

Review of income and Schedule 8 benchmark models

Final Report

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Executive Summary

Overview

1. On 15 January 2013 Network Rail published its Strategic Business Plan (SBP) setting out its proposals for outputs, efficiencies, costs and income for Control Period 5 (CP5) from 2014 to 2019.
2. On 12 June 2013, as part of Periodic Review 2013 (PR13), the Office of Rail Regulation (ORR) published its Draft Determination for CP5. This required Network Rail to publish, by 12 July, its draft price lists for CP5, based on the charging framework and efficiency assumptions set out in the Draft Determination.
3. On 18 July Network Rail appointed Steer Davies Gleave to review five spreadsheets, and to report with findings and recommendations by 23 August 2013. One of the spreadsheets was being developed to determine benchmarks for Schedule 8 in CP5. The other four were being used to perform calculations relating to charges in CP5.
4. We carried out a “bottom-up” review of the spreadsheets focusing on whether they correctly perform the calculations intended, which are often clear from the context or from documentation provided or published by Network Rail or ORR. Where we identified potentially material errors in the calculations, Network Rail provided revised versions of the spreadsheets demonstrating that the errors had been corrected.

Correctness of calculations and fitness for purpose

5. Our examination of the spreadsheets was limited to the checks described in this document and should not be interpreted as a full audit. However, from our initial bottom-up reviews of the spreadsheets, discussions with Network Rail, and corrections to errors we had identified, we are satisfied that the spreadsheets carry out the calculations as intended, given the inputs used and the intended outputs, and are fit for the purpose described by Network Rail.

“Quick win” recommendations

6. We identified a number of relatively minor points where Network Rail may wish to consider additional work to be certain that the spreadsheets are correct, and in particular to ensure that any future use of them is done correctly and does not introduce any new errors.
7. The table overleaf lists a number of specific recommendations, based on our findings, for how the benchmarks and charges calculations could better reflect best practice if time and resources were available. Some could be implemented relatively quickly by Network Rail, although we note, for example, that at least some inputs are no longer traceable (see 5.9).
8. In Section 7 we summarise an approach to Spreadsheet Modelling Best Practice (SMBP) which we believe is relevant to many of these issues.

“QUICK WIN” RECOMMENDATIONS

Issue	Example	Recommendation
Inputs	3.9, 5.9	<p>“Escrow” copies of all inputs are held with a record of source, date, and approach to updating.</p> <p>Inputs are only required in one place in each spreadsheet, or ideally only on place on the process (see RPI below) to avoid the risk of incomplete updating.</p>
Units	3.5, 4.7	<p>All units should be labelled.</p> <p>Ideally calculations would be on a consistent basis, such as miles or kilometres, or units or thousands.</p> <p>Where this is not possible (different industry systems may use different units), considering converting to the standard unit immediately after input.</p>
Rounding	3.11, 3.21, 4.28	<p>Physical constants (kilometres/mile) are input exactly.</p> <p>All calculations are carried out exactly as specified unless rounding has been agreed and documented.</p> <p>Numbers are transferred between spreadsheets as either links or pasted values.</p> <p>Derived values, such as ratios or reciprocals, are calculated from the originals in each spreadsheet.</p>
RPI	3.14	<p>Historic and forecast RPI (and other common data) are stored in a common file referenced by all spreadsheets.</p> <p>Ratios between RPIs in different years and months are calculated when needed.</p> <p>If necessary, RPI is calculated explicitly for the indexation point which will determine each year’s prices.</p>
Validation	4.28	<p>Text inputs used in Excel functions such as “LOOKUP” or “MATCH” should be validated on input to ensure that typographical errors due not result in calculation errors. Check for such errors regularly within the calculation.</p>
Allocation Metrics	6.20	<p>Consistent metrics should be used across calculations.</p>

1 Introduction

Background

- 1.1 On 15 January 2013 Network Rail published its Strategic Business Plan (SBP) setting out its proposals for outputs, efficiencies, costs and income for Control Period 5 (CP5) from 2014 to 2019.
- 1.2 On 12 June 2013, as part of Periodic Review 2013 (PR13), the Office of Rail Regulation (ORR) published its Draft Determination for CP5. This required Network Rail to publish, by 12 July, its draft price lists for CP5, based on the charging framework and efficiency assumptions set out in the Draft Determination.
- 1.3 On 18 July Network Rail appointed Steer Davies Gleave to review five spreadsheets, and to report with findings and recommendations by 23 August 2013.

The spreadsheets to be reviewed

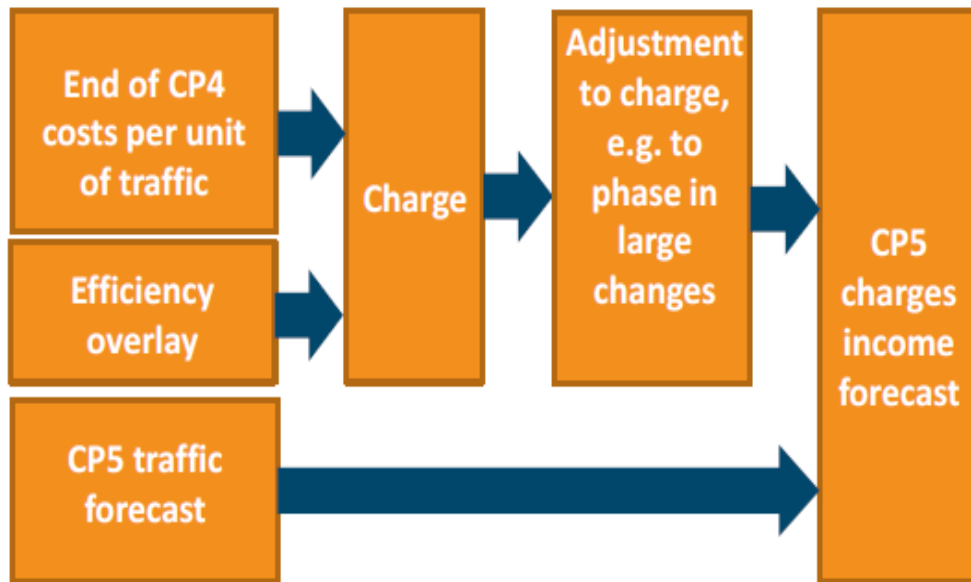
- 1.4 The spreadsheets to be reviewed are listed in Table 1.1. One was being developed to determine benchmarks for Schedule 8 in CP5. The other four were being used to perform calculations relating to charges in CP5.

TABLE 1.1 SPREADSHEETS TO BE REVIEWED

Spreadsheet	Function	Initial review due
Schedule 8 benchmarks	Converts the benchmark Public Performance Measure (PPM) set for CP5 into benchmark Average Minutes Lateness (AML) for Schedule 8 of each train operator's track access agreement.	26 July 2013
Variable usage charge (VUC) rate	Estimates a single average variable usage charge for all traffic on the network during CP5.	2 August 2013
Variable usage charge (VUC) allocation	Converts the single average variable usage charge for all traffic to more cost-reflective charges for individual vehicles: <ul style="list-style-type: none">• Per vehicle-mile, for passenger vehicles.• Per gross tonne-mile, for freight vehicles.	
Variables charges income	Provides Network Rail with estimates of the variable income expected during CP5 by year, route and train operator.	
Fixed track access charge (FTAC)	Allocates Network Rail's net revenue requirement, after deducting variable charges and other income, as fixed track access charges for franchised train operating companies (TOCs). Apportions Network Rail's regulatory asset base (RAB) to each of its routes on an indicative basis.	9 August 2013

