RFCpro workshop

29 October 2012

Agenda

Time	Subject	
10:30	Aims of workshop	NR
10:45	RFCpro (introduction and background)	University of Huddersfield
11:30	Break	
11:40	RFCpro (software demonstration)	University of Huddersfield
12:25	Questions and discussion	
12:50	Next steps	NR
13:00	Lunch and close	

Aims of workshop

Introduction

- A significant quantity of work carried out over the past two years to review suspension factors used in freight variable usage charges
- Stakeholder meetings/workshops throughout the process
- NR submitted final proposal to ORR in August 2012 - approved today
  - All new vehicles in CP5 to use RFCpro to calculate suspension factor
  - Existing vehicles can be reassessed using RFC approach before February 2013 in time for start of CP5

Aims of workshop

- To explain:
  - RFC metric
  - RFCpro software
- To demonstrate:
  - RFCpro
  - Methods available to calculate RFC (specific v generic)
- to address questions / comments on the RFCpro software

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Calculation of Suspension Factors for Freight Vehicles using **RFCpro**

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Institute of Railway Research, University of Huddersfield

29th October 2012

Network Rail

Background

The ORR required *"a revised suspension banding method that can be used as criteria for deciding the appropriate level of discount that should apply to new suspension types as these are designed through CP4 and CP5"*. ORR specifically requested the following key points:

- a **quantitative** measure of the mid-point of each suspension factor band
- a **quantitative** measure of the boundary between each band
- consideration of whether it is appropriate to introduce tangential (wear and RCF) effects into the suspension bandings table

Background

The proposed new approach is based upon the magnitude of a vehicle's dynamic *ride forces* – a measure of a vehicle's suspension performance

The ride forces are processed to provide a 'Ride Force Count' (RFC) metric; the RFC is calculated separately for tare and laden conditions

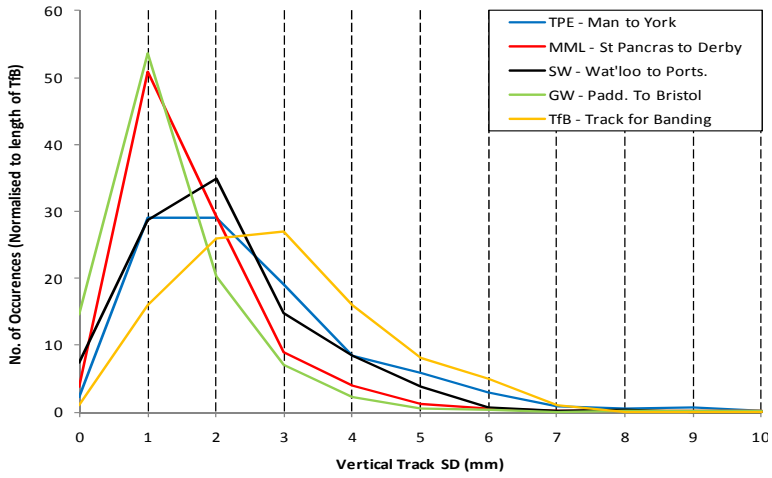
The RFC has been related to the level of Suspension Discount Factor based on vehicle dynamic analysis of a wide range of freight vehicle types (60 vehicle dynamic models)

The level of track access 'discount' available has been fixed at the current levels (+9.7 to -14.2%). Allocation of bands removed and replaced by continuous function

The process required to generate and submit an RFC based assessment has been fully developed and is defined within the RFCpro user guide

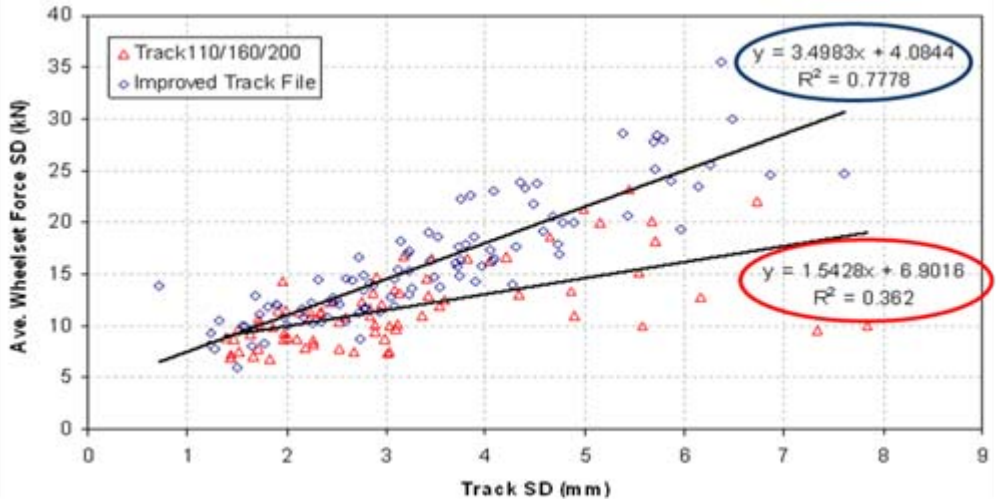
Background

Stage 1 – Determine the Ride Force Constants and Coefficients (RFCC) using vehicle dynamic simulation over the control Track for Banding file (TfB)



TfB file represents lower quality lines, more typical of freight vehicle operation. (Based on 1000 km of TRV data)

RFCC values with high correlation coefficient are achieved using TfB



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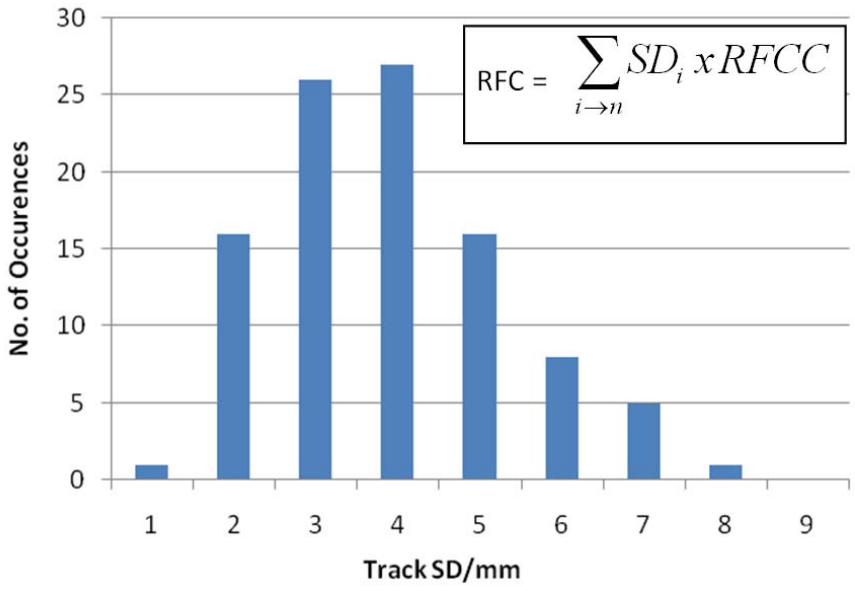
Stage 2 – Apply the TfB file vertical SD distribution to the RFCC data to obtain the Ride Force Count (RFC)



E.g. RFCC = 2.36kN/mm+0.29kN

For a track SD of 0-1mm, No. of Occurrences = 1
therefore RFC = (0mm*2.36+0.29)*1= 0.29

For a track SD of 1-2mm, No. of Occurrences = 16
therefore RFC = (1mm*2.36+0.29)*16= 42.4

For a track SD of 2-3mm, No. of Occurrences = 26
therefore RFC = (2mm*2.36+0.29)*26= 130.26

