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STOPDIST Train Braking Distance Calculation Tool User Guide

ESI-05-12

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1 Introduction

1.1 Purpose

This user guide describes how to use the STOPDIST calculation tool and how it is normally applied for calculating train braking distances.

1.2 Background

During the signalling design process, train braking distances for signal spacing are calculated using train brake tables. The majority of trains operating on the ARTC network are long and heavy hauled freight trains. Consequently, a train's mass is distributed over the entire length of the train which can be spread over a number of varying gradients. Providing consistent and accurate calculations for train braking distances can be quite complex.

By performing iterative style train braking calculations using the STOPDIST tool, improved consistency and accuracy will be provided.

1.3 Reference Documents

The following documents should be read in conjunction with this guide:

- ESD-05-03 Train Braking Application Design
- ESI0512T-01 STOPDIST ver 2.1

1.4 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
Brake Table	A table of predetermined braking distances for a particular type of train travelling at multiple speeds, on multiple gradients.
STOPDIST	The STOPDIST calculation tool calculates stopping distances for the different types of trains.



2 Description of STOPDIST

STOPDIST is an Excel program, which runs on a Windows based PC. It is important to ensure the most current approved version is being used for calculating train braking distances.

The STOPDIST tool shall be used for determining the actual train braking distances for all signalling design.

Refer to ARTC Engineering Extranet for the most current version.

2.1 Open STOPDIST

Open STOPDIST the same way as any regular excel file. The file should open on the "Start" worksheet, which is called the START FORM and is displayed as a green screen as below.

Note: it may be necessary to "Enable Macros" when opening the file.



The START FORM is the only worksheet in STOPDIST that data is entered to calculate the braking distance for determining signal spacing between each signal. All other worksheets are for information only.



Note: Before performing any calculations, check the version being used is the current version (highlighted red above).

2.2 START FORM Features

The active cells on START FORM are white cells. Values and text data can only be entered into active cells. Option buttons can be selected by clicking on them with the mouse.

2.2.1 Signal Designer and Associated Signal Details

Signal Designer Name: Organisation:	
Project: Design Task: Interlocking:	

For every braking distance calculation for each signal, the Signal Designer must complete the above table on the START FORM. The information required is self-explanatory, however the 'Design Task' details must include the associated signal numbers (*Entry and Stop signals*) the braking distance (signal spacing) is being calculated for.

The details entered in this table will automatically appear on a similar table on the Results Report worksheet.

2.2.2 Select Brake Table

C GW-6B	Historical Freight
@ GW-10	Loaded Coal
C GW-11	Empty Coal
C GW-16	3/4 Loaded Container 680
C GW-30	3/4 Loaded Container 1280 m
C GW-40	3/4 Loaded Container 1500 m
C GW-50	3/4 Loaded Container 1800 m
C M SP-120) Diesel Hydraulic (Xplorer etc)
C HSP-160	XPT

This table is used to select which train type is to be applied for the braking distance calculation. To select the train type, click on the appropriate option button, which will turn black when selected.

Where multiple train types are operating on a section of the network, the Signal Designer **must** undertake the calculations for each type of train.



2.2.3 Train Speed, Times and Coordinates Entries

TIMES?	ENTER MAXIMUM SPEED
© Yes C No	100
COORDINATES?	ENTER SPEED INCREMENT
Yes No Used for post processing	5
	ENTER TARGET SPEED
	0

To calculate the braking distance for each type of train the following must be entered:

- maximum speed in Km/h, usually the line speed for that type of train at that location
- the speed increment (usually 5 or 10 Km/h)
- target speed 0 Km/h for stopping or target speed for passing over a turnout
- Times option button, select 'Yes' if times are required to be displayed in the results table for each speed increment
- Coordinates option button, select 'No' (this function is Not Used)

Note: the line speed may vary considerably between train types, eg HSP160 may be 160Km/h, GW40 may be 115Kph and GW10 may 60Km/h at the one signal location.

2.2.4 Track Gradients

The STOPDIST Tool has a general function to calculate Pre-set Gradients or Specific Gradients but these are not used for a specific signalling design.

The 'Variable Gradients' option button must be selected for all braking distance calculations and entries added to a separate table (refer 2.2.5).

0	33	40	60	100	Level	-100	-60	-40	-33
0	50	60	80	100	Level	-100	-80	-60	-50
0	50	67	100	200	Level	-200	-100	-67	-50
	Enter val	ues (for le	evel enter	zero)					
0	0	-120	350	220					
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To create general brake tables for a particular train type for specific constant gradients, the appropriate 'Pre-set Gradients' can be selected or for customised gradients, the 'Specific Gradients' can be selected and the specific gradient values added to the table.