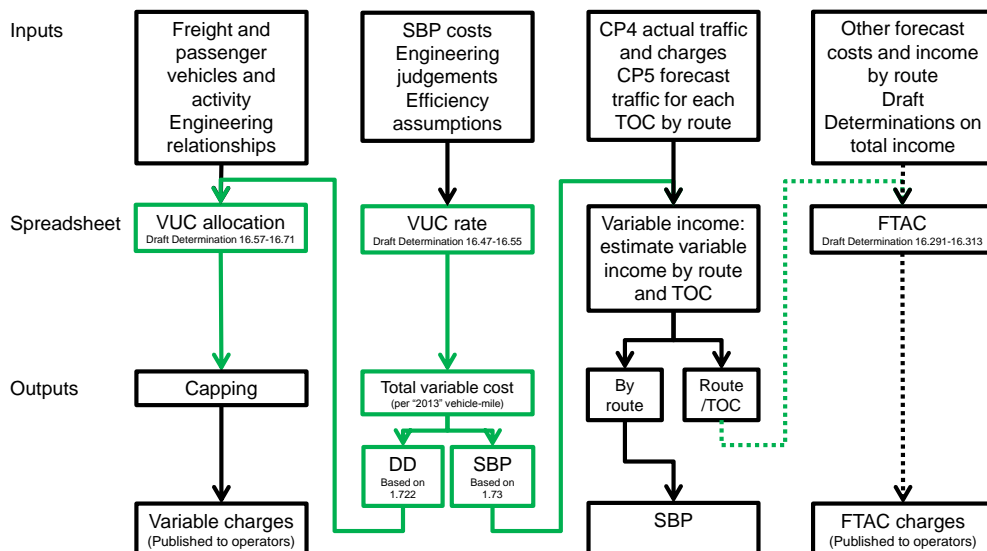
- 1.5 ORR summarised the calculation of CP5 charges in its Draft Determination¹, reproduced below as Figure 1.1. Common features of the calculations are:
- Data on traffic and costs from late or “end of” CP4, which may be forecast
 - Projected efficiencies for CP5, specified by ORR through its Draft Determination
 - Projected traffic for CP5, necessarily based on forecasts and assumptions

FIGURE 1.1 CONTEXT FOR VARIABLE USAGE CHARGE (VUC) CALCULATIONS



- 1.6 The relationship between the four spreadsheets relating to Network Rail’s charges is summarised in Figure 1.2.

FIGURE 1.2 CHARGING SPREADSHEETS TO BE REVIEWED



Source: Steer Davies Gleave analysis, see text for details.

¹ Draft Determination, Figure 16.1

The objectives of the review

- 1.7 Network Rail’s objectives were:
- To provide assurance that the calculations and results were robust
 - To provide evidence that could be shared with ORR and other interested parties to demonstrate the robustness of the calculations and results
 - To assess whether the correct inputs were used and were clearly identified
 - To identify errors in spreadsheet formulae
 - To assess whether the formulae “flow” consistently through the spreadsheets
 - To provide clear recommendations on correcting identified errors, if any
- 1.8 Network Rail did not request a full audit of the calculations. We made clear at the outset of our work that this could only be done on the basis of, inter alia, both:
- A complete specification of the calculations and their input
 - The opportunity to audit, at least on a sample basis, any or all of the calculation inputs back to definitive data sources, such as ORR’s Determination or data examined by ORR’s reporters or Network Rail’s auditors
- 1.9 Network Rail invited us to comment on the overall methodology used and the overall structure and efficiency of the spreadsheets, but these were not a formal requirement of the work.
- 1.10 Network Rail gave ORR the opportunity to comment on a draft of this Final Report, and we have taken both Network Rail and ORR comments into account.


Our proposed approach

- 1.11 We proposed a “due diligence” mixture of “bottom-up” and “top-down” review:
- Bottom-up review, supported by a spreadsheet auditing tool and methodology, such as whether inputs had been used consistently and without error and whether formulae were consistent and correct.
 - Top-down review, supported by our knowledge of the regulatory process and Network Rail’s charging and income framework, such as whether the calculation served its stated purpose, and including where practicable reproduction of key calculations and outputs by independent processes.

Our priorities

- 1.12 We agreed with Network Rail to prioritise our work as set out in Table 1.2 below.

TABLE 1.2 PRIORITIES IN OUR APPROACH

Priorities	Activity
	Highest
	Specific requests from Network Rail
	Errors with potential to have large effects
	Evidence of unintentional or random bias or distortion
	Errors unlikely to be material in most cases
Lowest	Best practice including formatting, layout and documentation

2 Schedule 8 benchmarks

Version development

- 2.1 Network Rail had been developing one Schedule 8 benchmark spreadsheet for each franchised passenger operator and asked us to review them at an early stage in their development.
- 2.2 On 19 July we received an initial sample of three of the spreadsheets. Our initial examination identified a number of errors, and we recommended that Network Rail did not attempt to correct all the spreadsheets until one was fully correct.
- 2.3 On 8 August we selected at random the Greater Anglia spreadsheet. Network Rail provided a revised copy of the spreadsheet in which we confirmed that all the errors we had identified had been removed². Our analysis and comments are based principally on this spreadsheet of 8 August for Greater Anglia.
- 2.4 On 12 August Network Rail informed us that it had corrected all the other spreadsheets to the standard of the Greater Anglia spreadsheet and provided a full set of 20 further spreadsheets to be checked for consistent correction of the errors³. We are satisfied that the corrections have been properly applied to all the spreadsheets, with the exception of one minor error which we have drawn to the attention of Network Rail⁴.

Purpose

- 2.5 Network Rail summarised the purpose of the spreadsheets as shown below.

To estimate the relationships between the Schedule 8 measure of performance (“average” and “deemed” minutes lateness, or AML and DML) and measures of performance used for industry planning and regulatory targets (PPM and CaSL).
To apply the relationships in order to “translate” PPM and CaSL performance trajectories into Schedule 8 benchmarks defined in terms of AML and DML.

- 2.6 The theory behind the spreadsheet and the methodology applied were set out in Network Rail’s “Setting Schedule 8 benchmarks for CP5 - Methodological note”⁵.

² File “2013 06 27 GA - Schedule 8 NR benchmarks v NR + TOC AML.xls” provided on 8 August 2013 at 09:15

³ Files provided on 12 August at 14:22, 14:23 and 17:19

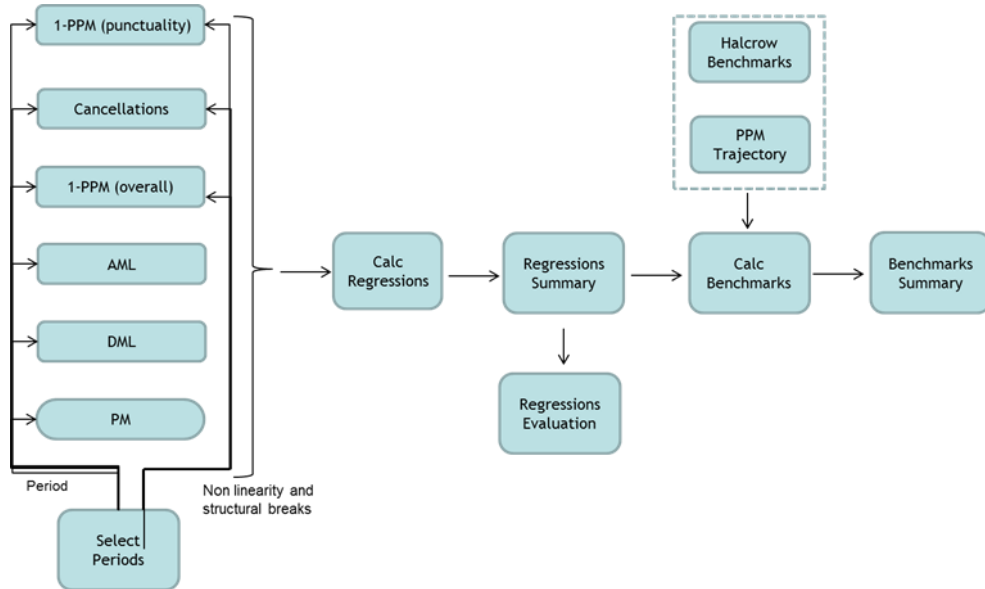
⁴ In the Grand Central spreadsheet (cells G13:G14)

⁵ Appended to Network Rail letter “Schedule 8 benchmarks - consultation letter.pdf” of 23 August 2013

Structure

2.7 Figure 2.1 below illustrates the structure of the spreadsheet.

FIGURE 2.1 STRUCTURE OF THE SCHEDULE 8 SPREADSHEET



Top down checks

2.8 We carried out a number of top down checks, discussed below.

Does the spreadsheet serve its stated purpose?

