Division / Business Unit: Enterprise Services
Function: Signalling
Document Type: Guideline

Run-a-Way Speed and Ballast Drag Length Calculator Tools User Guide

ESI-06-05

Applicability

ARTC Network Wide

Publication Requirement

Internal / External

Primary Source

Document Status

Version #	Date Reviewed	Prepared by	Reviewed by	Endorsed	Approved
1.0	22/12/16	Standards	Stakeholders	Signal Standards Engineer	A/GM Technical Standards 20/1/2017

Amendment Record

Version	Date Reviewed	Clause	Description of Amendment
1.0	22/12/2016		First issue

Table of Contents

1 Introduction

1.1 Purpose

This user guide describes how to use both the Run-a-Way Speed Calculator tool and the Ballast Drag Length Calculator tool. The tools are often used in combination: for calculating runaway wagon speed at a particular point on the track and calculating the associated length of a ballast drag trap to safely arrest the runaway wagon.

1.2 Background

During the signalling design process in areas of falling gradients, catch points or derailers are often required to be positioned on the track to provide controlled derailment of runaway rolling stock to prevent it fouling other train movements which may be taking place in the vicinity. This controlled derailment is also required to limit damage to the runaway vehicles to a degree.

The Run-a-Way Speed Calculator tool allows the designer to predict the speed of runaway vehicles at a particular point and then determine whether a derailer (and type) or set of catch points should be provided.

The Ballast Drag Length Calculator tool allows the designer to calculate the minimum length of a ballast drag required to arrest runaway vehicles derailed by set of catch points, travelling at various speeds.

1.3 Reference Documents

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

- ESD-06-02 Catchpoints

1.4 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
Derailer	Is a device used to derail unauthorised movements of trains or unattended movements of rolling stock to prevent it fouling the track. There are a number of types of derailer, which can be used for derailing vehicles at various ranges of speed.
ESI0605-T01	Run-a-Way Speed Calculator Excel Tool
ESI0605-T02	Ballast Drag Length Calculator Excel Tool

2 Description of the Run-a-Way Speed Calculator

The Run-a-Way Speed Calculator (ESI0605-T01) 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 runaway vehicle speeds.

Refer to ARTC Engineering Extranet for the most current version.

2.1 Open Run-a-Way Speed Calculator

Open Run-a-Way Speed Calculator the same way as any regular excel file. The file should open on the main page, the “Rolling calcs” worksheet, as shown in Figure 1 below.

