The Variable Usage Charge (VUC) in CP5

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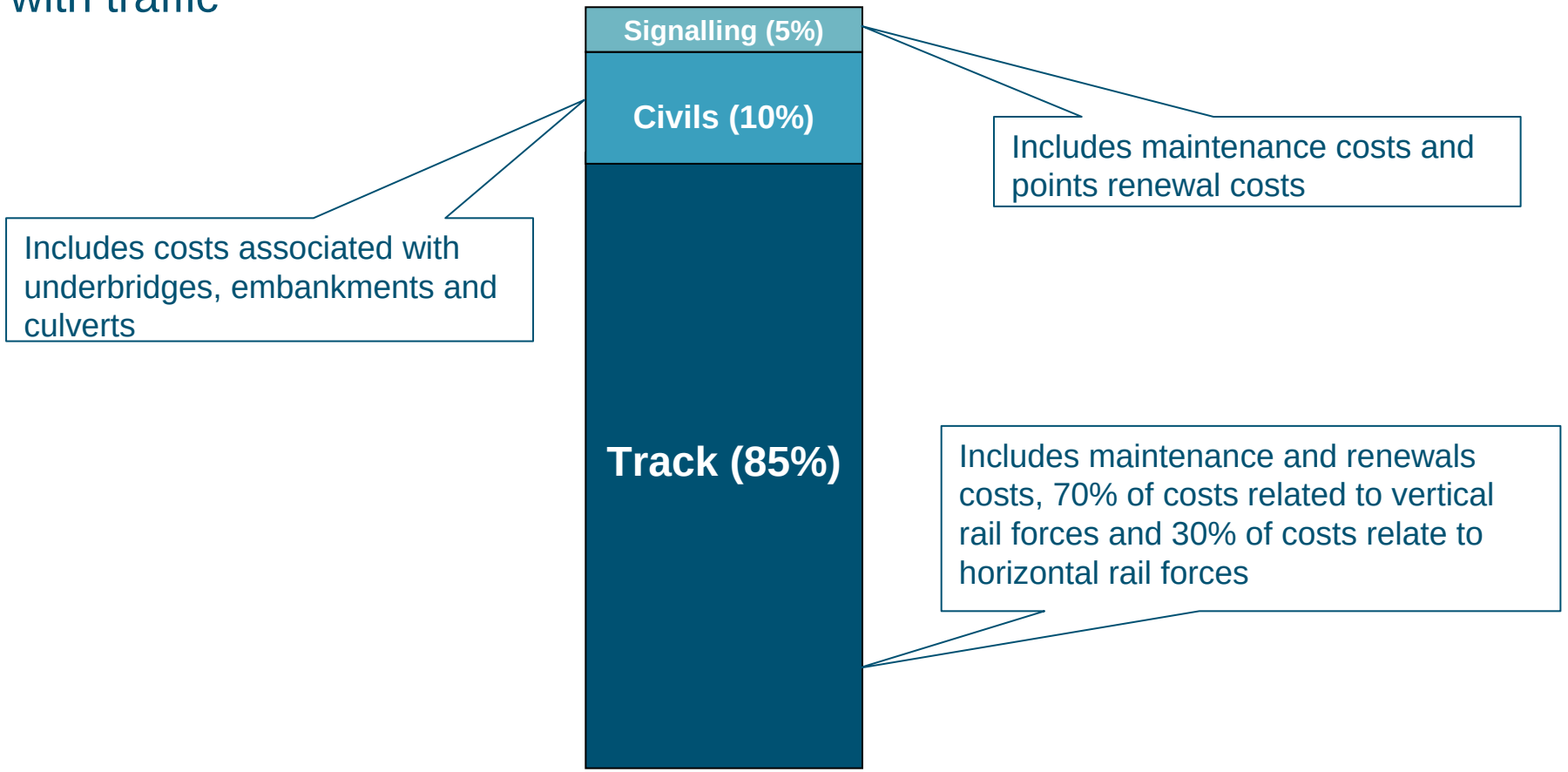
The CP5 VUC methodology