2.9 The spreadsheet uses forecasts of Public Performance Measure (PPM) and cancellations to derive benchmarks. We note that in its letter to ORR of 14 June 2013, “Network Rail Schedule 8 benchmarks in CP5”⁶ Network Rail stated that “Work is ongoing to model the relationships between PPM and performance minutes. These will be used to translate PPM trajectories into Schedule 8 benchmarks” and that ORR principles⁷ for setting Schedule 8 benchmarks include using relationships between Schedule 8 average minutes lateness AML and the performance targets specified in the draft determination.

2.10 Given that the agreed industry approach is to use forecasts of PPM and cancellations to derive benchmarks, the spreadsheet serves its stated purpose.

Is the theory behind the spreadsheet sound?

2.11 The theory behind the spreadsheet is set out in the “Setting Schedule 8 benchmarks for CP5 - Methodological note”. It is based on relationships between:

- PPM and AML
- Cancellations and DML

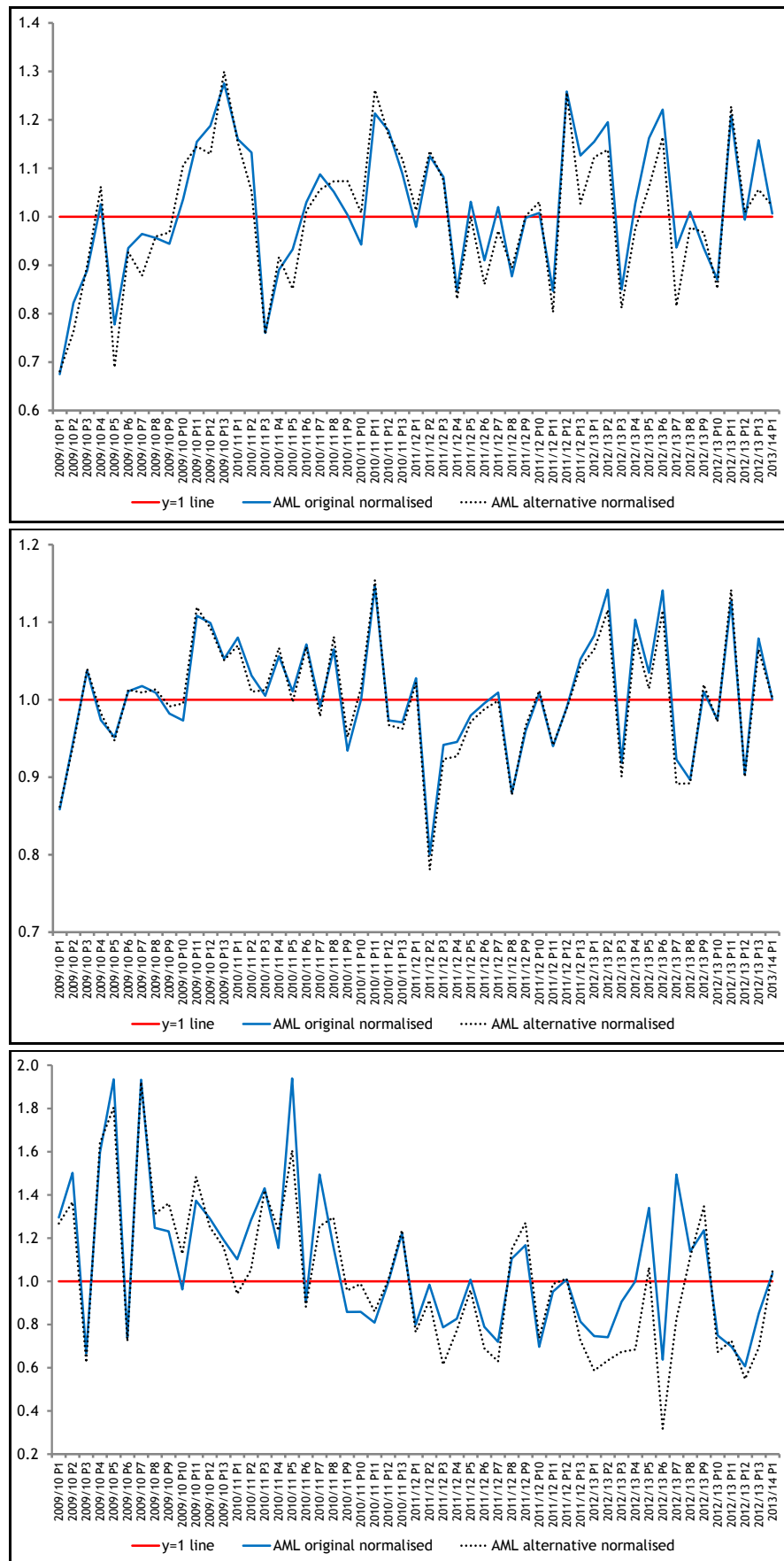
2.12 It is reasonable to assume that PPM and AML will be correlated, but it is important to note that the relationship is not a causal one. PPM and AML are both derivatives of delays, but neither is derived directly from the other.

⁶ <http://www.networkrail.co.uk/Schedule8benchmarksConclusionsLetter.pdf>

⁷ Set out in an email of 14 August 2013 from ORR to industry representatives

- 2.13 We address below a number of specific questions on the theory behind the spreadsheet.
- Which way round is the regression?*
- 2.14 Given that the relationship between AML and PPM is not a causal one, it is not a foregone conclusion that the relationship should be established by regressing AML against PPM rather than vice versa. Network Rail justify their approach on the grounds that:
- The aim of the exercise is to predict the level of AML for a given PPM, so the method chosen is the more direct
 - There is a precedent, in that the same approach was adopted in CP4
- 2.15 We accept that these points are valid, and we have made a check by comparing the actual and predicted levels of AML for three random service groups (Figure 2.2). We have done this by predicting AMLs using the original (AML as the dependent variable) and alternative (PPM as the dependent variable) method. The graphs in Figure 2.2 normalise the predicted AMLs with respect to the actual AML (so we are comparing a series of Predicted AML/Actual AML). While it may not be immediately evident from the graphs, we have checked that the predicted AML using the regression with AMLs as the dependent variable results in lower mean square errors (MSE) than with the regression with PPM as the dependent variable. This is as expected.
- Levels versus differences*
- 2.16 The relationships are derived on the basis of “levels” in which (for example) AML is regressed on PPM, as opposed to “differences” in which (for example) the change in AML is regressed on the change in PPM.
- 2.17 In estimating the relationship between PPM and AML, Network Rail are not suggesting that they are estimating an underlying causal relationship. Rather, they have sought to define an intuitive relationship between two measures that can be expected to move together. Caution must be exercised in using statistical tests in these circumstances, as the validity of the statistical tests depends on the properties of the error term, for example, whether there is a correlation between the error term and the regressors. However, we consider that Network Rail’s use of the Augmented Dickey Fuller (ADF) test for cointegration (that the two variables are not diverging over time) is valid.
- 2.18 We are satisfied that using levels is a robust approach. As Network Rail point out, compared to using differences it has the merits of being more readily understood and of avoiding the arbitrary choice of whether to take the first difference (one period) or thirteenth difference (one year). Additionally, Network Rail’s analysis shows that the variance in the coefficient on PPM is larger in a difference approach than a levels approach. This implies that there is more risk associated with errors arising from the setting of benchmarks if a difference rather than levels approach is used. We therefore support the use of this approach.

FIGURE 2.2 ALTERNATIVE REGRESSIONS OF PREDICTED AND ACTUAL AML



Are the assumptions in the spreadsheet correct?

2.19 The assumptions in the spreadsheet are reasonable, but in the review of the Arriva Trains Wales (ATW) spreadsheet we found two significant inconsistencies:

- Between the regression used to derive the relationship and the way in which the relationship was applied
- Between the calculation of punctuality and its definition

2.20 These inconsistencies have been removed, and the updated spreadsheet received on 8 August (see 2.1) is now internally consistent.