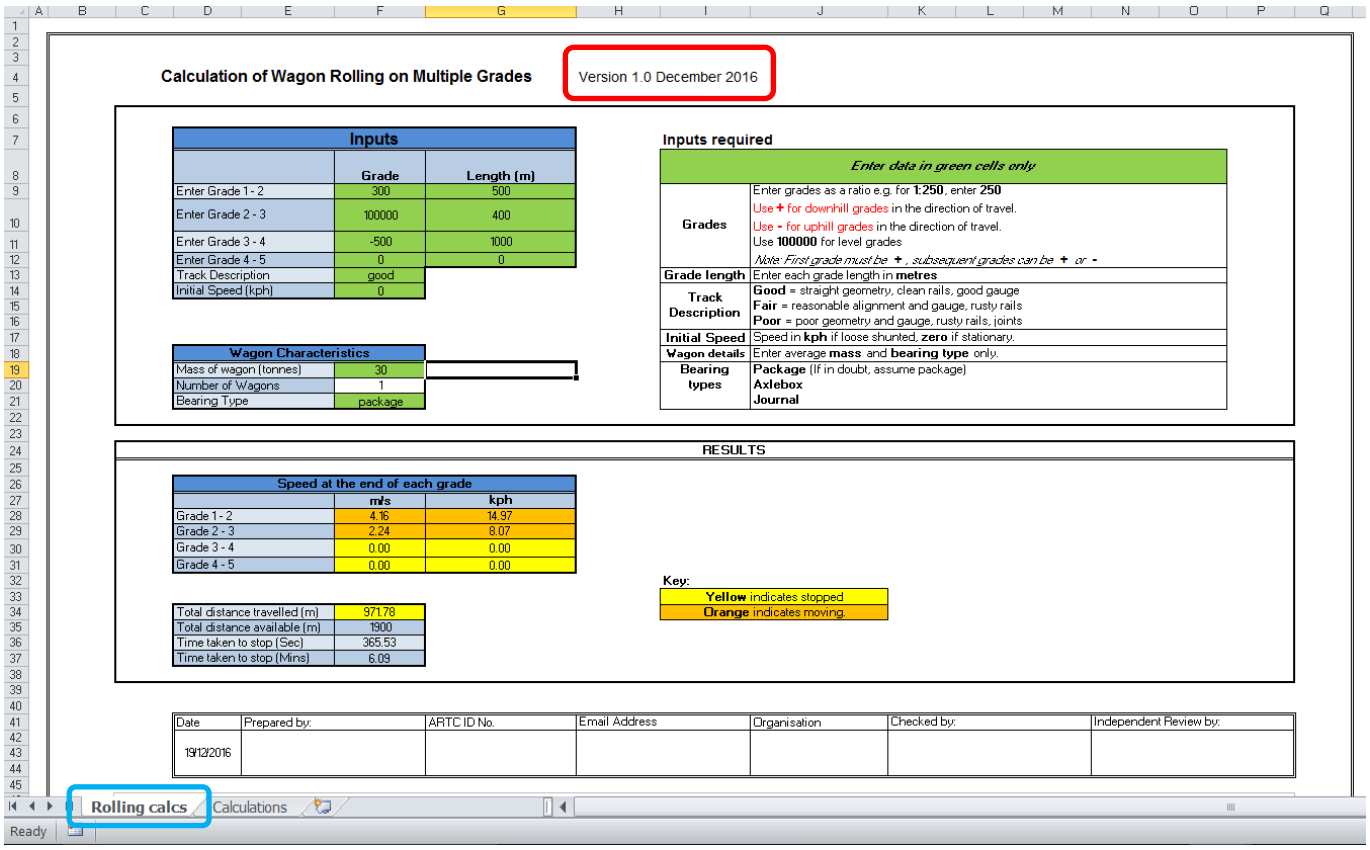


Figure 1

The “Rolling calcs” worksheet (*highlighted blue)* is the only worksheet used for data entry to calculate the rolling stock rolling speeds. All other worksheets are for information only.

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

2.2 Data Entry

The active cells are the ***Green*** cells. Values and text data must only be entered into active cells.

2.2.1 Data Inputs Entry

Inputs		
	Grade	Length (m)
Enter Grade 1 - 2	300	500
Enter Grade 2 - 3	100000	400
Enter Grade 3 - 4	-500	500
Enter Grade 4 - 5	0	0
Track Description	good	
Initial Speed (kph)	0	

#

Select from dropdown list

Wagon Characteristics	
Mass of wagon (tonnes)	30
Number of Wagons	1
Bearing Type	package

The above tables are used to enter the data for the speed calculation results. Working back from the end point, up to 4 variable gradient changes over the section of the network being considered can be accommodated in the calculation.

Note #: For grade sections not required for a calculation, ensure the “Grade” and “Length” cells are zero.

Explanatory notes for entering the input data are included in the worksheet as shown below.

Inputs required

Enter data in green cells only	
Grades	Enter grades as a ratio e.g. for **1:250**, enter **250** Use **+** for downhill grades in the direction of travel. Use **-** for uphill grades in the direction of travel. Use **100000** for level grades *Note: First grade must be* **+** *, subsequent grades can be* **+** *or* **-**
Grade length	Enter each grade length in **metres**
Track Description	**Good** = straight geometry, clean rails, good gauge **Fair** = reasonable alignment and gauge, rusty rails **Poor** = poor geometry and gauge, rusty rails, joints
Initial Speed	Speed in **kph** if loose shunted, **zero** if stationary.
Wagon details	Enter average **mass** and **bearing type** only.
Bearing types	**Package** (If in doubt, assume package) **Axlebox** **Journal**

IMPORTANT: For this tool and unlike other calculation tools, use **+** numbers for DOWNHILL grades, **–** numbers for UPHILL grades and 100,000 for level grades.

Some worked examples of values entered in the tables are shown in Appendix A.

2.2.2 Signal Designer Details

Date	Prepared by:	ARTC ID No.	Email Address	Organisation	Checked by:	Independent Review by:
7/12/2016						

For each calculation which provides the source data for a signal design, the Signal Designer must complete the above table. The information required is self-explanatory.

The calculation information must then be produced as a PDF, printed and included as supporting information in the design pack for verification and recording purposes.