Introduction

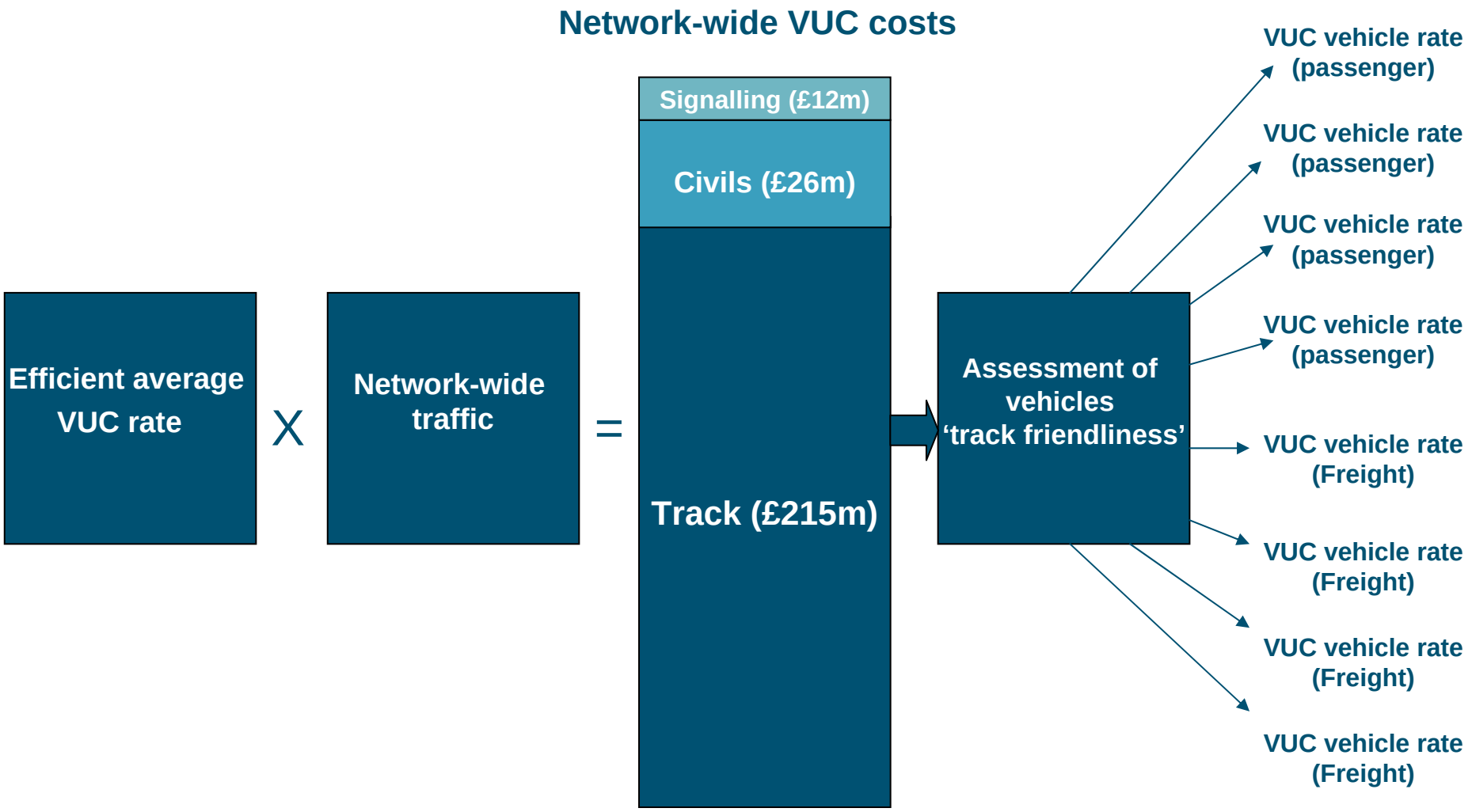
- The next few slides will provide a high-level overview of the following areas:
  - What costs are recovered through the VUC?
  - How are these costs calculated and turned into charges?
  - What factors determine the level of a vehicles charge?

What costs does the VUC recover?

- The VUC recovers operating, maintenance and renewal costs that vary with traffic



How are VUC costs turned into charges?



How do we assess 'track friendliness' – key variables

- The VUC for any vehicle type is determined by its 'track friendliness'
  - VUC rates are designed to be cost reflective
- For each vehicle type a 'track friendliness score' is calculated and used to apportion costs
- The four key vehicle characteristics that inform the 'track friendliness score' are:
  - Axle load
  - Operating speed
  - Un-sprung mass
  - Bogie primary yaw stiffness (indicative of its curving ability)
- In summary, the higher the above values the worse the vehicles 'track friendliness score' and the higher the vehicle's VUC rate

How do we assess 'track friendliness' – formulae

VUC cost category	Formula used to calculate 'track friendliness' score	Background
Track (Vertical)	*Ct * (0.473e^(0.133A) + 0.015 SU - 0.009 S - 0.284 U - 0.442) * GTM * axles*	Based on Serco analysis using VTISM in PR13
Track (Horizontal)	Allocated using the 'curving class' methodology	Based on TTCI analysis in CP4
Civils	$Ct.A^{3.00}.S^{1.52}$ *(per tonne.mile).GTM*	Based on TTCI analysis in CP4 and Serco analysis in PR13
Signalling	50% of costs assumed to be load-related allocated using Track (Vertical) formula, above, and 50% of costs assumed to be non-load-related allocated based on vehicle miles	Based on TTCI analysis in CP4 and Serco analysis in PR13

Where:

Ct = 0.89 for loco-hauled passenger stock and multiple units, 1 for all others (vertical track costs equation)
Ct = 1.2 for 2-axle freight wagons, 1 for all others (civils costs equation)
A = axle load (tonnes)
S= operating speed (miles/hour)
U = unsprung mass (tonne/axle)
GTM = gross tonne miles

Summary

- The VUC recovers our efficient track, civils and signalling ‘wear and tear’ costs that vary with traffic
- Variable usage costs are translated into VUC rates using a cost allocation model
- VUC rates are designed to be cost reflective and thus ‘track friendly’ vehicles will pay lower charges than ‘track nasty’ vehicles