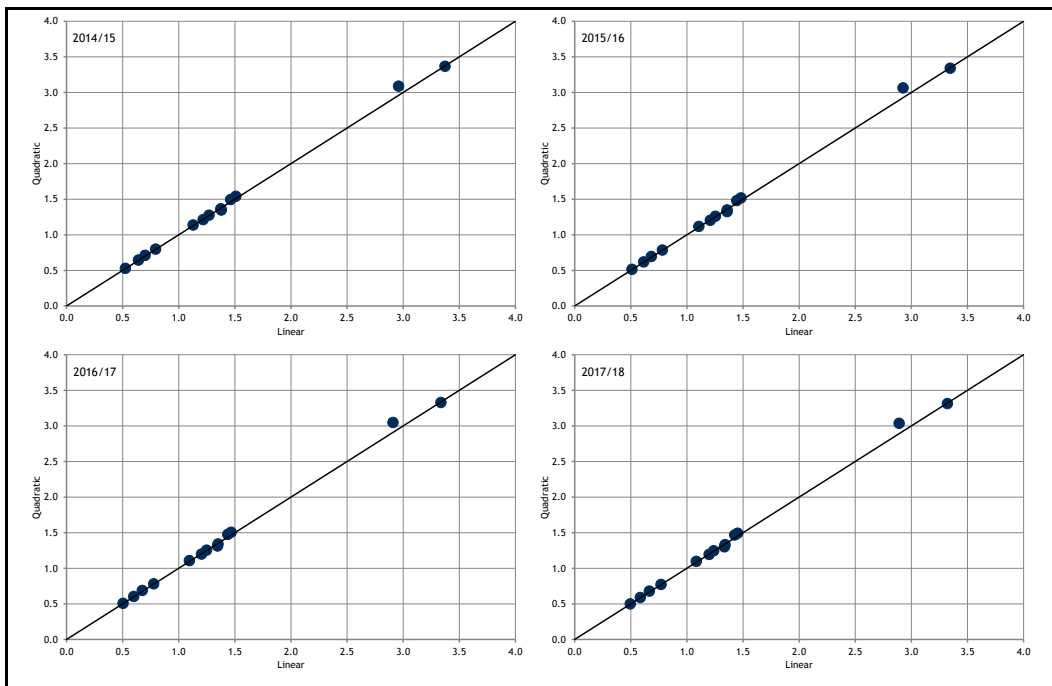
Is the relationship linear?

2.21 The spreadsheet is based on the assumption that the relationship between PPM and AML is linear within the ranges of PPM observed. If the relationship were non-linear, and the graph of AML versus PPM were consistently either concave or convex, this could cause bias in the forecast benchmarks. We tested this by comparing the regressions with and without a quadratic PPM term.

2.22 We plotted scatter diagrams, shown in Figure 2.3, for benchmarks calculated for a sample of service groups in four of the five CP5 years using:

- A constant and a linear term
- A constant and a linear term and a quadratic term

FIGURE 2.3 LINEAR AND QUADRATIC APPROACHES: SERVICE GROUP SAMPLE



2.23 Both groups of regressions resulted in a correlation coefficient very close to +1, and including the quadratic term did not systematically over- or under-estimate the benchmarks for service groups. We concluded that it was not inappropriate to exclude the quadratic term from the spreadsheet.

Have the correct inputs been used and incorporated appropriately?

- 2.24 Network Rail provided source spreadsheets for all the inputs and we are satisfied that these have been correctly transferred to the spreadsheet. The PPM and CaSL data are taken from TRUST, and the minutes lateness figures are taken from PEARS, which are the appropriate sources.

Sense check by replicating calculations

- 2.25 We sampled four of the 13 service groups in the Greater Anglia spreadsheet regressions, counting “peak” and “off peak” as separate service groups, either by checking the formulas or constructing the regression in Excel from scratch. We are satisfied that the spreadsheet performs the regressions correctly.

Formulae

- 2.26 We carried out a number of bottom up checks of the spreadsheet, assisted by the Spreadsheet Professional software, which inter alia checks for:

- Consistency of formulae across rows and columns within worksheets
- Lack of circular references
- Unused input values
- Errors in range names or external links

- 2.27 We found no errors in any category of these categories in the current version of the spreadsheet (see 2.1). We also made a number of manual checks:

- Are inputs transcribed correctly?
- Are formulae correct and reproduced accurately?
- Do the switches to exclude certain periods work correctly?

- 2.28 The inputs are correctly transferred to the spreadsheet.

- 2.29 The formulae in the spreadsheet are consistent with the specification in the methodology statement, and hence the spreadsheet correctly performs the intended calculations.

- 2.30 The switches which exclude certain periods from the regression calculation (where data may be distorted due to exceptional circumstances) work correctly.

Summary

- 2.31 On the basis of the checks carried out we are satisfied that:

- The theory behind the spreadsheet is sound
- The assumptions in the spreadsheet are reasonable and consistent
- The inputs have been correctly transferred from appropriate sources
- The formulae are consistent with the specification of the methodology

Recommendations

- 2.32 We discuss our recommendations in Section 8 below.

3 Variable usage charge (VUC) rate

Version development

- 3.1 Network Rail provided a copy of the VUC rate spreadsheet on 23 July⁸, and all our comments relate to this version of the spreadsheet.

Purpose

- 3.2 Network Rail summarised the purpose of the spreadsheet as shown below.

The purpose of this spreadsheet is to estimate a total average (passenger and freight) variable usage cost rate per thousand gross tonne kilometres. This rate is designed to reflect our track, civils and signalling “wear and tear” costs at the margin, that is as a result of small changes in traffic. It is an important input into the VUC allocation spreadsheet and the VTAC income spreadsheet.

The average variable usage cost rate is comprised of track and non-track (civils and signalling) costs. The average track variable usage cost rate is calculated in VTISM and then imported into this spreadsheet. The average non-track (civils and signalling) variable usage cost rates are calculated in this spreadsheet by calculating a long-run annual average variable cost for each asset type and dividing the respective cost estimates by forecast end CP4 (2013) traffic. The total average variable usage cost rate is then calculated by summing the variable usage cost rates for each of the track and non-track asset types. The total average variable usage cost rate can then be multiplied by a given traffic level in order to estimate the total variable usage costs that we would incur at that traffic level.

- 3.3 The spreadsheet carries out part of the calculation set out in Figure 16.1 of the Draft Determination reproduced as Figure 1.1, using data from a number of sources:

- On various elements of Network Rail’s costs at end CP4 efficiency levels, from sources such as Network Rail’s Hyperion system
- Engineering assumptions, which Network Rail informed us were accepted as part of the Draft Determination, on the proportion of each cost which is variable with levels of traffic
- Total traffic on the network in million gross tonne-miles forecast for 2013, which Network Rail informed us was used as an input to Network Rail’s VTISM model
- RPI assumptions from 2001/02 to 2018/19

- 3.4 The spreadsheet calculates:

- The total element of each cost category, converted where necessary to 2012/13 prices
- The total traffic on the network, converted to gross tonne kilometres
- The average variable charge required, in 2012/13 pounds per thousand gross tonne kilometres, to cover the variable costs at end-CP4 efficiency levels

⁸ “20121213 -BW- updated VUC charge rate for SBP vFINAL (corrected) v2.xls” provided on 23 July 2013 at 13:15

- 3.5 Note that these charges are calculated by **kilometre**, but the results are input to the VUC allocation spreadsheet (see Section 4) to calculate a price list by **mile**.

Structure

- 3.6 The spreadsheet consists largely of input sheets importing data on costs, the assumed variable portion, traffic data and RPI assumptions.
- 3.7 The spreadsheet includes duplicate copies of the core calculation, as shown in Figure 1.2, based on two different values of the average VUC rate:
- Approximately 1.733 (displayed as 1.73), as input to the variable charge income spreadsheet discussed in Section 5, used for the Strategic Business Plan (SBP)
 - Approximately 1.722, as input to the VUC allocation spreadsheet discussed in Section 4
- 3.8 Network Rail informed us that the figure of 1.733 results from a minor error which came to light shortly before publication of the SBP, disclosed in supporting documentation but not considered sufficiently material to correct before publication of the SBP, and that the correct figure is 1.722.