2.2.3 Results

RESULTS

Speed at the end of each grade		
	m/s	kph
Grade 1 - 2	4.16	14.97
Grade 2 - 3	2.24	8.07
Grade 3 - 4	0.00	0.00
Grade 4 - 5	0.00	0.00

Total distance travelled (m)	971.78
Total distance available (m)	1900
Time taken to stop (Sec)	365.53
Time taken to stop (Mins)	6.09

#1

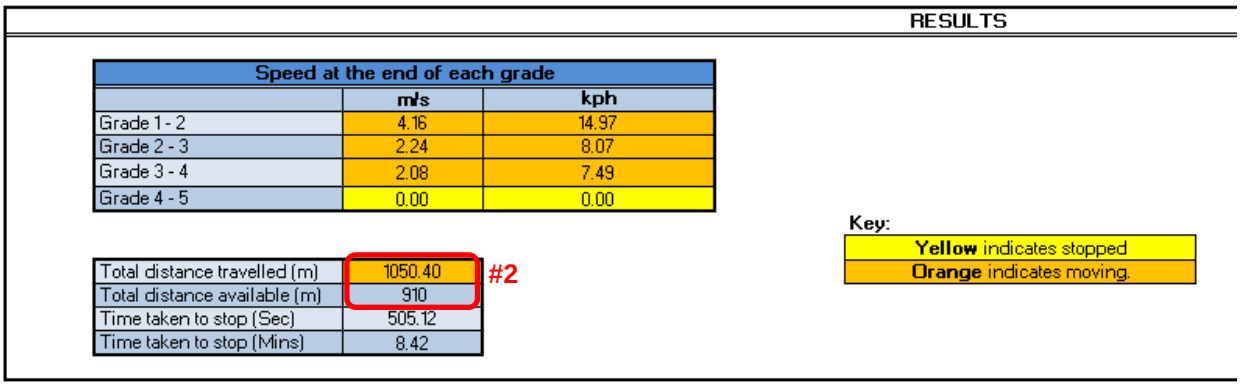
Key:
Yellow indicates stopped
Orange indicates moving.

The results of the calculations automatically appear in tables of the RESULTS window (see above). As described in the key, the resultant values are automatically indicated:

- Yellow for runaway vehicle which is stopped, and
- Orange for runaway vehicle which is moving

Note #1: If the Total Distance Travelled resultant value is less than the Total Distance Available, the distances will be shown as calculated with the Total Distance Travelled value text highlighted yellow (as per example shown above).

This means that the distance available for a runaway vehicle is adequate and protection will not be required.



RESULTS

Speed at the end of each grade		
	m/s	kph
Grade 1 - 2	4.16	14.97
Grade 2 - 3	2.24	8.07
Grade 3 - 4	2.08	7.49
Grade 4 - 5	0.00	0.00

Total distance travelled (m)	1050.40
Total distance available (m)	910
Time taken to stop (Sec)	505.12
Time taken to stop (Mins)	8.42

#2

Key:
Yellow indicates stopped
Orange indicates moving.

Note #2: If the Total Distance Travelled resultant value is greater than the Total Distance Available, the distances will be shown as calculated with the Total Distance Travelled value text highlighted orange.