…….and so on. These values are summed to obtain the RFC value for the complete TfG file SD set:-

i.e. 2.65 + 42.4 + 130.26 +…. n_7 + n_8… **RFC = 713**

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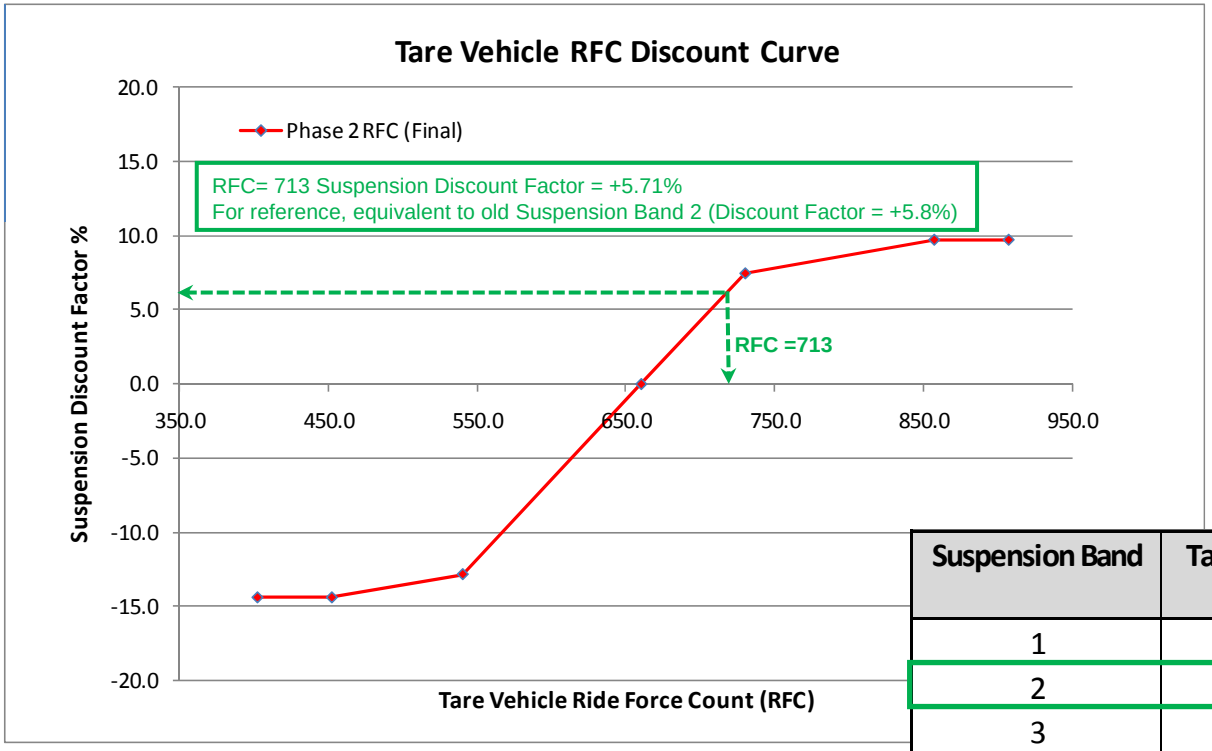
Stage 3 – Evaluate the Suspension Discount Factor using RFC Discount Curve



RFC Discount Curves for both Tare and Laden Vehicles (Tare shown)

Suspension Band	Tare RFC Range	Laden RFC Range	Suspension Discount Factor
1	RFC > 715	RFC > 1650	1.098
2	680 – 715	1545 – 1650	1.058
3	640 – 679	1450 – 1544	1.018
4	605 – 639	1350 – 1449	0.978
5	565 – 604	1255 – 1349	0.938
6	465 – 564	925 – 1254	0.898
7	RFC < 465	RFC < 925	0.858

RFCpro Software

RFC Pro Software

RFCpro is a piece of software used to calculate Suspension Factors

Suspension Factors are used in determining the Track Access Charge for freight vehicles

RFC Pro Software

Integrates the RFC and Suspension Factor calculation into a user friendly Graphical User Interface

Provides the user with the option of Specific Vehicle and Generic Vehicle methods

Outputs results to a Log File for submission to Network Rail

Calculation Methods

Specific Vehicle Method

- Assessment of a single wagon type of known properties
- 1 Tare and 1 Laden simulation required

Generic Vehicle Method

- Assessment of a bogie or suspension type for a range of generic body parameters
- Up to 7 Tare and 6 Laden simulations required
- Can be used in the tendering process

Vampire Simulations

- Predefined Vampire simulations are to be carried out for the freight vehicle under assessment
- For the Generic Vehicle method the parameters for the different cases are generated using RFC pro
- The user builds the Vampire models in the usual way using either actual or generic body parameters
- Standard template Run File for all simulations
- Simulations to be carried out using Vampire directly

Vampire Simulations

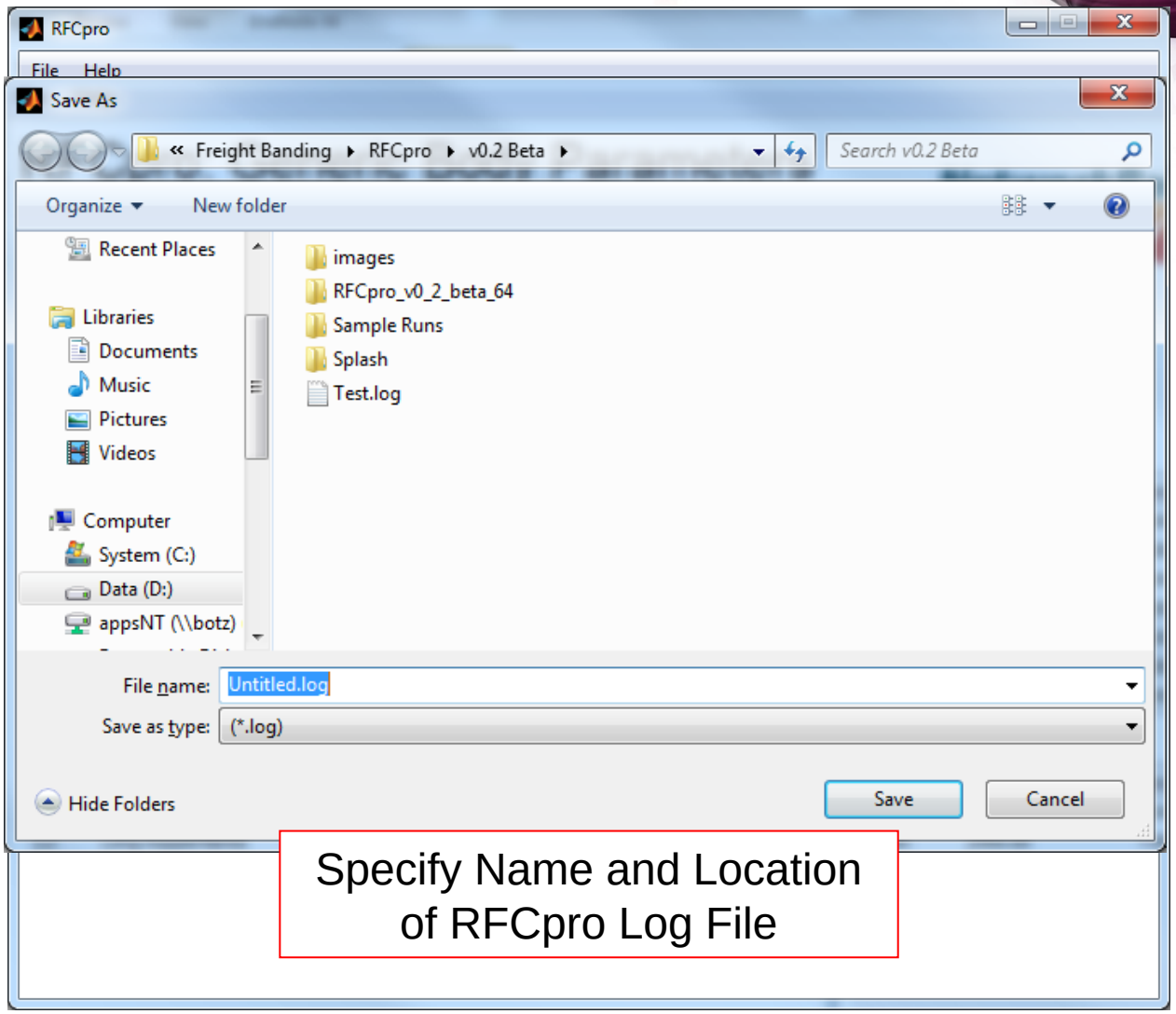
Template Vampire Run File:

```
Ride Force Calculation for freight banding: Tare Vehicle 1
UNITS VAMPIRE
C:\VampirePro\Freight_banding_11\Param_study\Vehicles\Vehicle_1
*TRANSIENT
   20000.0    0.0005     0.010      0.00
SPEED          33.53

C:\.....\track\ TfB_Vampire_20km_final_v1
*CREEP
   0.32000   0.32000   8.00000   0.32000   0.32000   0.32000   0.32000
NON-LINEAR
PROFILE   C:\.....\profiles\NR_Freightbanding_P10
**************************************** ****
*OUTPUT
**************************************** ****
Vertical axle load (w'set 1)              kN
FW01Z
Vertical axle load (w'set 2)              kN
FW02Z
Vertical axle load (w'set 3)              kN
FW03Z
Vertical axle load (w'set 4)              kN
FW04Z
*
```