Inputs

- 3.9 The inputs were clearly identifiable but we did not attempt to trace the input data to source.
- 3.10 We checked the assumed variability of some costs direct to the Draft Determination and sought reassurance from Network Rail on a number of other inputs.
- 3.11 We noted that the assumed percentage variability of signalling costs had been calculated as being (approximately) 5.89% but this had been rounded upwards to 6%. This is a proportional increase of almost 2% and equivalent to an additional £176,000 per annum of signalling costs being charged, through VUC, to all operators. If subsequent calculations are performed correctly this would result in a £176,000 reduction in the Fixed Track Access Charges (FTAC) charged to franchised operators.
- 3.12 Network Rail informed us that it considered that rounding a percentage variability based ultimately on engineering judgements to two decimal places implied an artificial level of accuracy, and that this rounding had already been reviewed and accepted by Arup, the independent reporter. We note, however, that the minor rounding results in a redistribution of charges from franchised passenger operators to other operators.
- 3.13 We asked for evidence of the source of assumed cost variability which could not be traced to the Draft Determination. Network Rail drew our attention to ORR's January 2013 Freight Conclusions and other correspondence with ORR in which these assumptions were agreed.
- 3.14 The RPI data were expressed in the form of ratios of RPI between any two years between 2000/01 and 2018/19. We did not compare them either to sources of historic RPI or against forecasts of future RPI, but carried out spot checks to confirm that reciprocal relationships were preserved, so that conversion from one price year to another and then back would restore the exact original value.

Formulae

- 3.15 We found no errors in the formulae and, as a check, created an independent calculation of the relevant functionality of the spreadsheet from the input data to the final output of variable usage charge in pounds per thousand gross tonne kilometres and its components of:
- Track maintenance and renewals (which dominates)
 - Embankment renewals
 - Metallic underbridge renewals
 - Brick and masonry underbridge renewals
 - Culverts renewals
 - Signalling maintenance
 - Minor works points renewal
- 3.16 The results were identical, subject to minor rounding issues which we discuss below.
- 3.17 Our ability to duplicate the entire calculation of the spreadsheet and achieve identical results confirmed that the core calculation was sound, and accordingly we did not carry out any further detailed bottom-up checks of the formulae.

Flow

- 3.18 The spreadsheet has not been developed to best practice and the calculations are not always carried out in the clearest and most logical location and order, but are sufficiently simple that it was possible to identify rapidly the exact sequence of calculation.
- 3.19 In addition to the duplicate copies of the core calculation described in 3.7, the spreadsheet included a number of inputs, calculations and outputs which were not relevant to the charges calculation and which we did not examine in detail.

Summary

- 3.20 On the basis of the checks carried out, we are satisfied that the core calculations in the spreadsheet were correct, subject to minor issues of rounding which we discuss below.

Recommendations

- 3.21 We have a number of specific recommendations, based on the details of the spreadsheet, which we have drawn to the attention of Network Rail.
- 3.22 Our principal concern was the use of rounding in the calculation including:
- Where inputs calculated outside the spreadsheet had been input as rounded numbers, rather than pasting the actual values. In the case of track renewals and maintenance costs we were also given the original data and actual values and confirmed that the difference (less than £5 per annum) was not material.
 - As a consequence, where a relationship between inputs which should be valid (such as $X = 1/Y$, as with the RPI figures discussed above (see 3.14), or $A+B=C$) no longer held true because each of the inputs had been rounded.
- 3.23 We discuss our recommendations further in Section 8 below.

4 Variable usage charge (VUC) allocation

Version development

- 4.1 Network Rail provided a copy of the VUC allocation spreadsheet on 23 July⁹, and all our comments relate to this version of the spreadsheet.

Purpose

- 4.2 Network Rail summarised the purpose of the spreadsheet as shown below.

The purpose of this spreadsheet is to estimate VUC rates for individual vehicle types for inclusion on the VUC price list. Ultimately, the model takes a single average (passenger and freight) variable usage cost rate and, based on the relative “track-friendliness” of the different vehicle types, calculates VUC rates for individual passenger and freight vehicle types. Passenger rates are set out on a pence per vehicle mile basis and freight rates are set out on a pounds per thousand gross tonne-mile basis.

The spreadsheet does this by multiplying the total average variable usage cost rate by total (freight and passenger) traffic in the model to create track, civils and signalling variable usage cost “pots” which are then allocated to individual vehicle types formulaically. The formulae used to allocate variable usage costs to individual vehicles are based on engineering analysis of the drivers of “wear and tear” and are designed to allocate charges in an equitable and cost reflective way: that is, less cost will be allocated to “track friendly” vehicles than to “track nasty” vehicles.

Core to the accuracy of the allocation of costs between individual vehicle types is the assumptions in relation to the characteristics of individual vehicle types, such as axle-load, speed and unsprung mass. In order to help ensure the accuracy of these characteristics they have been subject to significant industry consultation. Following the allocation of costs to different vehicle types, based on their relative “track-friendliness”, an efficiency overlay is applied in order to generate charges at a long-run efficient level.

The spreadsheet also reflects ORR’s decision to cap the maximum increase in the average freight variable usage charge rate in CP5. In addition the spreadsheet identifies the appropriate default rates from the price list (default rates are rates which will be applied to new vehicles which are not on the price list).

- 4.3 The spreadsheet uses data from a number of sources:

- By vehicle type, background information such as mass (“tare weight”), unsprung mass and operating speed
- By vehicle type, data on annual mileage which Network Rail informed us was based on 2011/12 data from its Track Access Billing System (TABS)
- Formulae, based on engineering studies, estimating the relationship between these characteristics and elements of variable costs summarised in Table 4.1

⁹ “New VTAC calculator-mb v1p-serco.xls” provided on 23 July 2013 at 13:15

TABLE 4.1 ELEMENTS OF VARIABLE COSTS FOR EACH VEHICLE TYPE

Element	Basis of calculation and apportionment
Variable track costs: horizontal component	Vehicle “curving class” methodology ¹⁰
Variable track costs: vertical component	Formula developed by Serco ¹¹ using the VTISM model
Variable civils costs	Formula for structures damage developed by Serco ¹²
Variable signalling costs	Serco proposal that these should be apportioned ¹³ : <ul style="list-style-type: none"> • 50% on the basis of vertical track costs • 50% on the basis of vehicle miles

- 4.4 The total calculated costs in each of these categories are then apportioned to individual vehicle types so that:
- Relative costs by vehicle type reflect relative modelled costs
 - Total costs over all vehicle types equal the total variable cost of each element
- 4.5 The cost elements for each vehicle type are then summed to give a single charge per vehicle type, which for freight vehicles is then subject to a capping process specified by ORR¹⁴ to avoid excessive changes between CP4 and CP5.
- 4.6 The resulting charges, including capping, are published in Network Rail’s draft price lists and expressed as:
- A price per vehicle-mile for passenger vehicles
 - A price per thousand gross tonne-miles for freight vehicles
- 4.7 Note that these charges are calculated, and the price list is published, by **mile**.

Structure

- 4.8 The spreadsheet comprises, with generally separate calculations for passenger and freight vehicles:
- Input sheets with background data on vehicle characteristics and usage
 - Input sheets with the parameters, generally as recommended by SERCO, needed to implement the calculations specified in Table 4.1
 - Calculation sheets which calculate the elements of variable costs listed in Table 4.1 for each vehicle type
 - Summary sheets apportioning and checking the total costs
 - Output sheets in the form of draft price lists

¹⁰ Draft price lists for CP5 consistent with ORR’s Draft Determination, July 2013, Annex A (i)

¹¹ Draft price lists for CP5 consistent with ORR’s Draft Determination, July 2013, Table 5

¹² Draft price lists for CP5 consistent with ORR’s Draft Determination, July 2013, Table 6, as modified by the text

¹³ Draft price lists for CP5 consistent with ORR’s Draft Determination, July 2013, Page 10

¹⁴ Draft Determination, 16.81

Inputs

- 4.9 We confirmed that the input variable usage charge in pounds per thousand gross tonne kilometres and its components (described in 3.15) were identical to the outputs of the VUC rate spreadsheet as shown in Figure 1.2.
- 4.10 We did not attempt to trace the source data on passenger and freight vehicle characteristics and usage and hence cannot confirm whether it has been input correctly. We understand from Network Rail that the usage data is based on information from its billing system and that the vehicle characteristics used have been the subject of extensive consultation. We note that the current methodology does not adjust for issues such as geographical variations in the average loaded mass of the vehicles, particularly for commuter stock where loadings are consistently higher at one end of the route. Network Rail advised us that it considers that reflecting these variations would introduce a disproportionate level of complexity.
- 4.11 We created independent calculations of the functionality used to calculate vertical and horizontal track costs, civils costs and signalling costs and confirm that they correctly reproduce the formulae set out in Network Rail's draft price lists¹⁵.