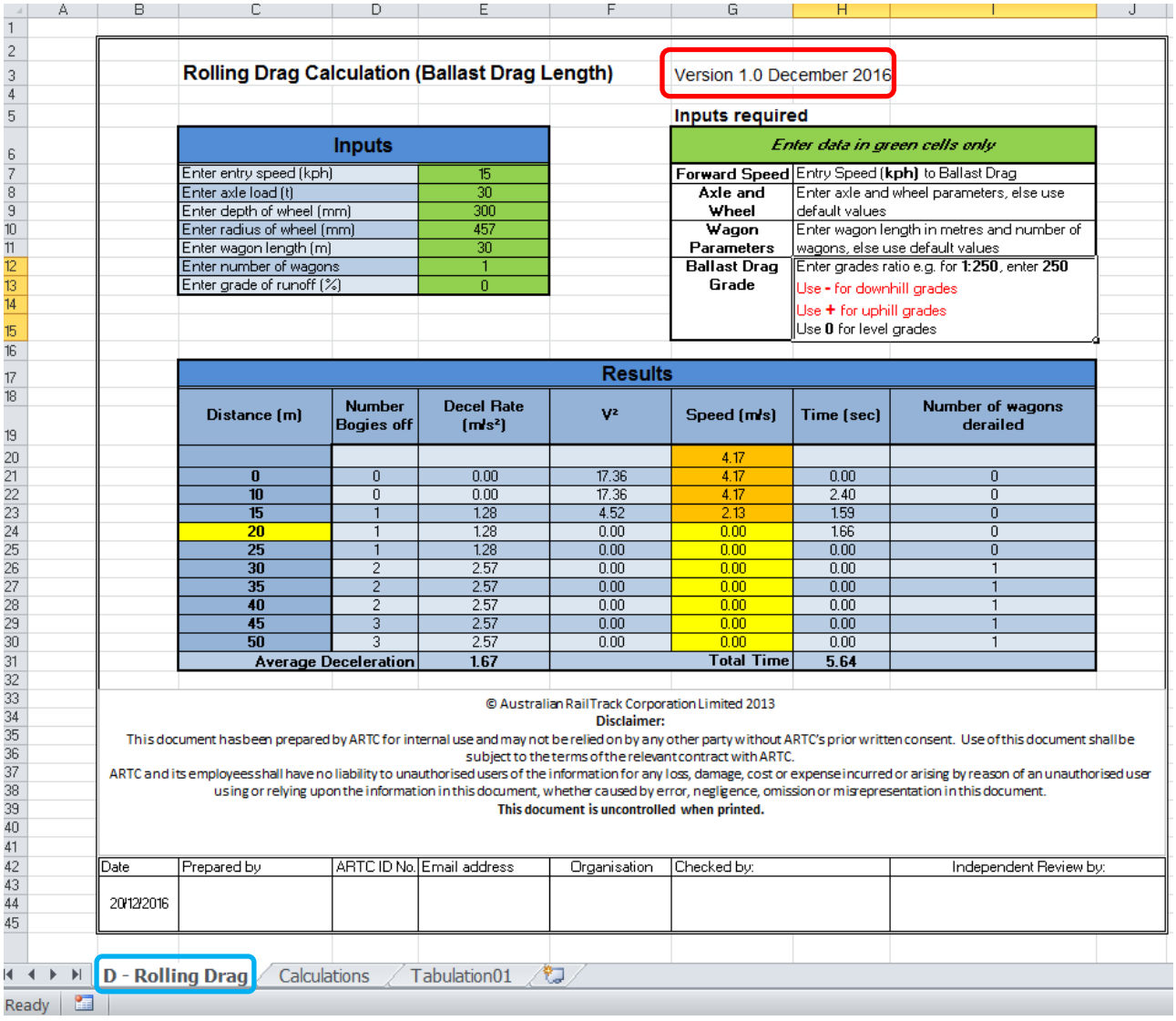
This means that the distance available for a runaway vehicle is inadequate and some form of protection will be required (eg a derailer or set of catch points). The selection of protection will depend on the calculated speed the runaway vehicle is travelling at when passing the location being considered.

3 Description of the Ballast Drag Length Calculator

The Ballast Drag Length Calculator (ESI0605-T02) 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 runaway vehicle speeds. *Refer to ARTC Engineering Extranet for the most current version.*

3.1 Open Ballast Drag Length Calculator

Open Ballast Drag Length Calculator the same way as any regular excel file. The file should open on the main page, the "D – Rolling Drag" worksheet, as shown in Figure 1 below.



Rolling Drag Calculation (Ballast Drag Length) Version 1.0 December 2016

Inputs

Enter entry speed (kph)	15
Enter axle load (t)	30
Enter depth of wheel (mm)	300
Enter radius of wheel (mm)	457
Enter wagon length (m)	30
Enter number of wagons	1
Enter grade of runoff (%)	0

Inputs required

Enter data in green cells only	
Forward Speed	Entry Speed (**kph**) to Ballast Drag
Axle and Wheel	Enter axle and wheel parameters, else use default values
Wagon Parameters	Enter wagon length in metres and number of wagons, else use default values
Ballast Drag Grade	Enter grades ratio e.g. for **1:250**, enter **250** Use **-** for downhill grades Use **+** for uphill grades Use **0** for level grades

Results

Distance (m)	Number Bogies off	Decel Rate (m/s²)	V²	Speed (m/s)	Time (sec)	Number of wagons derailed
				4.17		
0	0	0.00	17.36	4.17	0.00	0
10	0	0.00	17.36	4.17	2.40	0
15	1	1.28	4.52	2.13	1.59	0
20	1	1.28	0.00	0.00	1.66	0
25	1	1.28	0.00	0.00	0.00	0
30	2	2.57	0.00	0.00	0.00	1
35	2	2.57	0.00	0.00	0.00	1
40	2	2.57	0.00	0.00	0.00	1
45	3	2.57	0.00	0.00	0.00	1
50	3	2.57	0.00	0.00	0.00	1
Average Deceleration		**1.67**		**Total Time**	**5.64**	