2.2.5 Variable Track Gradients

Т	ain length	ר		
U	a) 1000	phetre	es	
#	Grade	Loca	ation	
1	b) 0			First gradient - rear of train when brakes applied
2	0	c)	400	Gradient change - where location is the distance from rear
3	0		800	of train at the time brakes were applied
4	0		1200	
5	0	·	1600	
6	0	1	2000	
7	0	1	2400	
8	0	1	2800	
9	0		3200	
10				
11				
12				
13				
14				
15				

In all cases, the 'Variable Gradients' option button (refer 2.2.4) shall be used and values entered in this table.

With reference to Figure 1 below of a train and track gradient profile, the table entries are:

- a) The length of the train is entered. (*Note: this provides a reference point for the changes in gradient. It does NOT change the braking rate, which is dependent on the train type selected.*)
- b) The changes of grades are entered (#1= -80 grade at EOT, #2=+400 grade at 1st change of grade, #3= +50 grade at 2nd change of grade, etc...)
- c) Location is the distance from **EOT** (End of Train) to start of each grade change (#2= 500m distance to start of +400, #3= 800m distance to start of +50, etc...)

#1	#2 #3		#4	level
-80	+400	+50		
500m	300m	700m	257m	813m
		Figure 1		

For a more detailed description of how to enter the values in the table, please refer to the worked example in Appendix A.



2.2.6 START Button

ENTER MAXIMUM SPEED	
100	
ENTER SPEED INCREMENT	
5	START
ENTER TARGET SPEED	
0	

Once all the parameters have been entered as described in sections 2.2.1 to 2.2.5, the START button can be activated by clicking on it. The program will generate the braking distance results on the "Results" worksheet.

2.3 **Results Report**

By clicking on the "Results" worksheet tab, the Results Report page will be displayed. For example:

GW-10)													Lo	adeo	l Coal
STOPPING	DIS	GTANC	т	ABLE	(tin	ne in s	seco	nds, d	ista	nces i	nm	etres)	(In	c ludes (di	15 % a stances	llowance) only)
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		Variat	ble													
Speed km/h	Time	Distance														
5	12	14														
10	16	37														
15	21	69														
20	25	107														
25	28	151														
30	32	200														
35	34	254														
40	37	313														
45	39	376														
50	41	444														
55	44	516														
60	47	593														
65	49	674														
70	51	760														
75	54	851														
80	56	946														
85	58	1048														
90	61	1157														
95	65	1274														
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3 Calculating Braking Distance to Determine Signal Spacing

3.1 General

The Signal Designer must first determine which train types will operate on the part of the ARTC network to be signalled. For a description of this process, train types and where they run on the network, please refer to the Train Braking Application Design document, ESD-05-03 section 2.

3.2 Calculating Braking Distance (Signal Spacing)

The STOPDIST tool is used iteratively by the Designer to determine the braking distance between 2 signals. Usually the braking distance will be calculated back to an Entry signal from a fixed signal (Stop signal), which may be fixed due to it providing protection of a set of points, for example.

To determine the optimum signal spacing, the designer will perform a number of iterative braking distance calculations. The final resultant braking distance value to be used as basis for signal spacing for the actual signal plan design must be within the range of the calculated braking distance <+20m >-0m.

3.3 Printed Reports

The STOPDIST tool has 'print areas' set up for both the START Form report and the Results Report. This allows the signal designer to print both reports of each brake distance calculation for verification and recording purposes.

It is important the signal designer includes the designer details and associated signal details (refer section 2.2.1) before printing the reports.



4 Appendix A – Worked Example

The following is an example of a 1500m train operating on track with a variable gradient profile with a line speed of 100Kph. There are 4 iterations of braking distance calculations to determine the optimum signal spacing between the fixed signal and the proposed signal.

The fourth iteration provides a result of the calculated braking distance +7m, which falls in the range of +20m/-0m.

The 4 iterations are listed below in sequence:

4.1 Iteration 1



Initial Calculation BD is excessive by +368m NOT within acceptable range of +20m/-0m



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16 6 0 2770 37 7 38 8 -	
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4.2 Iteration 2



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4.3 Iteration 3



3rd Calculation BD is short by -29m NOT within acceptable range of +20m/-0m



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4.4 Iteration 4



4th Calculation BD is 7m within acceptable range of +20m/-0m



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