Formulae

Curving class methodology

- 4.12 Network Rail provided us with a short note¹⁶ documenting the curving class calculation which had not been set out in consultation.

Equation 1 "crack initiation function"

$$f_1(T\gamma) = \begin{cases} 0 & T\gamma \leq 15 \text{ J/m} \\ \frac{T\gamma - 15}{50} \times 10^{-5} & T\gamma > 15 \text{ J/m} \end{cases}$$

Equation 2 "wear function"

$$f_2(T\gamma) = \begin{cases} 0 & T\gamma \leq 65 \text{ J/m} \\ \frac{(T\gamma - 65)160}{50 \cdot 110} \times 10^{-5} & T\gamma > 65 \text{ J/m} \end{cases}$$

Equation 3 "wear and RCF damage costs" in £ per kilometre

$$D = \sum_{i=1}^N \left[\sum_{j=1}^m \left[\left[\max(f_1(T\gamma_{ij}) - f_2(T\gamma_{ij}), 0) \right] G_c + \left[\left[\max(f_1(T\gamma_{ij}) - f_2(T\gamma_{ij}), 0) \right] d + f_2(T\gamma_{ij}) \right] \frac{R_c}{S} \right] \right] L_i$$

- 4.13 Where:

- The rolling contact fatigue (RCF) damage function is formed by subtracting the wear function (Equation 2) from the crack initiation function (Equation 1). The output of the function is the surface crack length in millimetres.
- It is assumed that a 1 millimetre surface crack has a depth of 0.5 millimetres.

¹⁵ Draft price lists for CP5 consistent with ORR's Draft Determination, July 2013

¹⁶ Provided in an email on 30 September 2013 at 15:08

- The first term of Equation 3 determines the RCF damage caused and apportions the cost due to grinding to remove this damage. It is assumed that each grinding cycle removes RCF cracks with a surface length of 1 millimetre.
- The second term of Equation 3 determines the amount of wear which each vehicle causes to the rail. This is due to either grinding (the depth of material removed due to RCF damage) or wear. This apportions the rail life, determined by the side wear limit, to each wheel pass.

4.14 Table 4.2 summarises the meaning, units and value of each of the parameters in these formulae.

TABLE 4.2 PARAMETERS IN CURVING CLASS METHODOLOGY FORMULAE

Parameter		Role	Value	Units
Input	N	Number of curves		Number
	L	Length of each curve		kilometre
	M	Number of wheel sets on vehicle		Number
Calculated parameter	T_{γ}	Wear energy number	For each wheel set and curve radius	Joules/metre
Fixed parameter	G_c	Cost of rail grinding	2,000	£/kilometre
	d	Depth ground	0.5	millimetre
	R_c	Cost of rail renewal	250,000	£/kilometre
	S	Side wear limit	10	millimetre
Output	D	Wear and RCF damage cost of operating a vehicle over the curves in the network	Output for each vehicle	£

4.15 The value used for each of the parameters, including the costs, is the same as was used in CP4.

Serco formulae

4.16 The documentation of the Serco formulae provided by Network Rail was insufficiently detailed for us to be able to confirm that they had been implemented correctly. We queried this with Network Rail and they informed us that Serco had earlier agreed that they had been implemented correctly.

The capping of changes to freight vehicle VUC

4.17 We noted that the decision to cap charges to freight vehicles but not to passenger vehicles means that vehicles used on both passenger and freight services are subject to different charges depending on their user.

4.18 We were concerned about whether ORR had intended that Network Rail capped decreases in freight vehicle VUC as well as increases. Network Rail informed us that this approach had been confirmed in correspondence with ORR.

- 4.19 We noted that freight speeds input with other freight data were not used and were instead input separately. Network Rail confirmed that this was the intention and referred us to published documentation confirming the assumptions used¹⁷.
- 4.20 We were able to reproduce the entire calculations for the vertical and horizontal components of variable track costs, the variable civils costs, and the variable signalling costs, for both passenger and freight, in two sheets. This reproduced the totals in the spreadsheet, subject to very minor differences which we attribute to the degree of precision with which Excel stores numbers.

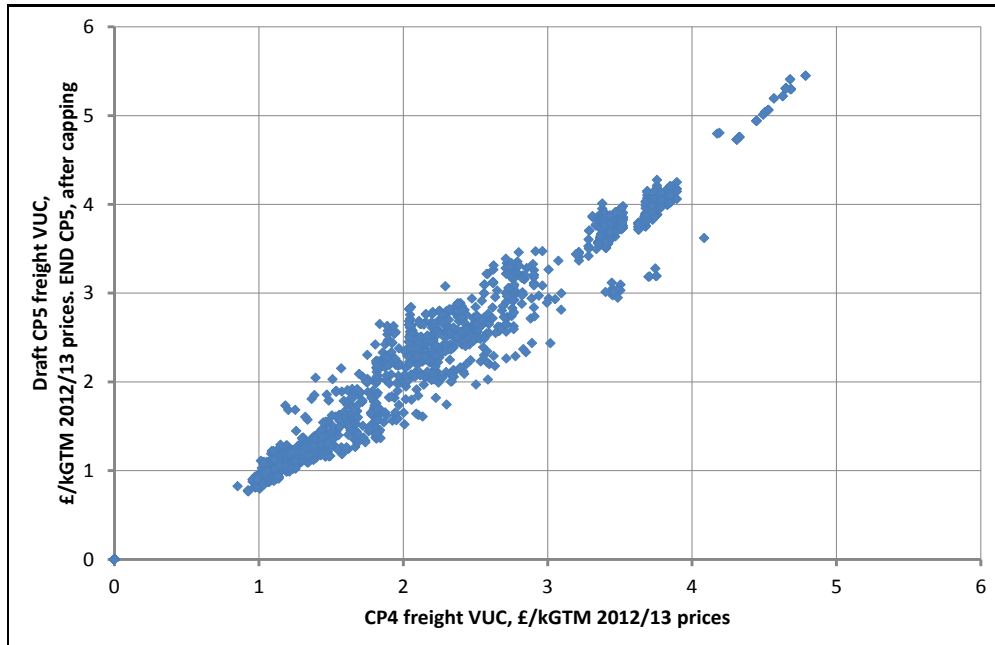
Flow

- 4.21 The spreadsheet has not been developed to best practice and the calculations are not always carried out in the clearest and most logical location and order, but are sufficiently simple that it was possible to identify rapidly the exact sequence of calculation.
- 4.22 The spreadsheet included a number of inputs, calculations and outputs which were not relevant to the charges calculation and which we did not examine in detail. These included, for example, calculation of freight charges by vehicle-kilometre and passenger charges by thousand gross tonne-kilometres, which Network Rail confirmed were not used in practice.
- 4.23 We checked that Network Rail's published draft prices¹⁸, in pence per vehicle mile and £ per thousand gross tonne-miles, agreed with the output of the spreadsheet to the two decimal places to which the draft price lists are formatted. We noted that the exact values in the spreadsheets sometimes differed in the fourth decimal place.
- 4.24 Given the functionality of the spreadsheet to cap rises in average freight charges, we prepared two charts comparing CP4 and CP5 charges for freight and passenger vehicles respectively.
- 4.25 Figure 4.1 compares the average CP4 charge and the average CP5 charge for each freight vehicle type. As would be expected, variation of CP5 charges from CP4 charges has been limited by the capping process.