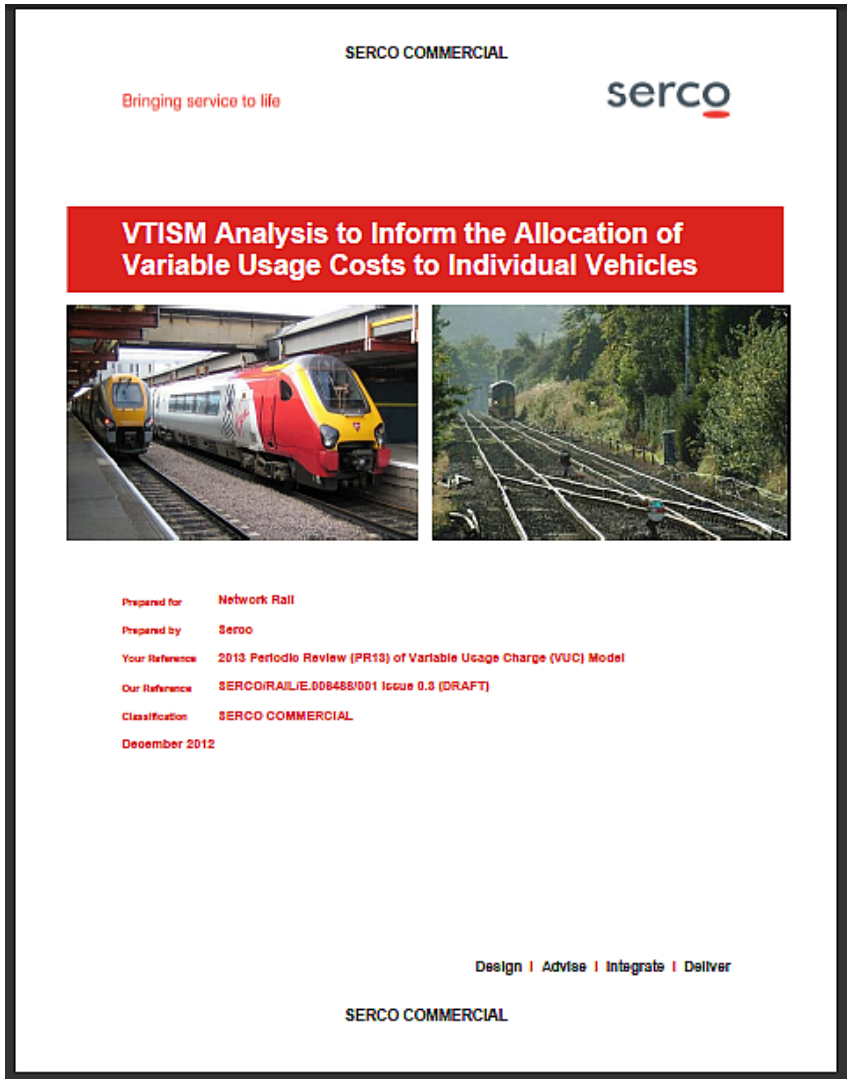
Class 139/M

Class 98/8

What has changed since CP4?

The VUC review

- Serco were commissioned to undertake a review of three components of the VUC
  - Track
  - Structures
  - Signalling
- Minor changes to ‘structures’ and ‘signalling’ components of VUC
- More significant changes to ‘track’ component of VUC



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VTISM Analysis to Inform the Allocation of Variable Usage Costs to Individual Vehicles

Prepared for	Network Rail
Prepared by	Serco
Your Reference	2013 Periodic Review (PR13) of Variable Usage Charge (VUC) Model
Our Reference	SERCO/RAIL/E.008488/001 Issue 0.3 (DRAFT)
Classification	SERCO COMMERCIAL

December 2012

Design | Advise | Integrate | Deliver

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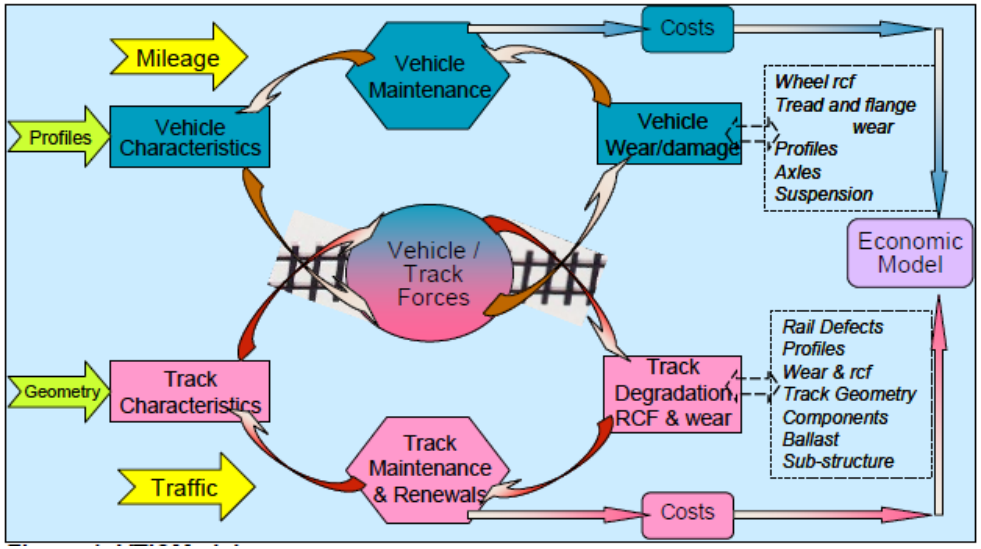
Methodology (1)

- Use VTISM to determine variation in track damage (vertical) for a range of vehicle parameters (not 'real' vehicles)
  - 4 Speeds: 25 – 100mph
  - 4 Axleloads: 5 – 25t
  - 3 Unsprung mass= 1000 – 3000kg



