include those accidents which could have been prevented by traffic engineering methods. We would not, for instance, include an accident caused by a driver parking too close to a track and leaving his vehicle. Ten years of accident data is used. If active warning devices have been added at a crossing within the last ten years, only the time since the improvement is considered.

G. SDF = Sight Distance Factor

This is a determination made by our field personnel.

Investigative Index Formula
For Railroad-Highway Grade Crossings

$$II = \frac{(PF)(ADT)(TV)(TSF)(TF)}{160} + (70 \frac{A}{Y})^2 \div SDF$$

Where: PF = Protection Factor

No Protection	=	1.0
Crossbucks	=	1.0
Traffic Signal Preemption	=	0.5
Flashers	=	0.2
Flashers and Gates	=	0.1

ADT = Average Daily Traffic

Add $\frac{\text{number of passengers}}{1.2}$ to ADT when school buses use crossing. Multiply by 1.2 when hazardous materials exist. Multiply by 1.2 when passenger trains exist.

TV = Train Volume

TSF = Train Speed Factor = $\frac{\text{Train Speed}}{50} \div 0.8$

TF = Track Factor =

No. Tracks	No. Thru Tracks				
	0	1	2	3	4
1	1.0	1.0			
2	1.5	1.75	2.0		
3	1.6	1.85	2.25	2.5	
4	1.75	2.0	2.5	2.75	3.0

$\frac{A}{Y}$ = Accidents per Year

SDF = Sight Distance Factor x 16

Sight Distance Factors

0 = Sight distance not a factor toward need for signalization
1 = above average sight distance
2 = average sight distance
3 = below average sight distance
4 = poor sight distance

III. RAILROAD-HIGHWAY GRADE CROSSING SIGNAL PROJECT SELECTION PROCESS

This describes the procedures the N.C.D.O.T. uses to determine which railway-highway grade crossings to signalize.

There are approximately 5,000 public at-grade railroad crossings in North Carolina. Of these, about 60 percent are presently unsignalized. Railroad signalization projects are administered primarily under the Federal-aid Safety Program and cost on the average $75,000 - $100,000 per installation.

Since Federal funds are involved, the Federal Highway Administration (F.H.W.A.) requires a systematic approach in the selection of locations to be improved with the most needy crossings being improved first. The I.I. was developed by the Department of Transportation and approved by the F.H.W.A. for this reason. The higher the index, the higher the priority for improvement.

We update the information on each crossing annually and select approximately 300 crossings with the highest Investigative Indexes for possible candidates for improvement. A field investigation is made by our area traffic engineers for each possible candidate; and, based on their recommendations, we then select as many crossings as we can, in priority order, to match the amount of money available for the program. The amount of funds available for this program is limited.

After the selected crossings have been added to our Safety Program, we submit the new projects to the Board of Transportation for inclusion into the Transportation Improvement Program.

RAILROAD-HIGHWAY GRADE CROSSING INVESTIGATIVE INDEX

Crossing Number
County
Route
Calculated by
Date

PROTECTION FACTOR TABLE

No Protection	1.0
Crossbucks	1.0
Traffic Signal Preemption	0.5
Flashers	0.2
Flashers & Gates	0.1

Protection Factor	(From Table Above)	1.0
Number of School Bus Passengers		0
Hazardous Cargo (No=1, Yes=1.2)		1.0
Average Annual Daily Traffic (ADT), vpd		782
Adjusted ADT, vpd		782
Train Volume (Trains/day)		4
Passenger Trains Present (Yes=1, No=0)		0
Passenger Train Factor		1
Train Speed, MPH		15
Train Speed Factor		1.10
Number of Thru Tracks		1
Total Number of Tracks		2
Track Factor	(From Table)	1.75
Accidents Per Year		0.10
Sight Distance Factor		3

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