¹⁷ Periodic Review 2013 - Conclusions on the allocation of the Variable Usage Charge, April 2013

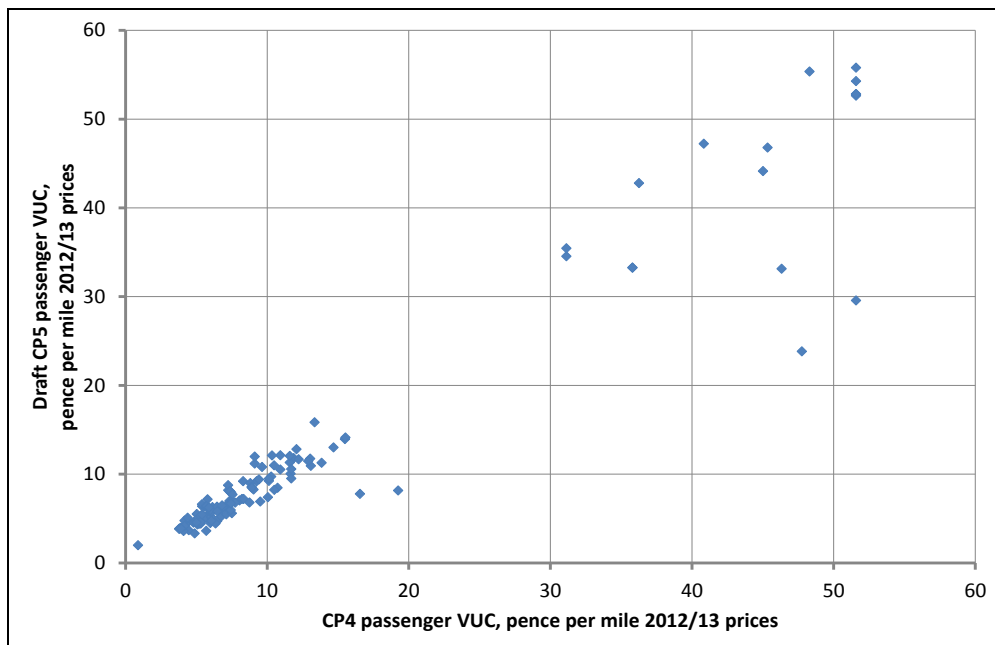
¹⁸ <http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/periodic-review-2013/>, "VARIABLE USAGE CHARGE (JULY 2013).xls" headed "Draft CP5 VUC price list (July 2013) consistent with ORR's Draft Determination"

FIGURE 4.1 VARIABLE USAGE CHARGES, FREIGHT VEHICLE: CP4 & END CP5



4.26 Figure 4.2 compares the average CP4 charge and the average CP5 charge for each passenger vehicle type, omitting very high CP5 charges for some Class 98 vehicles, which Network Rail informed us were subsequently reduced in the light of better vehicle characteristic information. In the absence of capping, it can be seen that charges for some types of vehicle fall by more than half between CP4 and CP5.

FIGURE 4.2 VARIABLE USAGE CHARGES, PASSENGER VEHICLE: CP4 & END CP5



Note: scale omits high charges for some Class 98 vehicles, see text

Summary

4.27 On the basis of the checks carried out, we are satisfied that:

- The spreadsheet correctly performs the calculations for the vertical and horizontal components of variable track costs, the variable civils costs, and the variable signalling costs, for both passenger and freight.
- Network Rail's draft price lists¹⁹ reproduce the outputs of the spreadsheet to the two decimal places to which they are formatted, but may differ in the fourth decimal place.

Recommendations

4.28 Our principal concerns were the use of rounding in the calculation and the need to check text names used as inputs:

- In the curving class calculations the physical constant of the number of kilometres in a mile had been truncated to 1.6 rather than input exactly as 1.609344. In practice, this has no effect on the calculation as the result is in any case prorated to match a control total. Elsewhere the constant had been truncated to the fifth significant figure (1.6093) but we checked that this had no material effect on the output. Nonetheless, best practice would be to enter this constant once, and exactly, as a named variable.
- Where text names such as vehicle classes are used as inputs, a typing error could mean that it was not found in a "LOOKUP" or "MATCH" function. It would be desirable to use Excel's "Data validation" feature to check that spreadsheet inputs were valid, rather than to apply checks on outputs.

4.29 We discuss our recommendations further in Section 8 below.

¹⁹ <http://www.networkrail.co.uk/publications/delivery-plans/control-period-5/periodic-review-2013/>, "VARIABLE USAGE CHARGE (JULY 2013).xls" headed "Draft CP5 VUC price list (July 2013) consistent with ORR's Draft Determination"

5 Variable charges income

Version development

- 5.1 Network Rail provided a copy of the variable income charges spreadsheet on 23 July²⁰.
- 5.2 Following correction of two minor errors in the EAUC calculation. Network Rail provided a revised version on 10 September²¹, and all our comments relate to this revised version of the spreadsheet.
- 5.3 Network Rail also provided a high level functional specification on 18 July, followed by a supporting spreadsheet on coal spillage on 23 July.
- 5.4 As illustrated in Figure 1.2 and set out above, we understand that the spreadsheet forms part of Network Rail's SBP and has not been updated to be consistent with the Draft Determination. As a result, it was not possible to identify numbers common to the variable income charges spreadsheet and other spreadsheets we have examined, which have been updated to reflect the Draft Determination. We have however seen an earlier version of the model²² (v21) which is consistent with the FTAC model.

Purpose

- 5.5 Network Rail summarised the purpose of the spreadsheet as shown overleaf.

²⁰ "VTAC_ICM_v022_CorrectedTraffic.xls" provided on 23 July 2013 at 09:52

²¹ "VTAC_ICM_v021_SBP_with_EAUCCalcCorrection.xls" provided on 10 September 2013 at 16:40

²² "VTAC_ICM_v021.xls" provided on 10 September 2013 at 16:21

The purpose of this spreadsheet is to forecast income from the following charges:

- Variable usage charge (franchised passenger, open access and freight)
- Capacity charge (franchised passenger, open access and freight)
- Electrification asset usage charge (franchised passenger and freight)
- Freight only line charge (freight)
- Coal spillage charge (freight)

The model takes the relevant charge rates and multiplies by forecast traffic volumes, from the same traffic model used to inform cost and performance forecasting in the SBP, to give the forecast income. This multiplication is carried out at service group (passenger) / commodity (freight) and route level.

Passenger VUC calculation

This uses the following steps:

- Calculating VUC rate for each service group from 2011/12 outturn revenue and traffic data
- Inflating to 2012/13 prices (x 1.03)
- Uplifting by a factor comparing the average derived VUC rate from 2011/12 outturns and the SBP average VUC rate (from the VUC rate model)
- Multiplying by traffic forecast to get income
- Normalising using a factor that represents the difference between outturn traffic and forecast traffic

Freight VUC calculation

As with passenger but by commodity instead of service group.

Capacity charge calculations

As with the VUC calculations, but assuming CP4 rates because there was no CP5 rate at the time of the SBP.

EAUC calculations

Multiply actual CP4 and proposed CP5 charge rates, separate for AC/DC and passenger/freight, by the forecast traffic volumes.

Freight-only line charge calculations

In CP4, the freight only line charge is levied on freight trains carrying ESI coal and spent nuclear fuel and is designed to recover freight only line costs. In Network Rail's billing system, spent nuclear fuel traffic is recorded as part of the "Other" commodity and therefore is not explicitly identified in the traffic forecasts. However, spent nuclear fuel traffic volumes are available in the billing system and it is possible to calculate a percentage of "Other" traffic that carries spent nuclear fuel. The model takes a forecast of the CP5 freight only line cost, divides by average CP5 traffic volumes to calculate CP5 charge rates, and multiplies charge rates by traffic volumes.

Coal spillage charge calculations

Multiply actual CP4 and proposed CP5 charge rates by the forecast traffic volumes.