Date	Prepared by	ARTC ID No.	Email address	Organisation	Checked by:	Independent Review by:
20/12/2016						

Figure 1

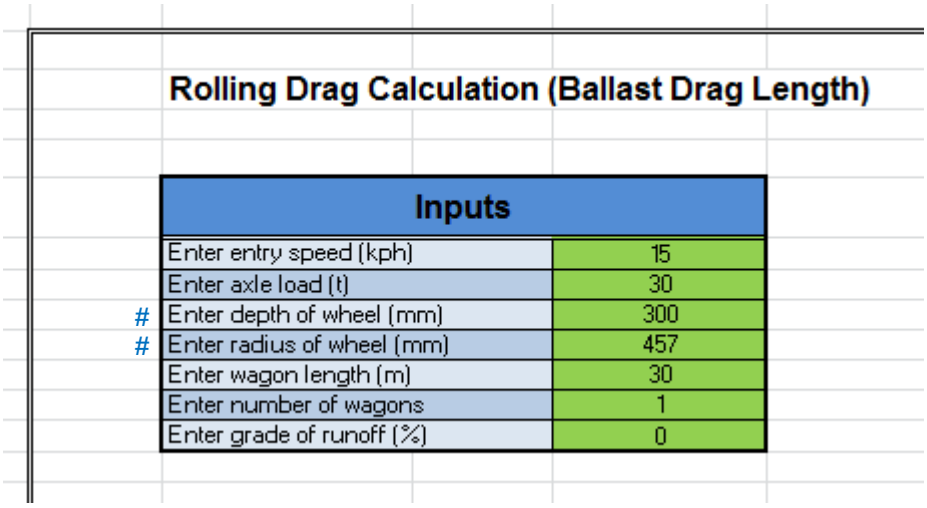
The "D – Rolling Drag" worksheet (*highlighted blue)* is the only worksheet used for data entry to calculate the length of a ballast drag necessary to arrest runaway wagon(s). All other worksheets are for information only.

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

3.2 Data Entry

The active cells are the ***Green*** cells. Values and text data must only be entered into active cells.

3.2.1 Data Inputs Entry



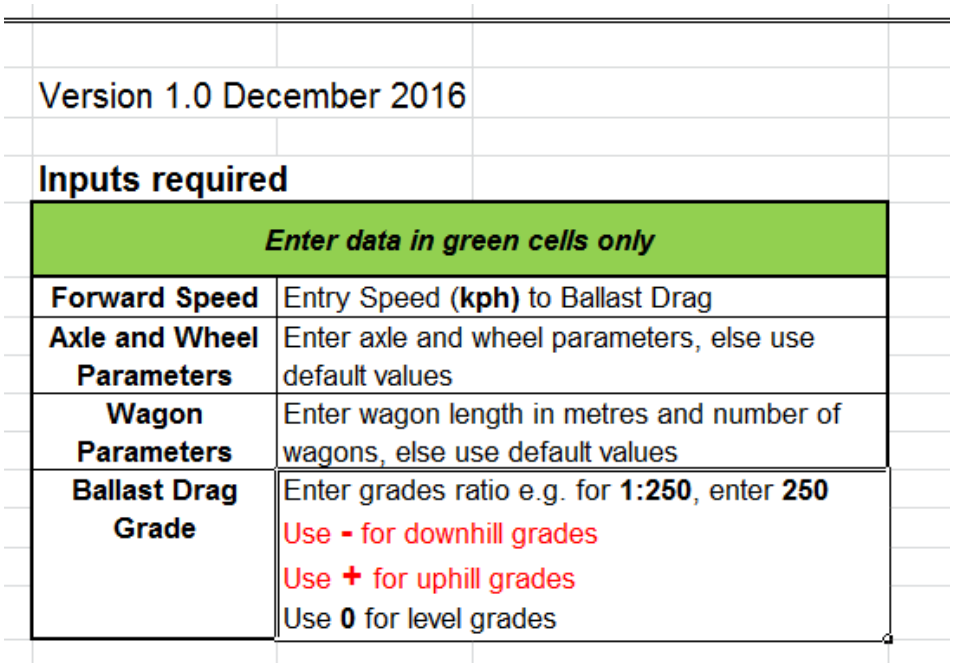
Rolling Drag Calculation (Ballast Drag Length)

	Inputs	
	Enter entry speed (kph)	15
	Enter axle load (t)	30
#	Enter depth of wheel (mm)	300
#	Enter radius of wheel (mm)	457
	Enter wagon length (m)	30
	Enter number of wagons	1
	Enter grade of runoff (%)	0

The above table is used to enter the data for the ballast drag length calculation.