Values in **Red** are fixed and should not be altered.
Values in **Blue** are varied by the user as appropriate.

RFCpro – Specific Vehicle Method



Specify Name and Location of RFCpro Log File

RFCpro – Specific Vehicle Method

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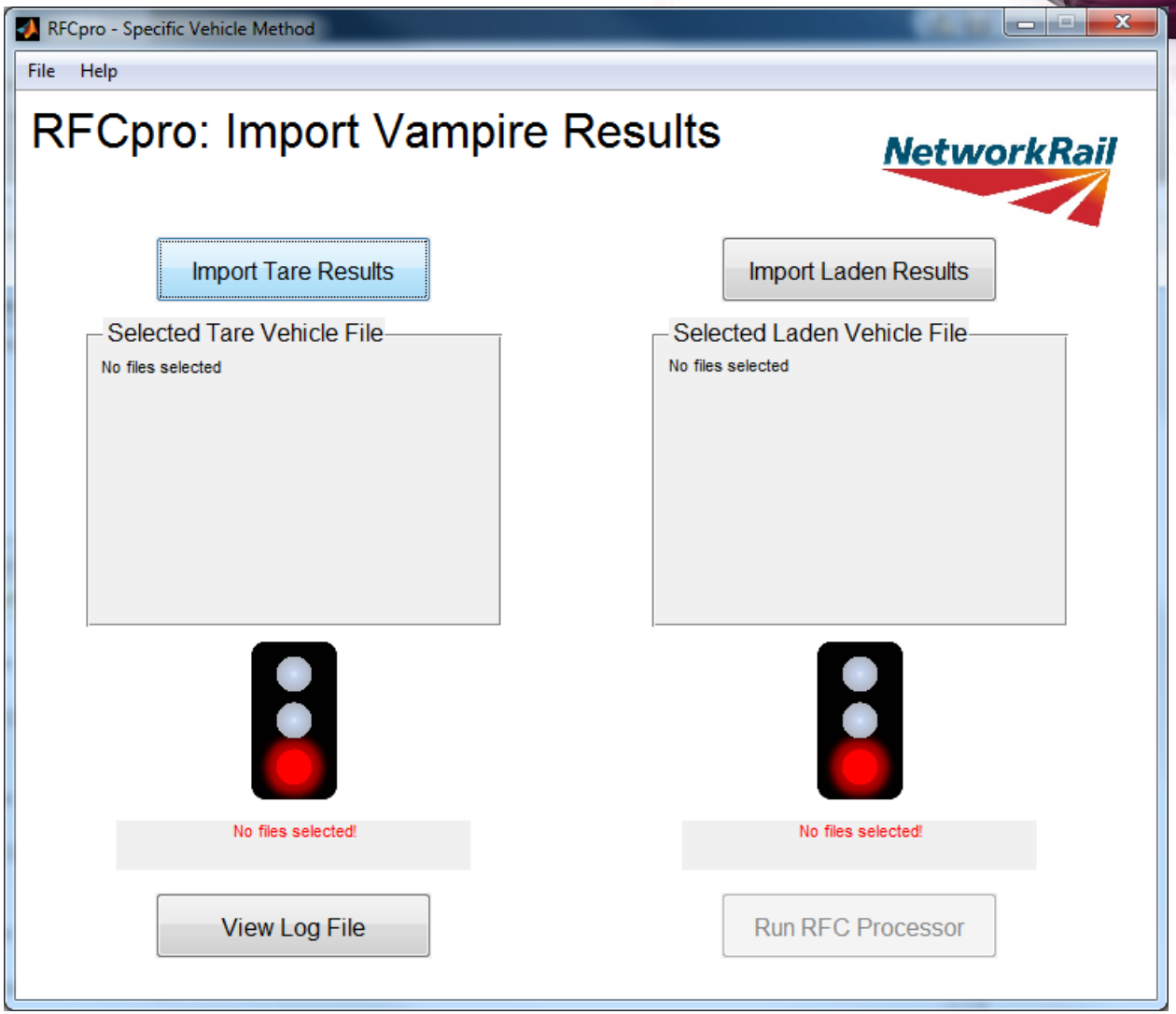