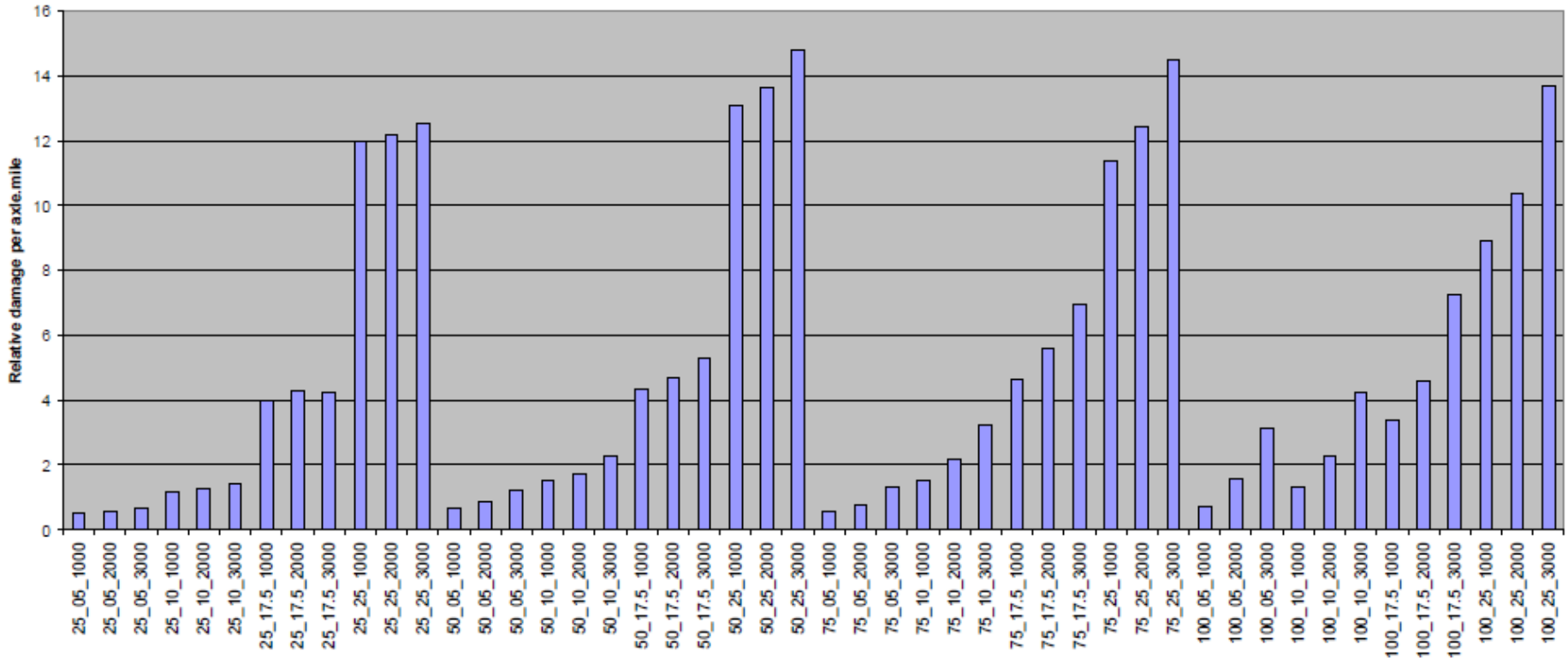
- Fit a continuous relationship between these damage costs
  - The formula used in CP4 is power law
- Calibrate this against agreed NR recoverable total track costs to determine VTAC

Methodology (2)

- Simulations run over a range of 'representative' track sections
  - Track quality
  - Length (significant sample length), 5% full network
  - Taking account of linespeed for simulation

Line speed sample	Plain line		S&C	
	Available network mileage	Sampling frequency (1 every x sections)	Available network mileage	Sampling frequency (1 every x sections)
>=25 mph	17,555	19.0	694	13.9
>=50 mph	15,369	16.6	502	10.0
>=75 mph	8,675	9.4	280	5.6
>=100 mph	3,267	3.5	105	2.1

Results


Relative damage per axle.mile
0
2
4
6
8
10
12
14
16
25_05_1000
25_05_2000
25_05_3000
25_10_1000
25_10_2000
25_10_3000
25_17.5_1000
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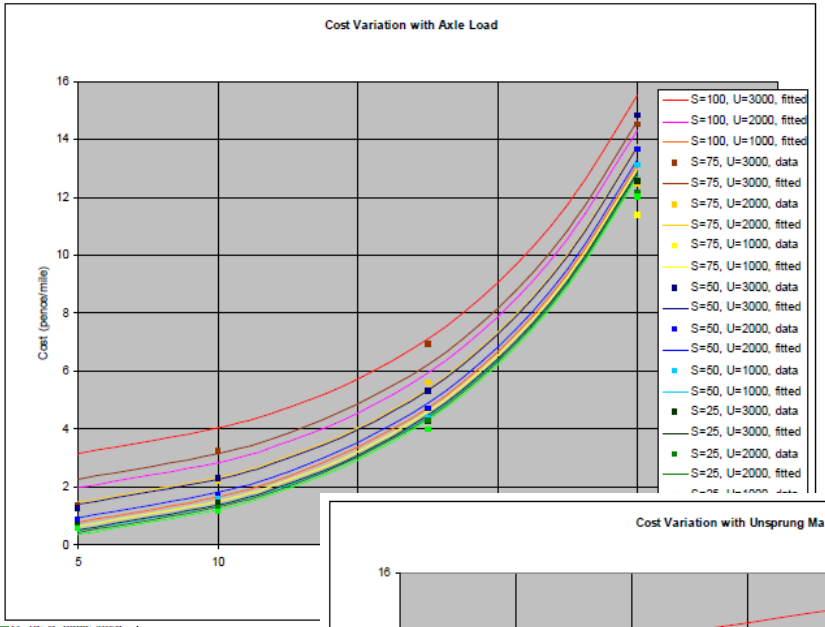
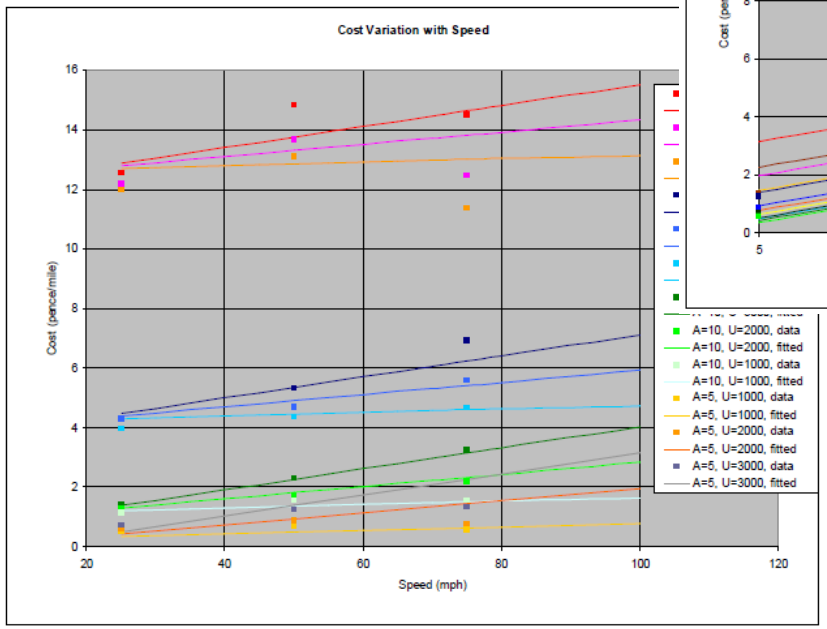
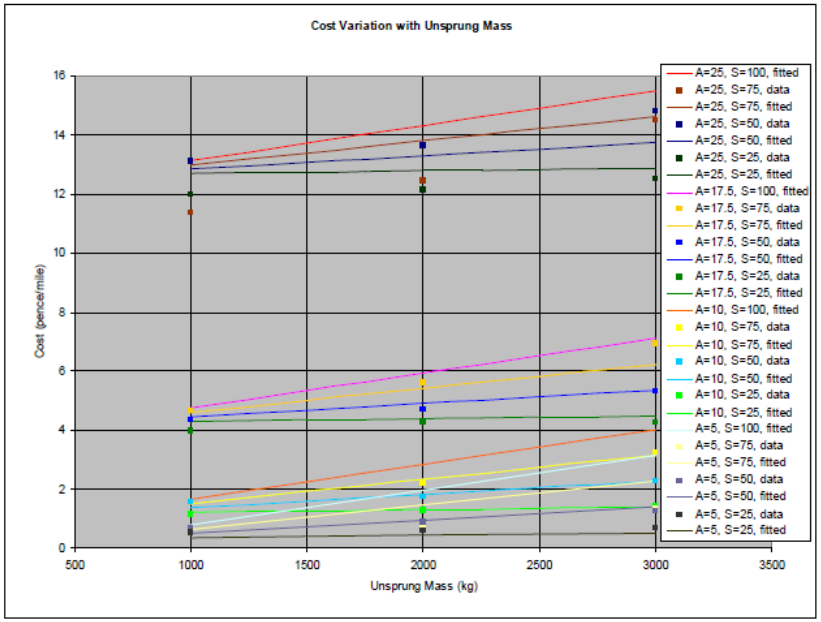
Curve fitting