Note #: Normally, the input data would be selected and entered in accordance with the parameters for each design. However, the values “300’ and “457” can be considered as default values if the actual wheel parameters are unknown.

Explanatory notes for entering the input data are included in the worksheet as shown below.



Version 1.0 December 2016

Inputs required

Enter data in green cells only	
Forward Speed	Entry Speed (**kph)** to Ballast Drag
Axle and Wheel Parameters	Enter axle and wheel parameters, else use default values
Wagon Parameters	Enter wagon length in metres and number of wagons, else use default values
Ballast Drag Grade	Enter grades ratio e.g. for **1:250**, enter **250** Use **-** for downhill grades Use **+** for uphill grades Use **0** for level grades

IMPORTANT: For this tool, use **+** numbers for UPHILL grade, **–** numbers for DOWNHILL grade and zero for level grade.

Some worked examples of values entered in the tables are shown in Appendix A.

3.2.2 Signal Designer Details

Date	Prepared by	ARTC ID No.	Email address	Organisation	Checked by:	Independent Review by:
19/12/2016						

For each calculation which provides the source data for a signal design, the Signal Designer must complete the above table. The information required is self-explanatory.

The calculation information must then be produced as a PDF, printed and included as supporting information in the design pack for verification and recording purposes.

3.2.3 Results

Results

Distance (m)	Number Bogies off	Decel Rate (m/s²)	V²	Speed (m/s)	Time (sec)	Number of wagons derailed
				4.17		
0	0	0.00	17.36	4.17	0.00	0
10	0	0.00	17.36	4.17	2.40	0
15	1	1.28	4.52	2.13	1.59	0
20	1	1.28	0.00	0.00	1.66	0
25	1	1.28	0.00	0.00	0.00	0
30	2	2.57	0.00	0.00	0.00	1
35	2	2.57	0.00	0.00	0.00	1
40	2	2.57	0.00	0.00	0.00	1
45	3	2.57	0.00	0.00	0.00	1
50	3	2.57	0.00	0.00	0.00	1
Average Deceleration		1.67		Total Time	5.64	

#1

The results of the calculations automatically appear in the table of the RESULTS window (see above). The resultant values are automatically highlighted:

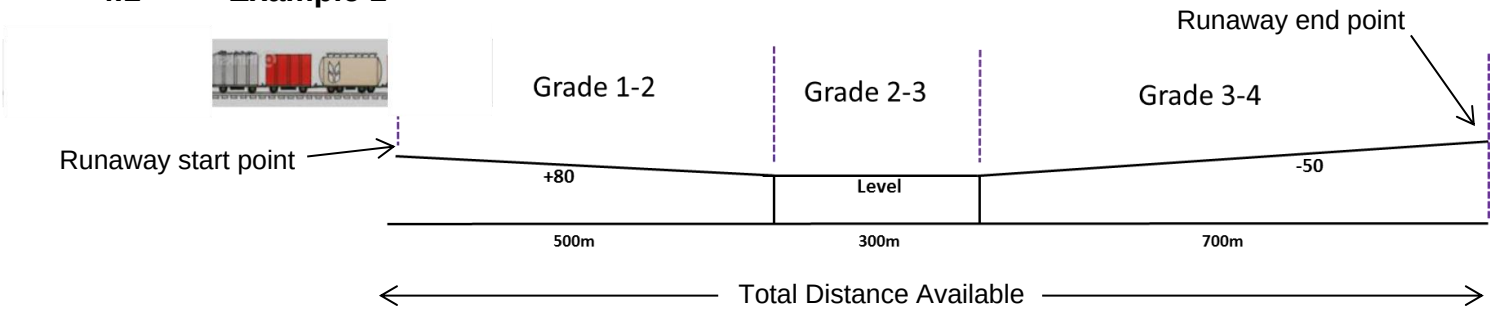
- Yellow for stopped runaway vehicle(s) and the minimum length of the ballast drag
- Orange for moving runaway vehicle(s)

Note #1: In the example shown above, the minimum length of a ballast drag to arrest a single 30m long and 30T wagon travelling at 15 kph is calculated to be 20m.

4 Appendix A – Worked Examples

The following are some worked examples on 1500m of a variable gradient track.