RFCpro – Specific Vehicle Method

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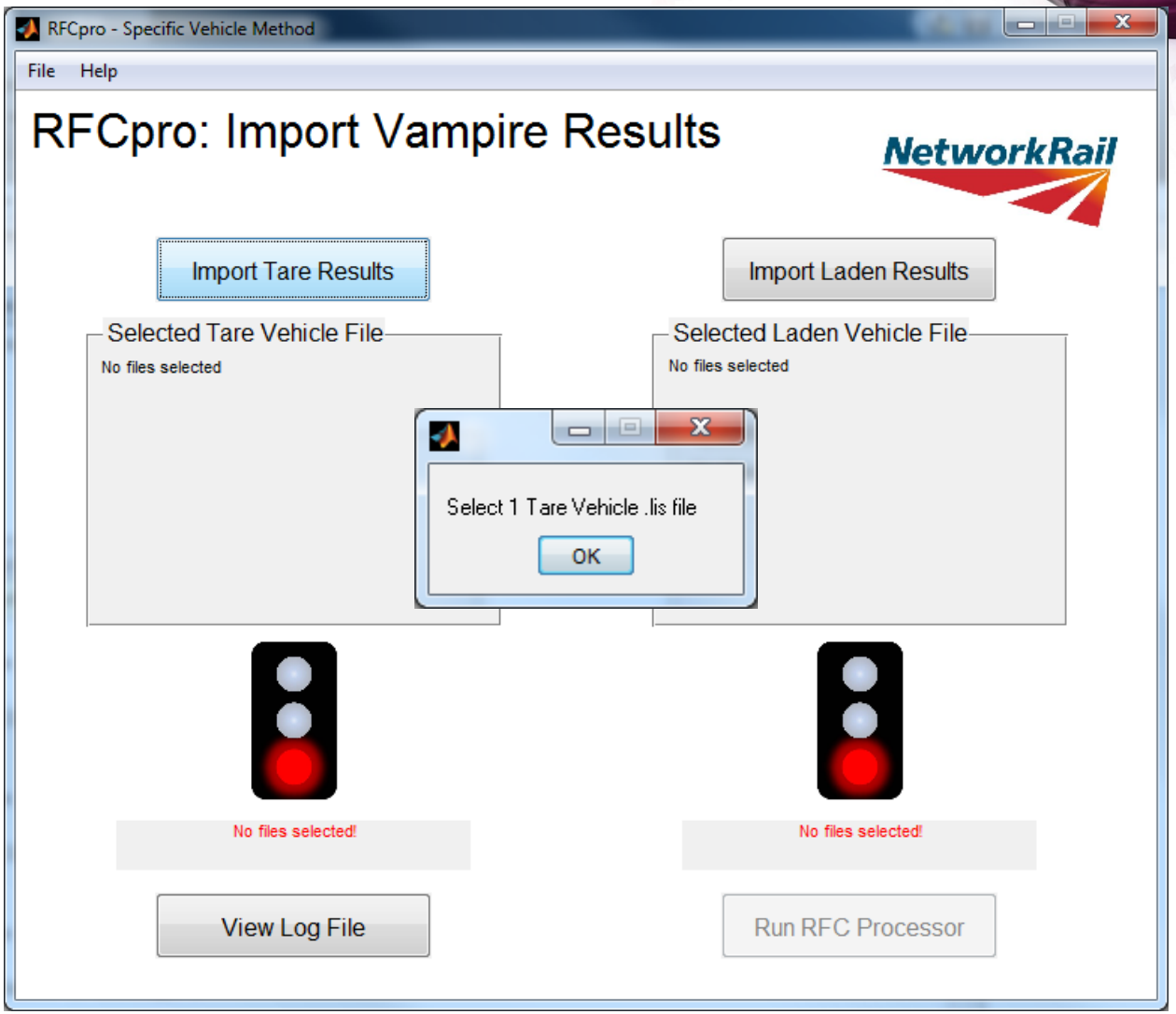
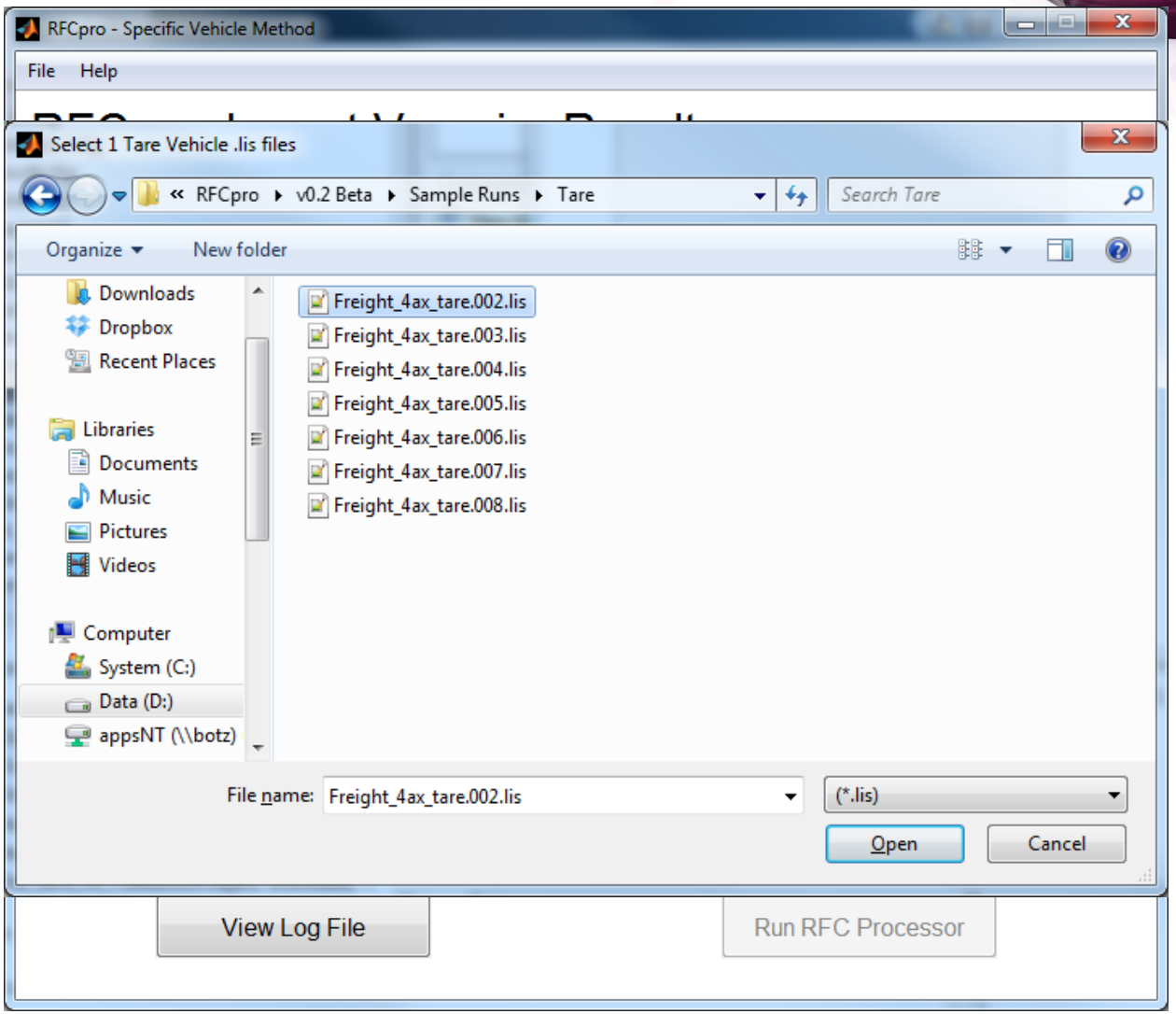


RFCpro – Specific Vehicle Method



RFCpro – Specific Vehicle Method

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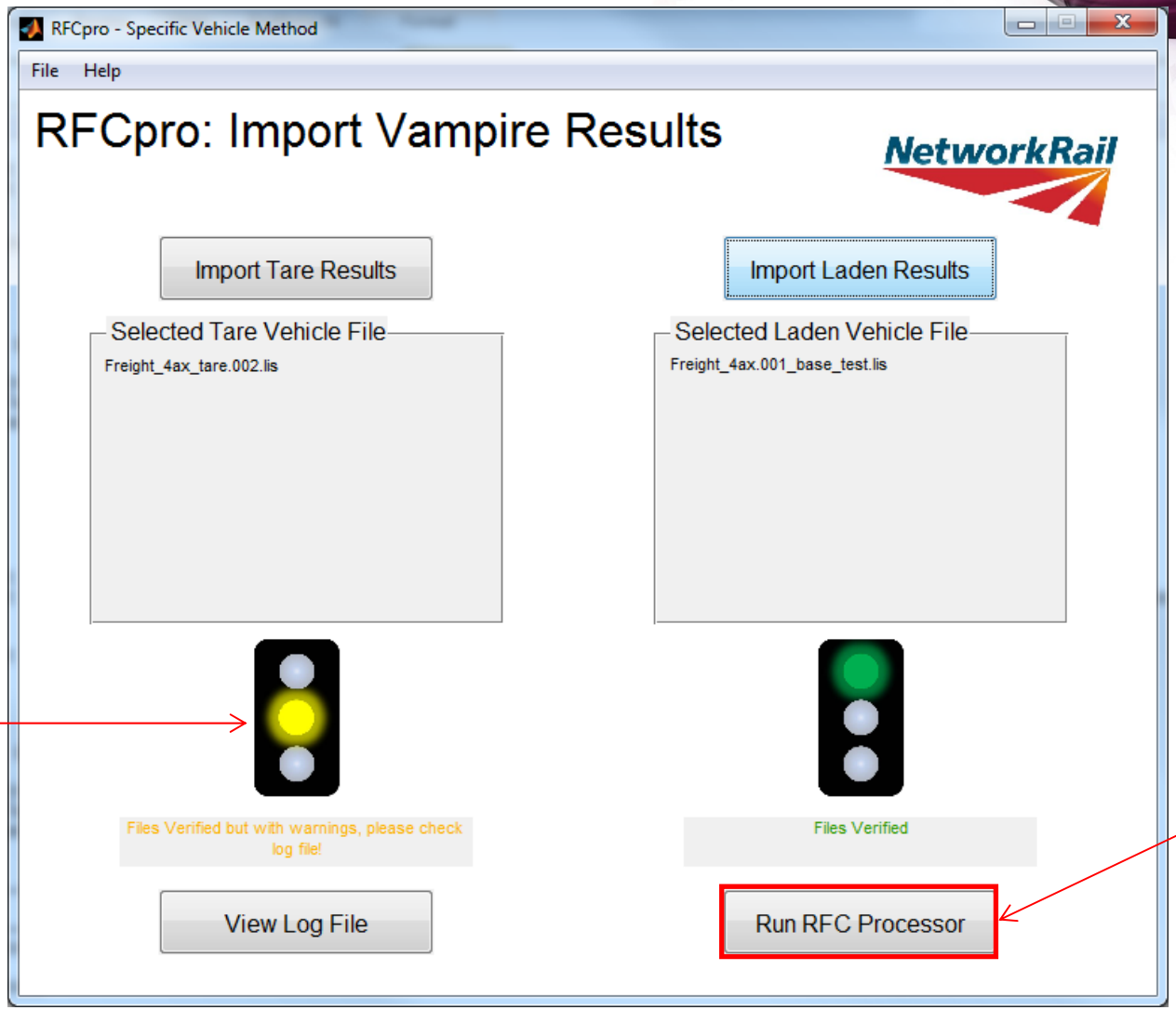