An improved track damage relationship

- Existing track damage cost model for CP4

Equivalent Track Damage = $Ct.A^{0.49}.S^{0.64}.U^{0.19}$ *(per tonne.mile).GTM where,*

Ct is 0.89 for loco-hauled passenger stock and multiple units, and 1 for all other vehicles, A is the axle load (tonnes), S is the vehicle operating speed (miles/hour), U is the un-sprung mass (kg/axle) and GTM is the Gross Tonne Miles.

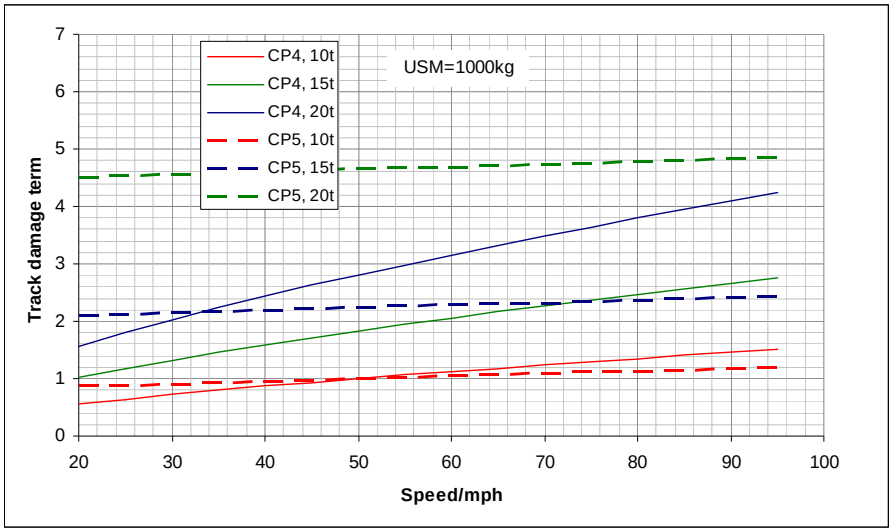
- New track damage cost model for CP5

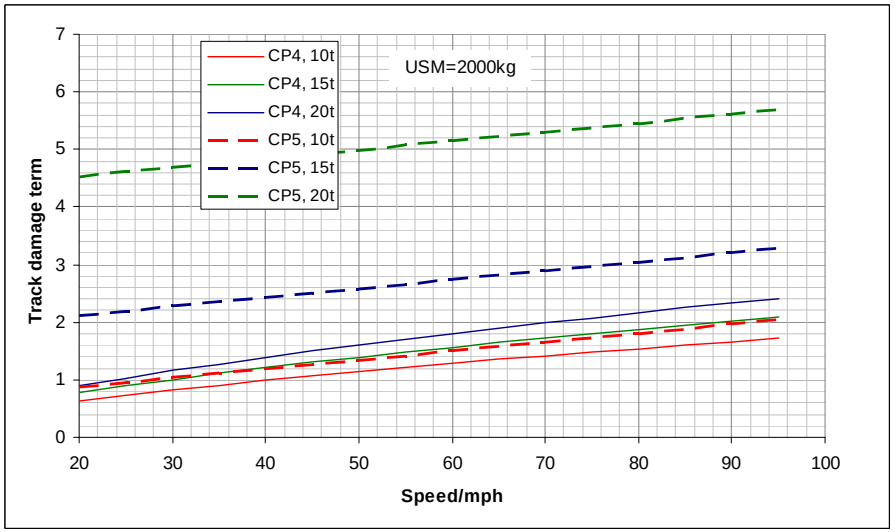
Proposed VTISM-derived track damage formula based on a hybrid fit:

Relative damage (per axle.mile) = $0.473.e^{0.133A} + 0.015.S.U - 0.009.S - 0.284.U – 0.442$

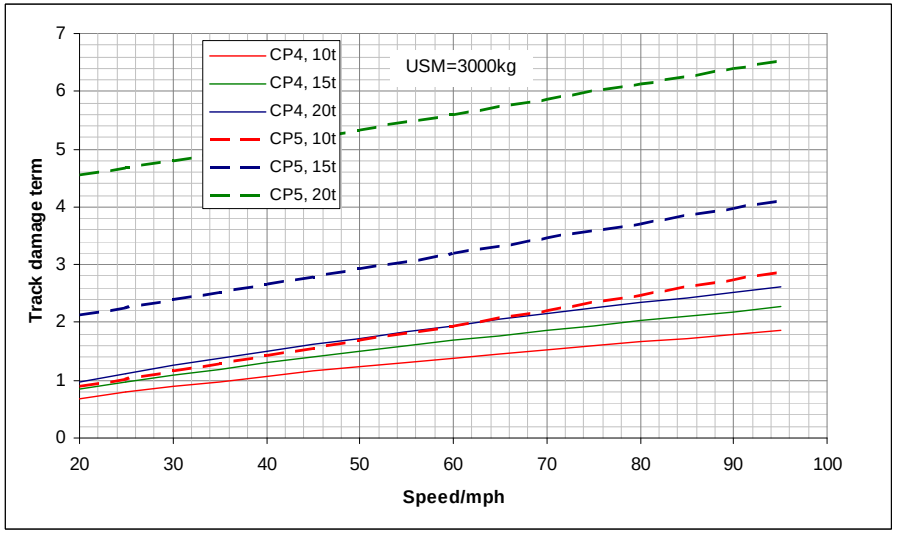
where:
A = Axle load (tonnes), within the range: 5 to 25 tonnes
S = Operating speed (mph), within the range: 25 to 100 mph
U = Un-sprung mass (tonnes / axle), within the range: 1 to 3 tonnes

Comparison of CP4 and CP5 track damage models





- CP5 model significantly more strongly dependent on axleload
- VTISM has been reviewed by industry bodies and is widely considered to be the best track damage model there is



Surface damage methodology

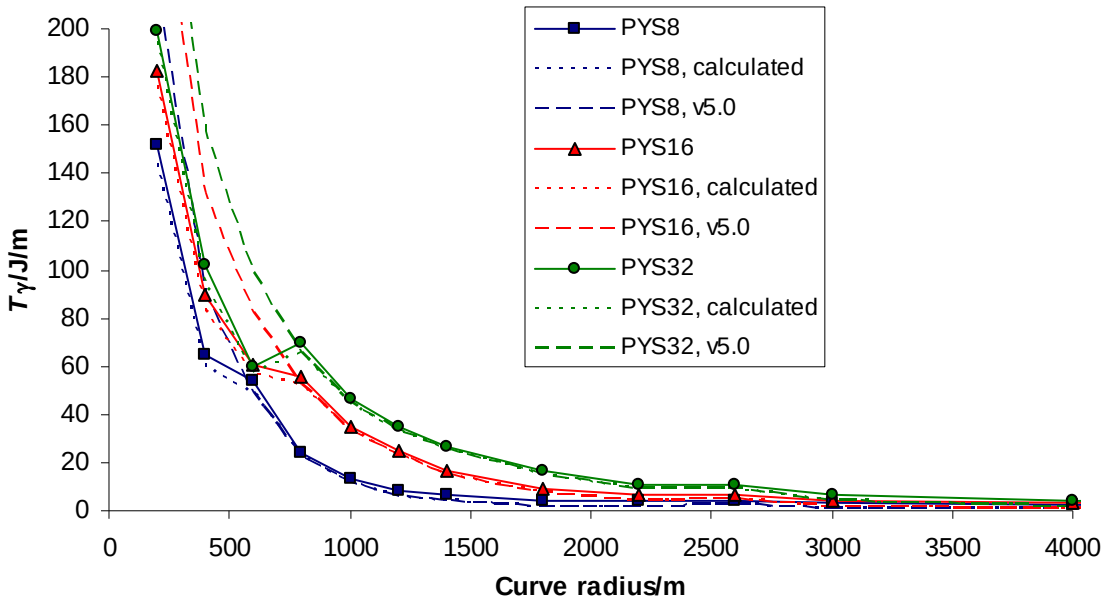
- The methodology for determining the surface damage component in CP5 remains the same
- Existing VUC includes components for horizontal and vertical track damage
- Horizontal track damage covers rail wear and rolling contact fatigue
  - Developed from models developed to predict RCF
- RCF/wear damage depends on wheel/rail forces (often referred to as Tgamma or $T\gamma$)
- $T\gamma$ depends on
  - Vehicle suspension type
  - Curve radius
  - Cant deficiency (speed & installed cant)

Methodology

- $T\gamma$ can only be evaluated using detailed vehicle dynamics simulations
  - The existing VUC formulation allows users to either
    - 'look-up' pre-calculated values for a range of vehicle characteristics (the **'vehicle curving class'**), or
    - do the simulations for the required vehicle and enter the values into the VTAC spreadsheet to determine the horizontal damage cost
      - A document exists to specify how to do the simulations: wheel/rail profiles, friction conditions, curve & cant deficiency, required outputs etc.