4.1 Example 1



Calculation of Wagon Rolling on Multiple Grades Version 1.0

Inputs		
	Grade	Length (m)
Enter Grade 1 - 2	80	500
Enter Grade 2 - 3	100000	300
Enter Grade 3 - 4	-50	700
Enter Grade 4 - 5	0	0
Track Description	good	
Initial Speed (kph)	0	

Wagon Characteristics	
Mass of wagon (tonnes)	30
Number of Wagons	1
Bearing Type	package

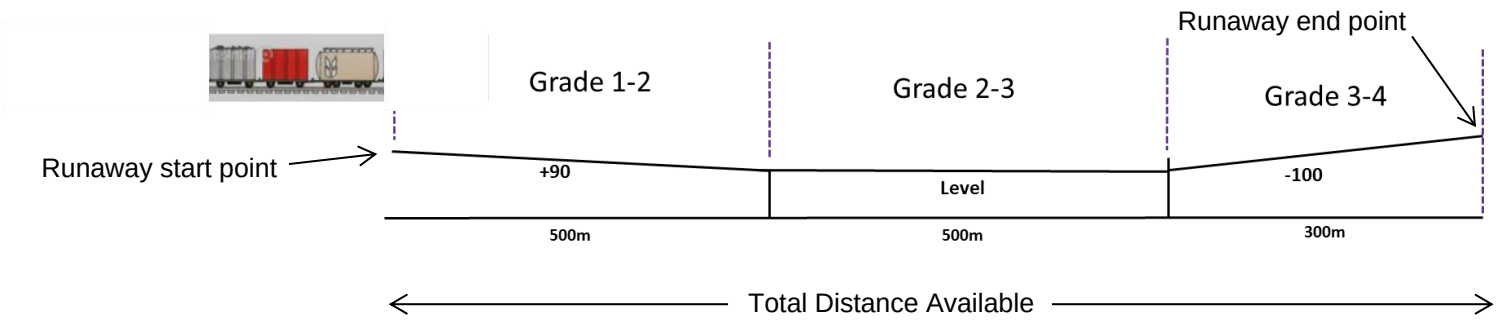
Speed at the end of each grade		
	m/s	kph
Grade 1 - 2	10.35	37.28
Grade 2 - 3	9.90	35.64
Grade 3 - 4	0.00	0.00
Grade 4 - 5	0.00	0.00

Total distance travelled (m)	1031.59
Total distance available (m)	1500
Time taken to stop (Sec)	126.20
Time taken to stop (Mins)	2.10

Yellow highlight indicates vehicle will stop within the grade 3-4 section

In this example, it is calculated that the runaway vehicles would take 1031.59m to stop in the Grade 3-4 area. Therefore there is adequate distance available for the runaway vehicles to stop before the end point.

4.2 Example 2



Calculation of Wagon Rolling on Multiple Grades Version 1.0 I

Inputs		
	Grade	Length (m)
Enter Grade 1 - 2	90	500
Enter Grade 2 - 3	100000	700
Enter Grade 3 - 4	-100	300
Enter Grade 4 - 5	0	0
Track Description	good	
Initial Speed (kph)	0	

Wagon Characteristics	
Mass of wagon (tonnes)	30
Number of Wagons	1
Bearing Type	package

Speed at the end of each grade		
	m/s	kph
Grade 1 - 2	9.67	34.83
Grade 2 - 3	8.49	30.58
Grade 3 - 4	2.01	7.23
Grade 4 - 5	0.00	0.00

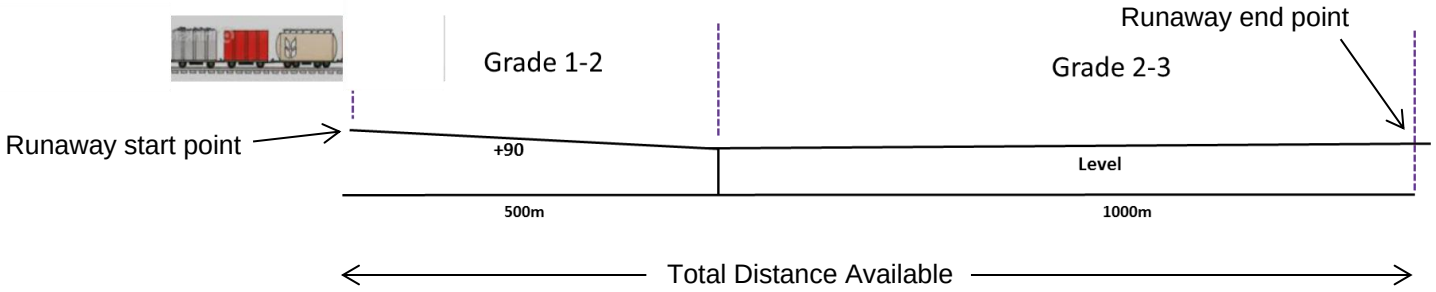
Total distance travelled (m)	1630.68
Total distance available (m)	1500
Time taken to stop (Sec)	367.78
Time taken to stop (Mins)	6.13