Signals highlight the verification status of the imported files

'Run RFC Processor' button is enabled once all selected files are verified

RFCpro – Specific Vehicle Method

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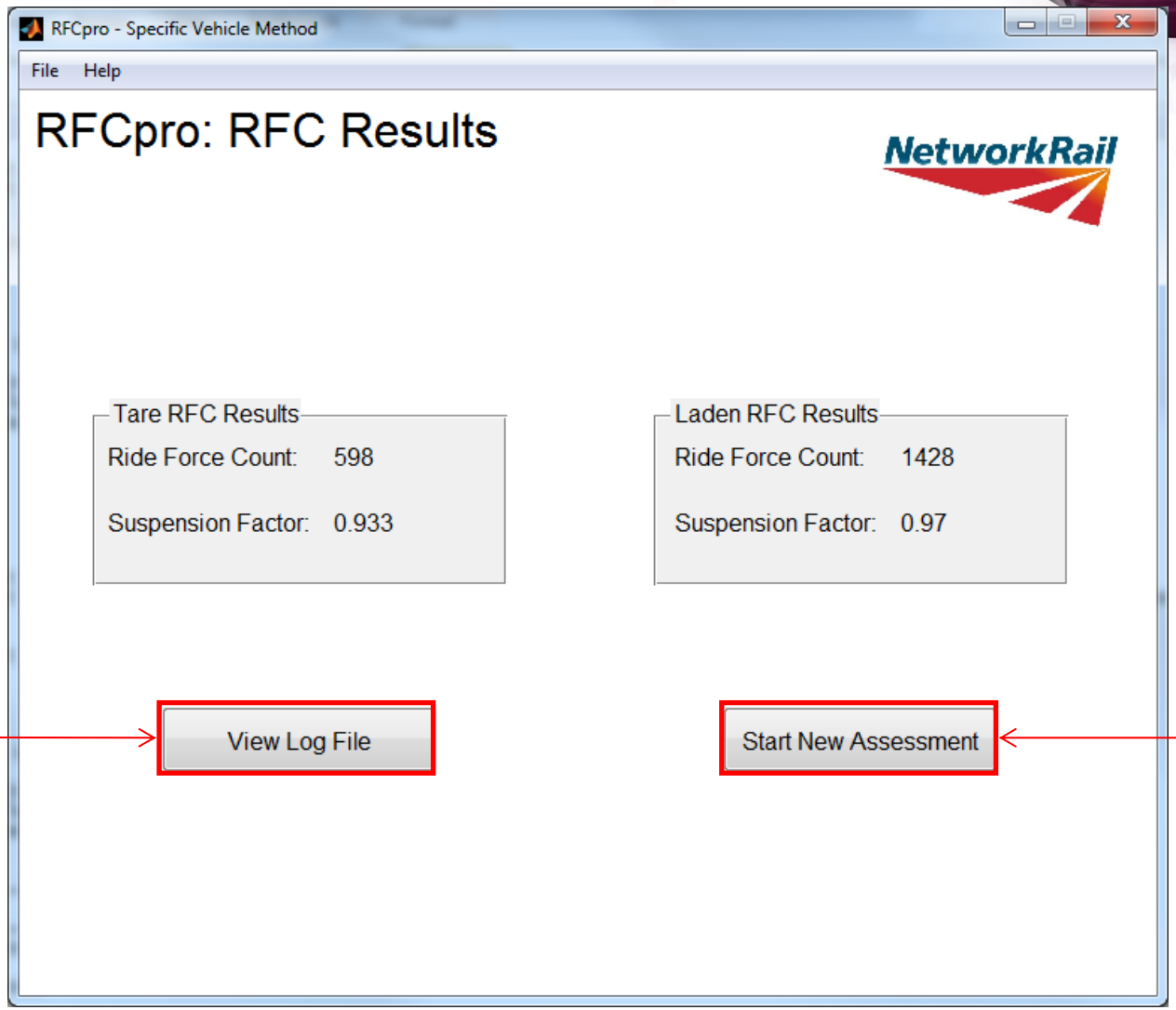
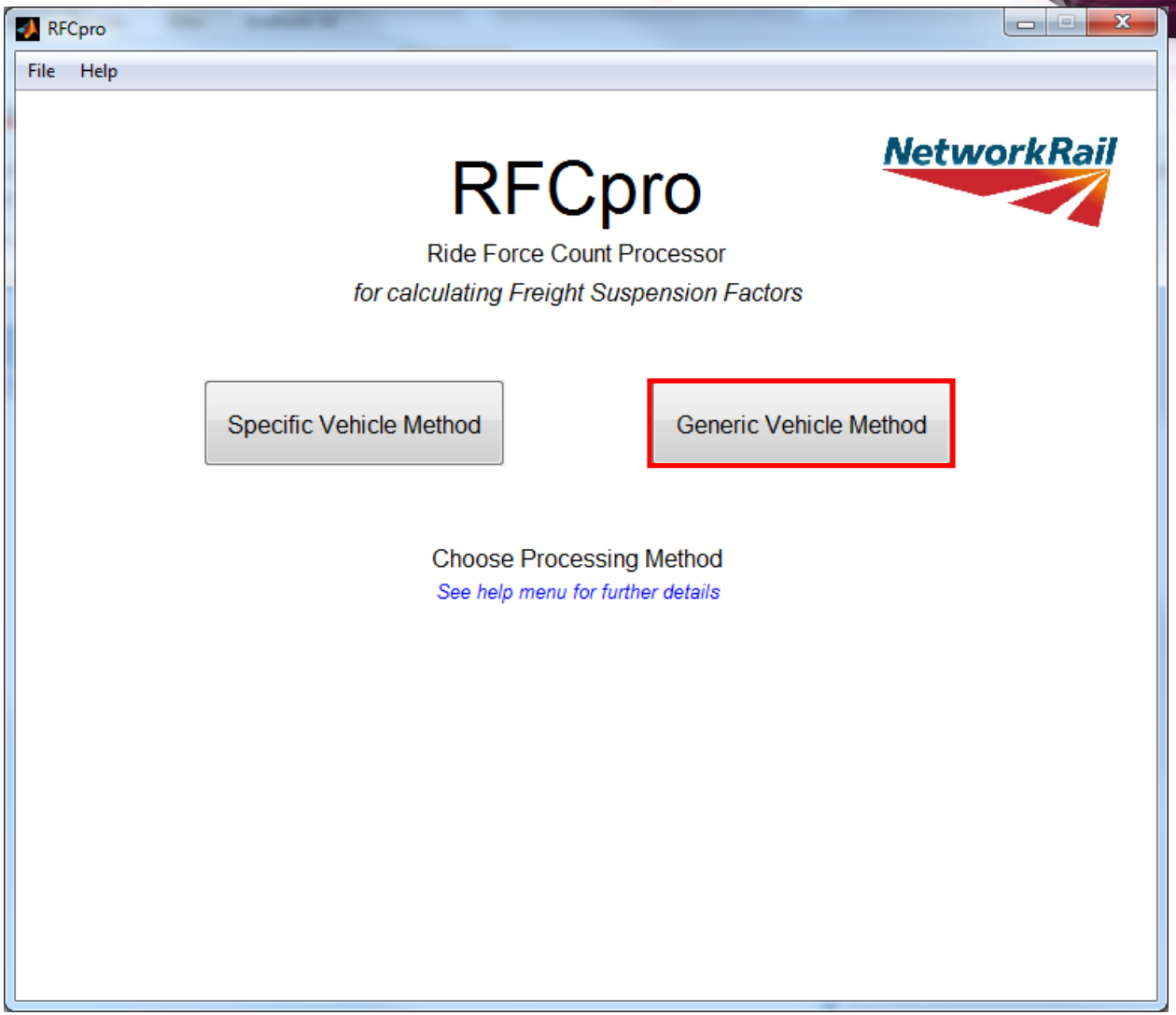