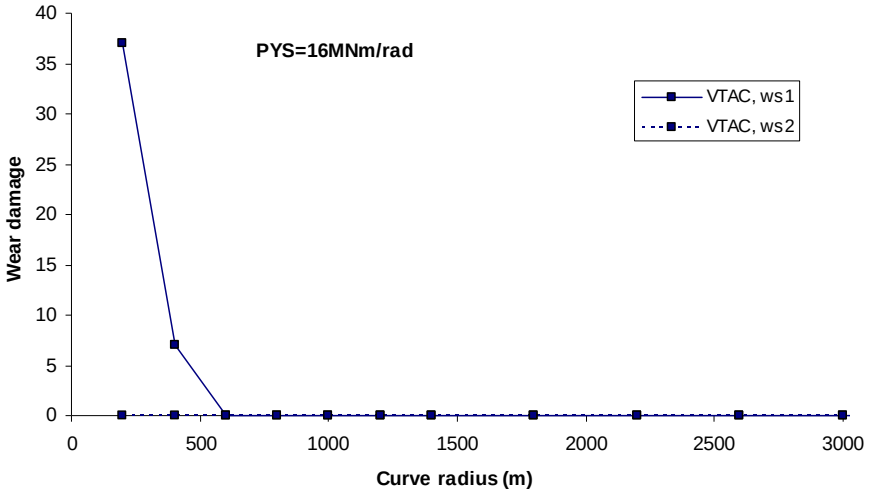
Current methodology

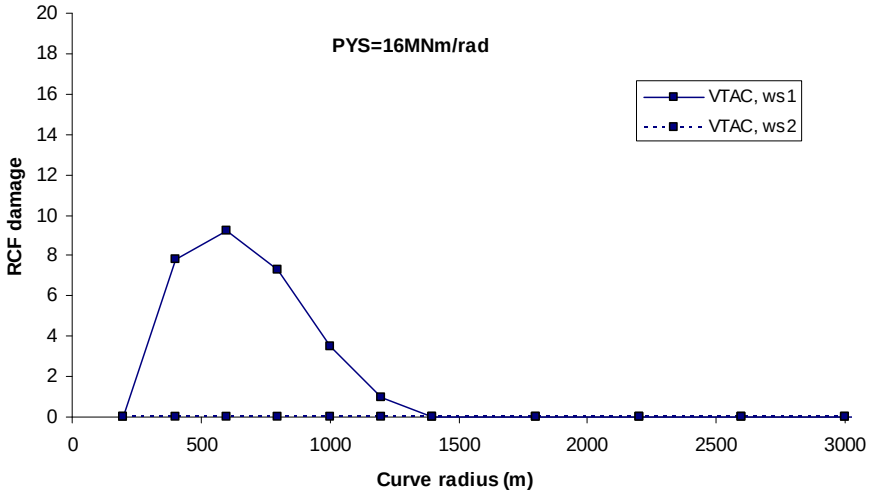
- How horizontal VUC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)



Current methodology

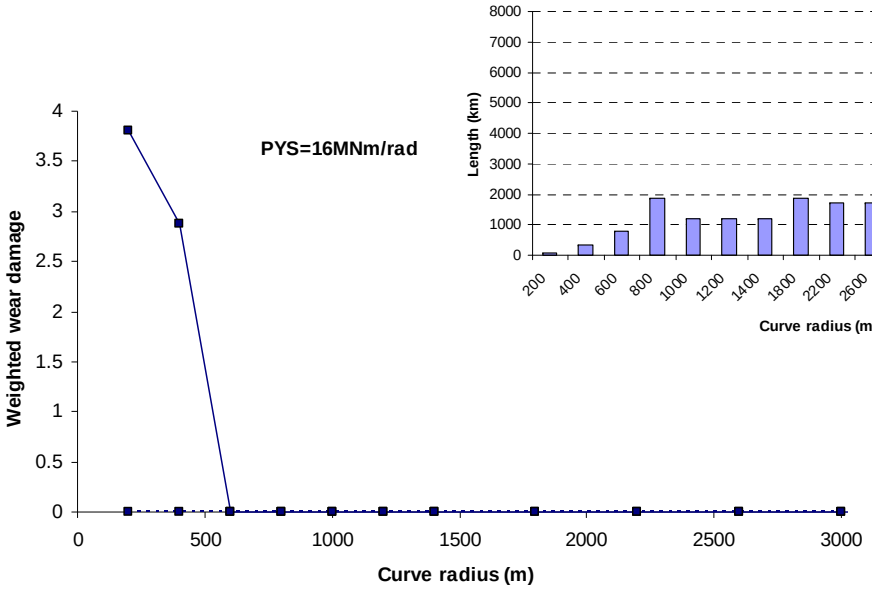
- How horizontal VUC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)
  - Spreadsheet converts $T\gamma$ to wear and RCF damage for each radius
    - Same functions as those used in VTISM