Orange highlight indicates vehicle is still moving beyond the end point

In this example, it is calculated that the runaway vehicles would take 1630.68m to stop beyond the Grade 3-4 area (provided the -100 grade continues). Therefore there is not adequate distance available for the runaway vehicles to stop before the end point.

The speed the runaway vehicles are calculated to be travelling at the end point is 2.01m/s (7.23Kph). Therefore appropriate protection will be necessary to prevent it fouling other train movements which may be taking place in the vicinity of the end point. Refer to type approved derailer/crowders which could be applied (eg Aldon, Siemens, etc).

4.3 Example 3



Calculation of Wagon Rolling on Multiple Grades Version 1.0

Inputs		
	Grade	Length (m)
Enter Grade 1 - 2	90	500
Enter Grade 2 - 3	100000	1000
Enter Grade 3 - 4	0	0
Enter Grade 4 - 5	0	0
Track Description	good	
Initial Speed (kph)	0	

Wagon Characteristics	
Mass of wagon (tonnes)	30
Number of Wagons	1
Bearing Type	package

Speed at the end of each grade		
	m/s	kph
Grade 1 - 2	9.67	34.83
Grade 2 - 3	7.93	28.56
Grade 3 - 4	0.00	0.00
Grade 4 - 5	0.00	0.00

Total distance travelled (m)	1500.00
Total distance available (m)	1500
Time taken to stop (Sec)	216.96
Time taken to stop (Mins)	3.62

Orange highlight indicates vehicle is still moving beyond the end point

In this example, there are only 2 grade sections. It is calculated that the runaway vehicles would still be moving beyond the Grade 2-3 area end point.

The speed the runaway vehicles are calculated to be travelling at the end point is 7.93m/s (28.56Kph). Therefore appropriate protection will be necessary to prevent it fouling other train movements which may be taking place in the vicinity of the end point. With this speed, a set of catch points would be necessary. Depending on the situation, a ballast drag may also be required which would be correctly sized by using the Ballast Drag Length Calculator tool. Refer example below…

Rolling Drag Calculation (Ballast Drag Length) Version 1.0 December 2016

Inputs	
Enter entry speed (kph)	28.56
Enter axle load (t)	30
Enter depth of wheel (mm)	300
Enter radius of wheel (mm)	457
Enter wagon length (m)	30
Enter number of wagons	3
Enter grade of runoff (%)	0

Inputs required

Enter data in green cells only	
Forward Speed	Entry Speed (**kph**) to Ballast Drag
Axle and Wheel	Enter axle and wheel parameters, else use default values
Wagon Parameters	Enter wagon length in metres and number of wagons, else use default values
Ballast Drag Grade	Enter grades ratio e.g. for **1:250**, enter **250** Use **-** for downhill grades Use **+** for uphill grades Use **0** for level grades

Results

Distance (m)	Number Bogies off	Decel Rate (m/s²)	V²	Speed (m/s)	Time (sec)	Number of wagons derailed
				7.93		
0	0	0.00	62.94	7.93	0.00	0
10	0	0.00	62.94	7.93	1.26	0
15	1	0.43	58.66	7.66	0.64	0
20	1	0.43	54.38	7.37	0.67	0
25	1	0.43	50.10	7.08	0.69	0
30	2	0.86	41.53	6.44	0.74	1
35	2	0.86	32.97	5.74	0.82	1
40	2	0.86	24.41	4.94	0.94	1
45	3	1.28	11.57	3.40	1.20	1
50	3	1.28	0.00	0.00	2.65	1
Average Deceleration		**0.64**		**Total Time**	**9.60**	

Date	Prepared by	ARTC ID No.	Email address	Organisation	Checked by:	Independent Review by:
20/12/2016						

In this example, the entry speed is 28.56 Kph as calculated with the Run-a-Way Speed Calculator and the number of wagons is 3. The minimum length of the ballast drag is calculated to be 50m.