Results are automatically written to the Log File

Click here to start a new assessment

RFCpro – Generic Vehicle Method



RFCpro – Generic Vehicle Method

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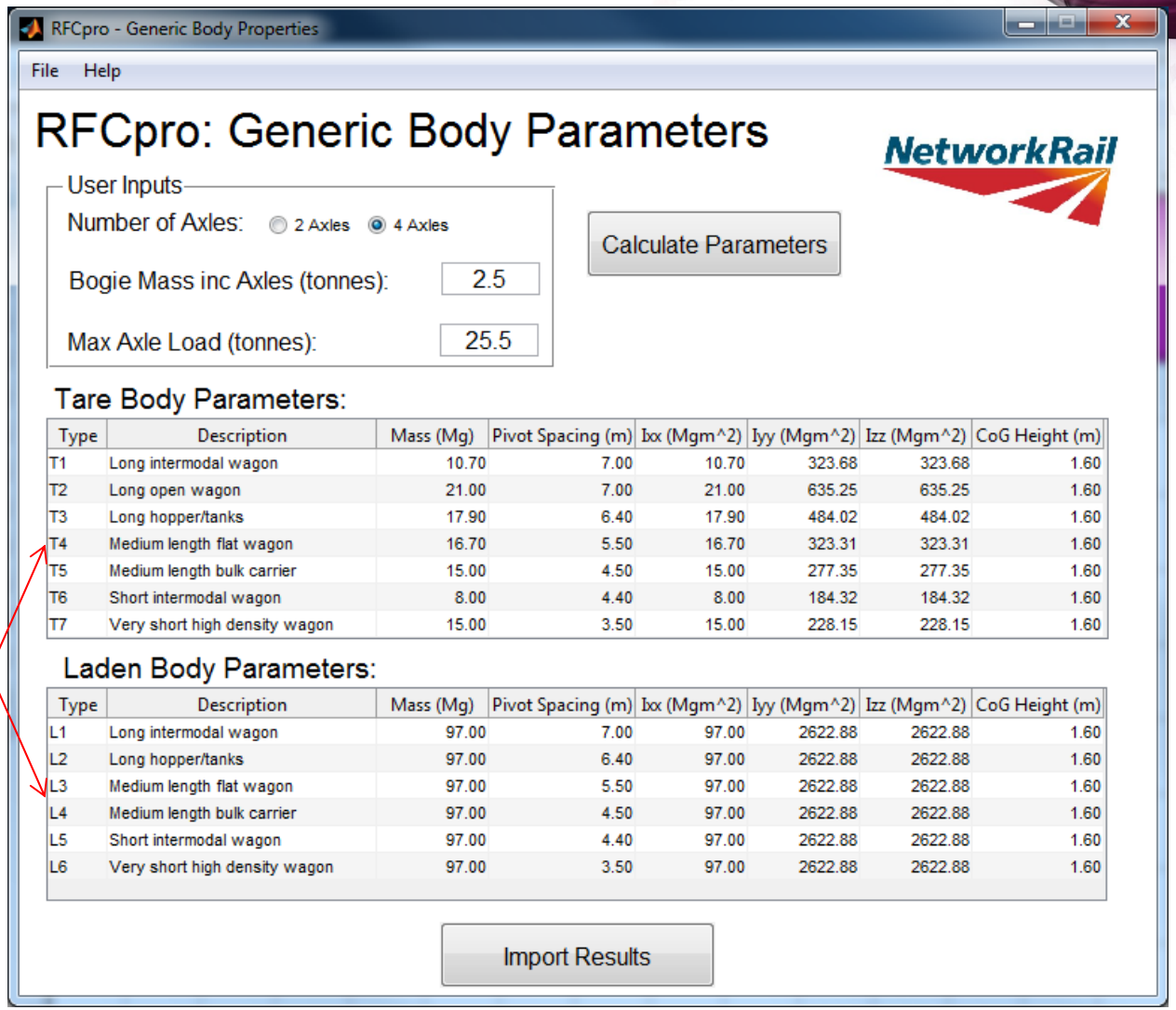

Type	Description	Mass (Mg)	Pivot Spacing (m)	Ixx (Mgm^2)	Iyy (Mgm^2)	Izz (Mgm^2)	CoG Height (m)
T1	Long intermodal wagon	10.70	7.00	10.70	323.68	323.68	1.60
T2	Long open wagon	21.00	7.00	21.00	635.25	635.25	1.60
T3	Long hopper/tanks	17.90	6.40	17.90	484.02	484.02	1.60
T4	Medium length flat wagon	16.70	5.50	16.70	323.31	323.31	1.60
T5	Medium length bulk carrier	15.00	4.50	15.00	277.35	277.35	1.60
T6	Short intermodal wagon	8.00	4.40	8.00	184.32	184.32	1.60
T7	Very short high density wagon	15.00	3.50	15.00	228.15	228.15	1.60

Type	Description	Mass (Mg)	Pivot Spacing (m)	Ixx (Mgm^2)	Iyy (Mgm^2)	Izz (Mgm^2)	CoG Height (m)
L1	Long intermodal wagon	97.00	7.00	97.00	2622.88	2622.88	1.60
L2	Long hopper/tanks	97.00	6.40	97.00	2622.88	2622.88	1.60
L3	Medium length flat wagon	97.00	5.50	97.00	2622.88	2622.88	1.60
L4	Medium length bulk carrier	97.00	4.50	97.00	2622.88	2622.88	1.60
L5	Short intermodal wagon	97.00	4.40	97.00	2622.88	2622.88	1.60
L6	Very short high density wagon	97.00	3.50	97.00	2622.88	2622.88	1.60