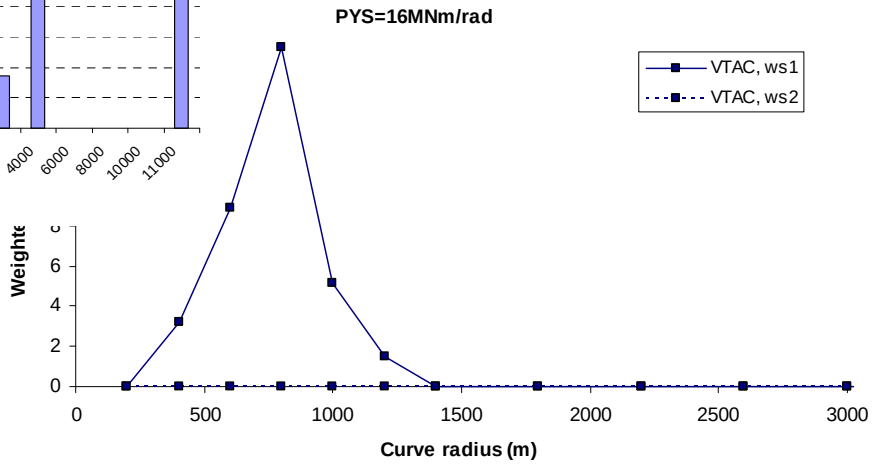




Current methodology

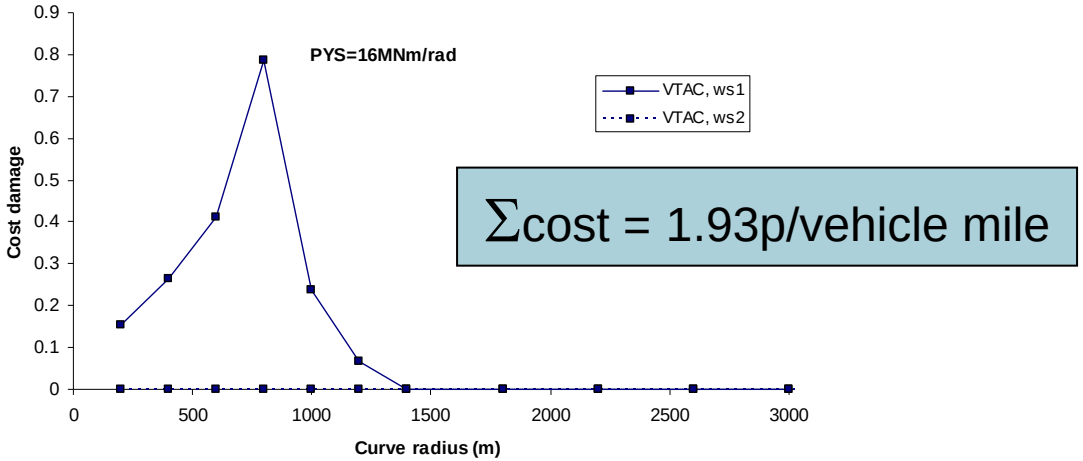
- How horizontal VUC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)
  - Spreadsheet converts $T\gamma$ to wear and RCF damage for each radius
  - Weights damage by population of curve radii in network





Current methodology

- How horizontal VUC is calculated:
  - User inputs variation of $T\gamma$ with curvature for required vehicle(s)
  - Spreadsheet converts $T\gamma$ to wear and RCF damage for each radius
  - Weights damage by population of curve radii in network
  - Converts damage to cost for each curve and sums to get total



Horizontal VUC component

- For a wide range of suspension stiffnesses/vehicle weights the VUC component has already been determined
- For new/modified vehicles it is possible to use a pre-calculated rate or calculate a new rate
  - To ‘maximise’ the VUC reduction do a bespoke calculation for a specific vehicle
  - Where axle spacing is shorter than on other vehicles
  - Vehicle dynamics simulations have to be undertaken of the vehicle
    - Details of the procedure can be obtained from: Mark Burstow (mark.burstow@networkrail.co.uk)

Loco2_50	Coach_64_40
Loco3_50	Coach_64_50
Class_60	Coach_64_60
Class_66	Coach_80_30
Pacer_10	Coach_80_40
Coach_8	Coach_80_50
Coach_12_30	Coach_100_40
Coach_12_35	Coach_128_30
Coach_12_40	Coach_128_35
Coach_12_50	Coach_128_40
Coach_12_60	Coach_128_50
Coach_16_30	Tilting_50_50
Coach_16_35	Artic2_80
Coach_16_40	Artic3
Coach_16_50	Y25_loaded
Coach_17_30	Y25_empty
Coach_17_40	NACO_loaded
Coach_23_30	NACO_empty
Coach_23_40	3Piece_empty
Coach_23_50	3Piece_loaded
Coach_24_30	2axle_empty
Coach_24_35	2axle_loaded
Coach_24_40	TF25_empty
Coach_24_50	TF25_loaded
Coach_24_60	Coach_15_30
Coach_26_50	Coach_15_40
Coach_35_50	Coach_15_60
Coach_48_40	Shunter
Coach_48_50	Coach_HB_40
Coach_48_60	Coach_HB_50
Coach_50_40	Coach_HB_60
Coach_50_50	Coach_HB_Cl221
Coach_50_60	Class_68
Coach_60_50	PPM_2axle
Coach_64_30	
Coach_64_35	

CP5 price lists

Introduction

- The next few slides will provide a high-level overview of the following areas:
  - Where can I find the CP5 price lists?
  - What key things should I be aware of?
  - What if the price lists are not quite right?

Where can I find the CP5 price lists?

- On 20 December 2013 we published the following CP5 price lists, consistent with ORR's Final Determination:
  - Long term charges for franchised stations
  - Long term charges for managed stations
  - Capacity charge rates
  - Schedule of fixed charges
  - **Track usage price list**
  - Traction electricity modelled consumption rates
- These are available on our website at: www.networkrail.co.uk/using-our-network/cp5-access-charges/

A few things to note . . .

- The price lists are in 2012/13 prices, we will shortly be re-publishing the price lists in 2014/15 prices, to take account of the impact of inflation
- In CP5 we will re-publish the price lists each year uplifted for RPI
- In CP5 we will publish all new rates that are determined by ORR
- Prior to the commencement of CP5 we will be publishing a VUC guidance document and be making available a CP5 VUC ‘calculator’
- If a vehicle type is not on the VUC price list it will be subject to the relevant default rate until such a time that a bespoke rate is determined by ORR, at which time any over/under charge will be refunded

What if the price list is not quite right?

- The price lists were put together following significant consultation and industry engagement, which should reduce the likelihood of there being material errors
- We stated in the consultation process that we wanted to try and avoid re-opening price lists during in CP5
- Indeed, consistent with this, ORR determined that the provision to correct a “manifest error” should be removed from the passenger TAC (this did not exist in the freight TAC)
- Consistent with Schedule 7 of operators’ TACs it is possible to supplement the price lists where a ‘new’ rate is required (i.e. there is not a rate on the published price list for the vehicle type)

Questions and contact details?

- Questions?

- Please contact me on Ben.Worley@networkrail.co.uk / 0203 356 9322 if you would like to discuss any aspect of this presentation, or the VUC in CP5, further