Parameters can be selected and copied using Ctrl+C

RFCpro – Generic Vehicle Method

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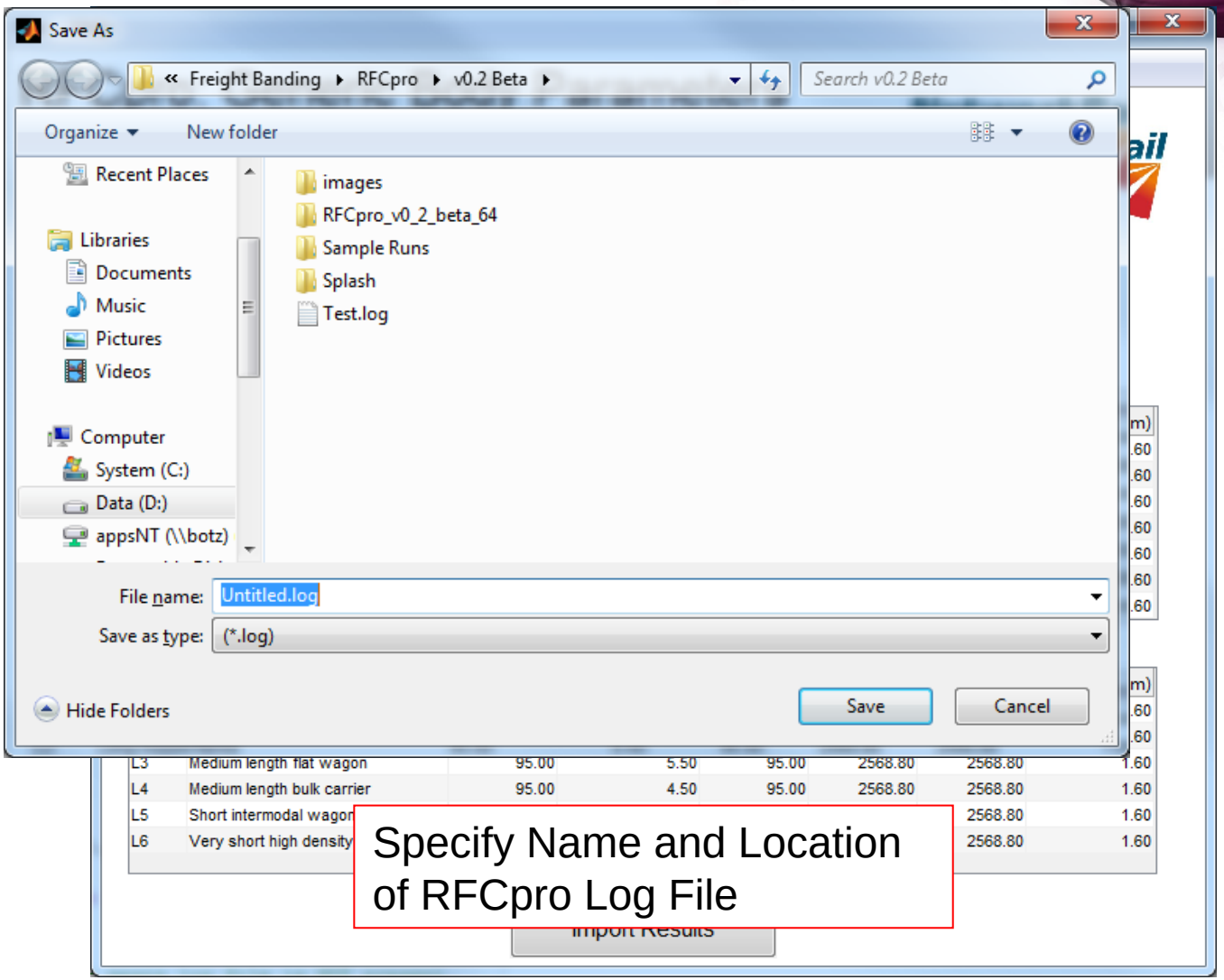
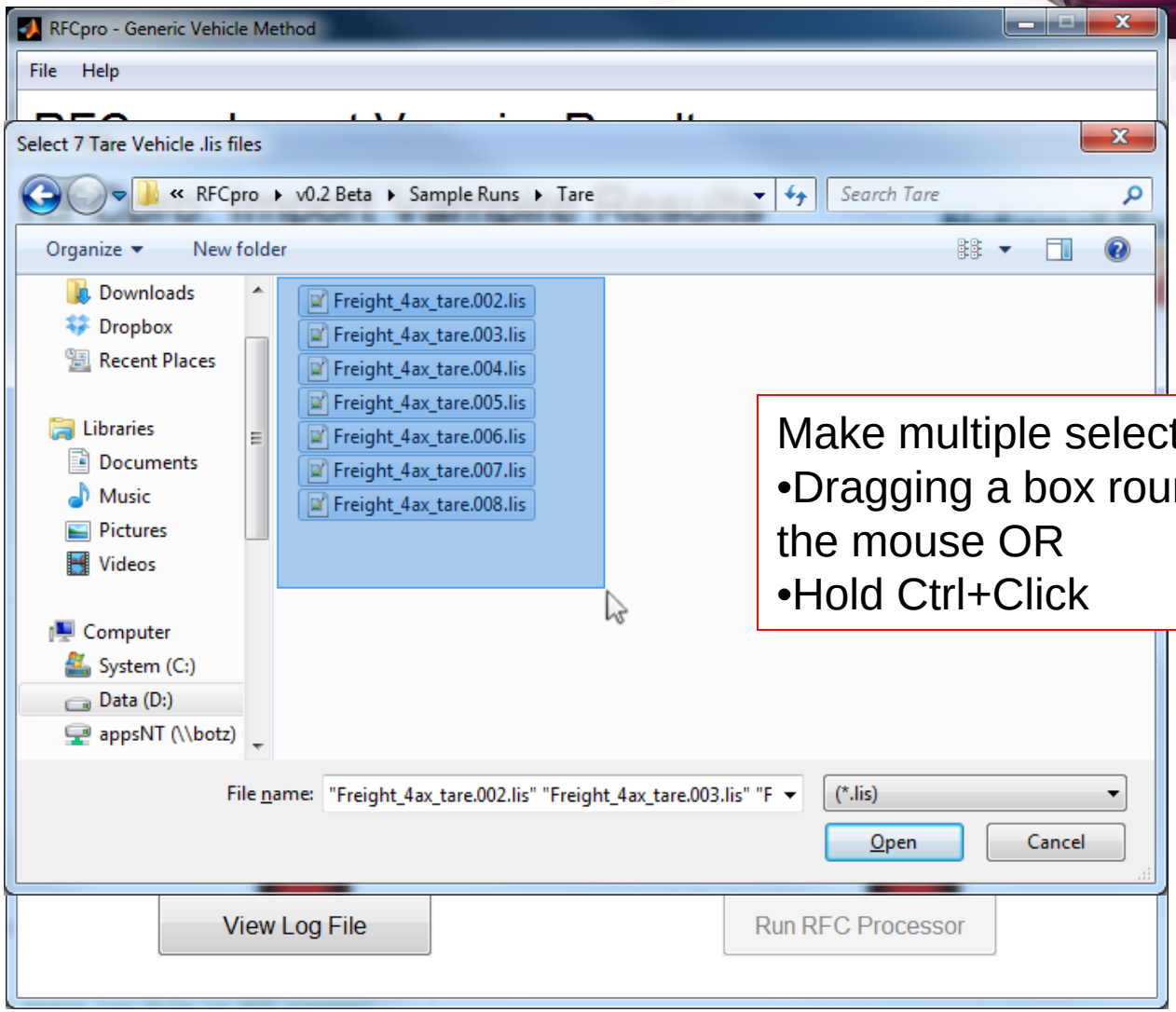


Specify Name and Location of RFCpro Log File

RFCpro – Generic Vehicle Method



Make multiple selections by:
- Dragging a box round with the mouse OR
- Hold Ctrl+Click

RFCpro – Generic Vehicle Method

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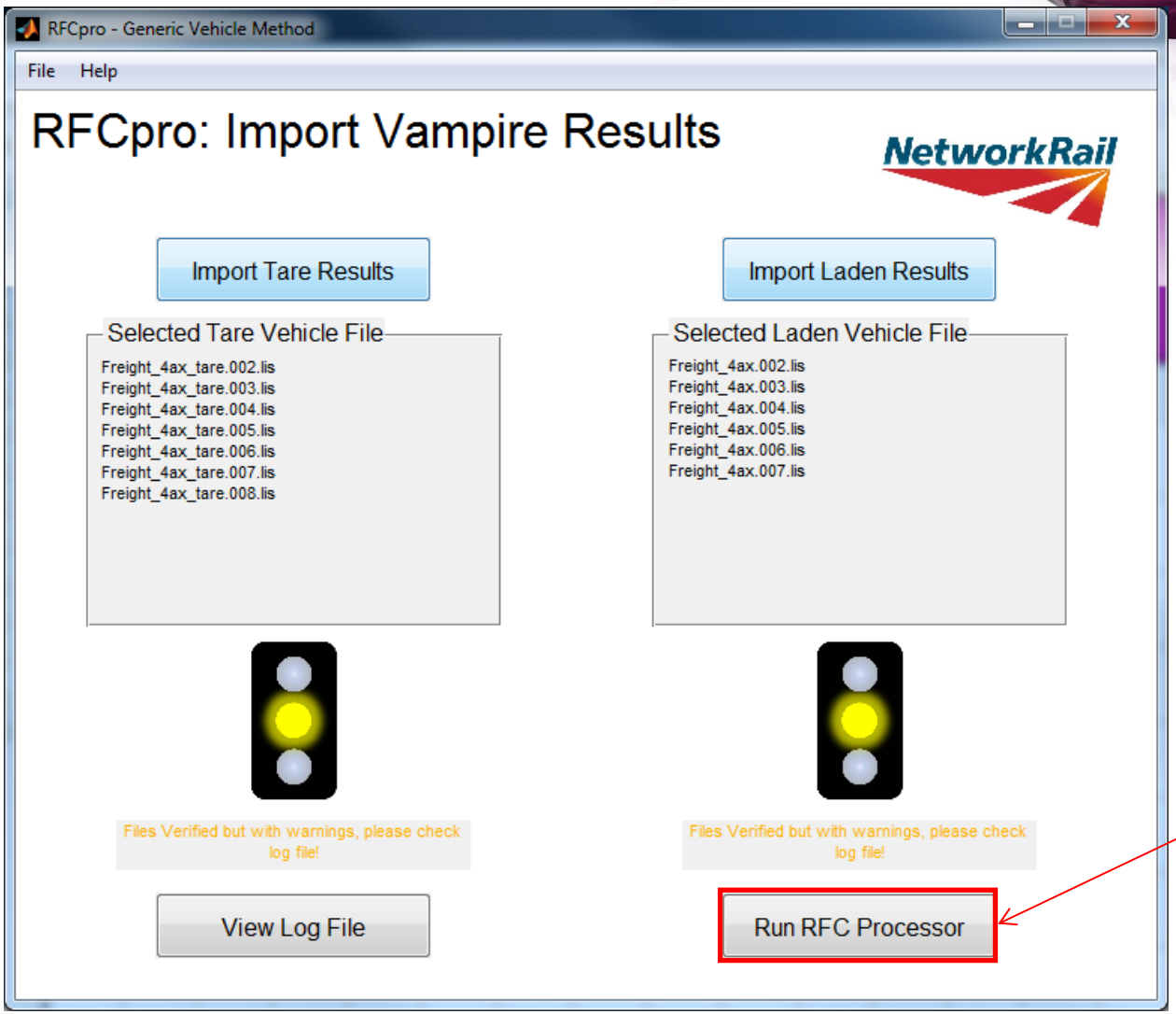
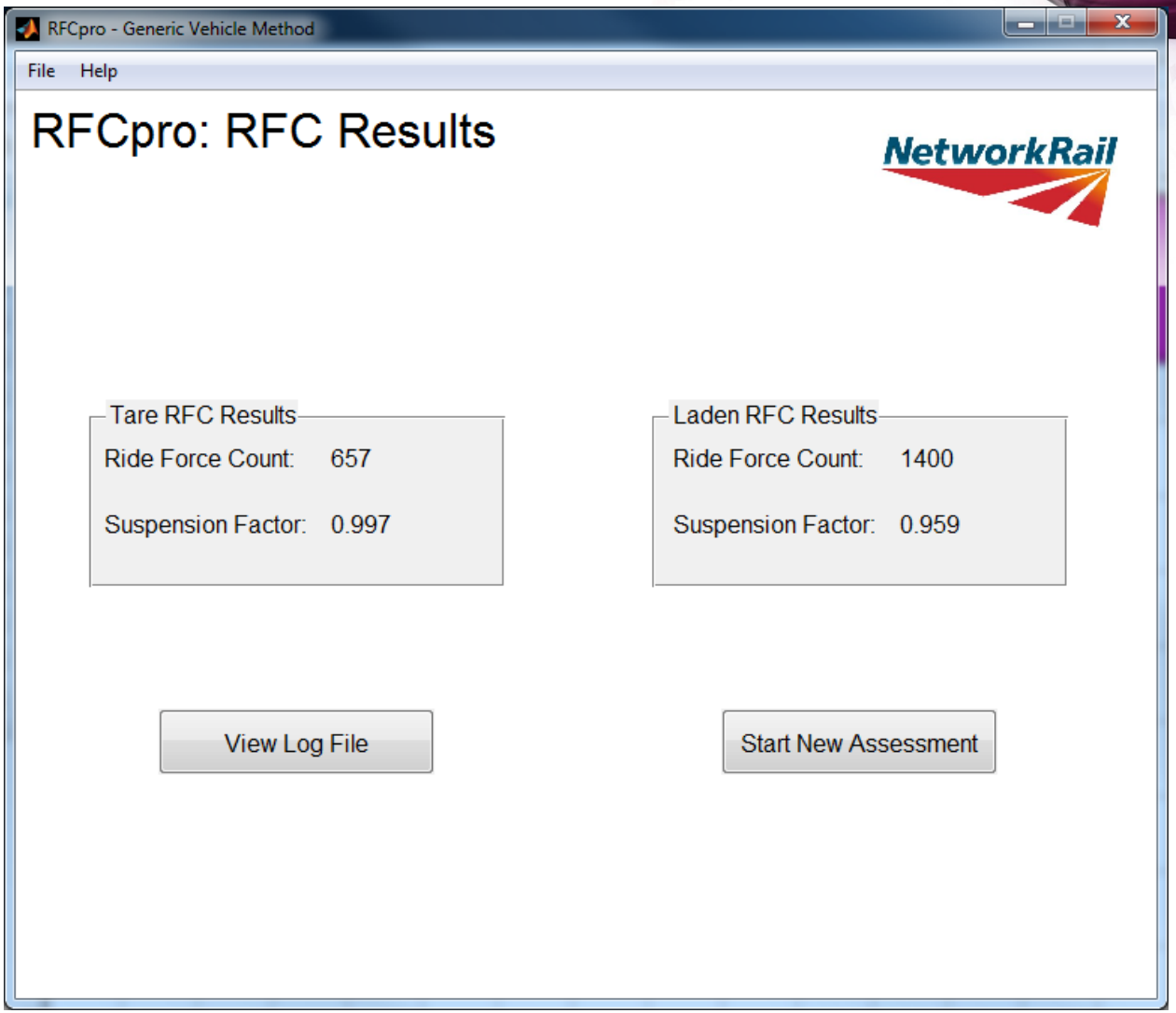


'Run RFC Processor' button is enable once all selected files are verified

RFCpro – Generic Vehicle Method



Test.log

RFCpro – File Verification

Imported Vampire Results Verification:

- Checks for existence of .lis, .log & .out files
- Checks that simulation was a Transient analysis and that it has executed correctly
- Checks the log file for Vampire Warnings
- Checks input axleloads match generic body details and do not exceed 25.5t
- Checks Run file parameters
  - Speed, Integration Timestep, Simulation Length
  - Correct Track Irregularity file has been used
  - Output equations are correct

Software Demonstration

Support

IRR will provide support for RFCpro until end of April 2013

NR beyond this point

Any problems should be directed to:

- Paul Allen p.d.allen@hud.ac.uk
- David Crosbee d.crosbee@hud.ac.uk

Any Questions?

Next steps

Next steps

- Software to be made available for use (subject to any substantial comments)

- Technical queries to Mark.Burstow@networkrail.co.uk
- Policy/charging queries to Ekta.Sareen@networkrail.co.uk