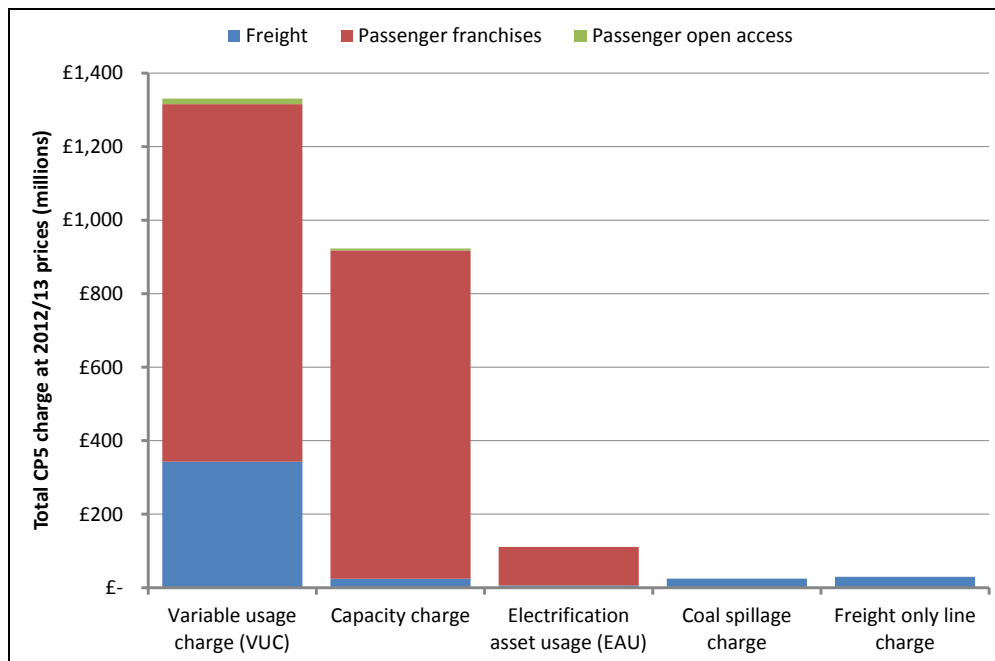
5.6 Payment of these charges is as shown in Table 5.1.

TABLE 5.1 APPLICATION OF VARIABLE CHARGES

	Freight	Passenger franchise	Passenger open access
Variable usage charge	✓	✓	✓
Capacity charge	✓	✓	✓
Electrification asset usage charge	✓	✓	
Coal spillage charge	Some		
Freight only line	Some		

5.7 The calculated relative sizes of these charges in the SBP is summarised in Figure 5.1 below. Network Rail informed us that the latest expectation of the income from each type of charge is different, especially in the case of the capacity charge, which is expected to be at least double that shown in the Figure.

FIGURE 5.1 RELATIVE INCOME FROM VARIABLE CHARGES IN SBP



Structure

5.8 The spreadsheet includes a number of input sheets importing data, a number of calculation sheets related to each of the types of variable charge, and output sheets:

- Listing each element of charge by route
- Summarising the above at the national level

Inputs

Variable usage charge and capacity charge

- 5.9 Inputs for the variable usage charge and capacity charge appear in two main blocks:
- Actual 2011/12 data on unit charges and volumes, which we understand are from Network Rail’s Track Access Billing System (TABS), which are imported into five separate sheets through Excel pivot tables. We have extracted the pivot table data but understand from Network Rail that the original spreadsheet²³ is no longer available.
 - Forecast passenger and freight traffic by service group for the years 2011/12 to 2033/34, which we understand are drawn from the Infrastructure Cost Model (ICM) traffic model.
- 5.10 Network Rail also point out that, at the time the spreadsheet was prepared, there was no proposed CP5 rate for the capacity charge, so the calculation for CP5 and beyond was based on the CP4 rate.

Electrification asset usage charge

- 5.11 This calculation consists of a relatively simple multiplication of a rate by forecast traffic.
- 5.12 Inputs for the electrification asset usage charge are imported in the form of electric vehicle-kilometres for passenger traffic and electric thousand gross tonne-kilometres for freight traffic, each of which are multiplied by input unit charges:
- For passenger and freight
 - For AC and DC
 - For CP4 and CP5
- 5.13 The CP5 freight charges agreed to four significant figures, and the CP5 passenger charges agreed to three significant figures, with Network Rail’s SBP charges as reported in the Draft Determination²⁴.

Freight only line charge

- 5.14 This calculation consists of a relatively simple multiplication of a rate by forecast traffic.
- 5.15 We compared the spreadsheet with the Draft Determination²⁵ and noted that the Draft Determination²⁶ reports, in rounded form, the outputs of the spreadsheet.

Coal spillage charge

- 5.16 This calculation consists of a relatively simple multiplication of a rate by forecast traffic. We have not examined the coal spillage charge in detail.

²³ “Income ICM v015 (no charge for 2003).xlsx”

²⁴ Draft Determination, Tables 16.26, 16.28 and 16.30

²⁵ Draft Determination, 16.213-16.235

²⁶ Draft Determination, Table 16.32

Volume incentive

- 5.17 The spreadsheet has provision for inputs of volume incentive income, by year and route, at 2012/13 prices, which it then transfers direct to the output sheet. We did not examine this part of the spreadsheet.

Formulae

Variable usage charge and capacity charge

- 5.18 The variable usage charge is calculated in pence per vehicle kilometre for passenger trains and pounds per thousand gross tonne-kilometres for freight trains. The capacity charge is calculated in pounds per train-kilometre.
- 5.19 We have a number of observations about the process used to calculate income from the variable usage charge and the capacity charge.
- 5.20 In principle, to forecast income by route, Network Rail needs as inputs the data listed in Table 5.2.

TABLE 5.2 INFORMATION REQUIRED FOR VARIABLE CHARGES CALCULATION

Information	Details	Issues
Vehicle type	Forecasts of the types of vehicle to be operated by each train operator.	Deployment of existing fleets may change and new stock will be introduced during CP5. The calculation assumes that fleet mix by service group does not change.
Vehicle usage	Forecasts of the volume of usage (mileage or gross tonne kilometre) of each vehicle type by year and operating route.	Neither franchise specifications nor detailed timetables to the end of CP5 exist. The calculation assumes growth in vehicle mileage by service group.
Vehicle charge	The CP5 charges which will apply to each vehicle.	In principle, available from the VUC allocation spreadsheet. In practice, the variable charges income spreadsheet predates the VUC allocation spreadsheet.

- 5.21 Ideally, variable income would be estimated from forecast CP5 vehicle types, characteristics and usage, but this is not possible for the reasons set out in the Table.
- 5.22 Network Rail could in principle base the calculation on the exact CP5 charges, which are calculated using the VUC allocation spreadsheet described in Section 4, but has not done so because the VUC allocation spreadsheet was not complete when the variable income charges spreadsheet was prepared.
- 5.23 Even if it used the exact CP5 charges calculated in the VUC allocation spreadsheet, Network Rail still could not know what vehicles would operate over what distances in CP5: assumptions on volume and vehicle type are necessarily estimates.

- 5.24 Network Rail's approach seems broadly reasonable but, as discussed above, some elements could potentially be improved, particularly in relation to the estimation of income from variable usage charges.
- 5.25 Variable usage charges for some vehicle types change significantly between CP4 and CP5. Network Rail estimated the average CP5 variable usage charge by service group by prorating the CP4 variable usage charges by the average increase between CP4 and CP5, but this reflects neither the exact change for each vehicle type nor ORR's later decision to cap the level of change for freight vehicles.
- 5.26 As we discuss in Section 4, ORR has imposed a cap on the level of change for freight vehicles, with the result that changes for any given freight vehicle type are limited as shown in Figure 4.1. However, no such cap is imposed for passenger vehicles, and we would expect that there might be considerable fall in average variable usage charge in service groups using vehicles which are outliers in Figure 4.2.
- 5.27 Given that the data imported into the variable income charges spreadsheet includes the actual composition of the 2011/12 fleets, it would be possible in principle for at least the changes between CP4 and CP5 to be reflected. We are aware, however, that a possible counterargument is that such additional detail may be irrelevant given the uncertainty in the actual fleets to be used during CP5. If this were the case, omission of detail which cannot be justified by the available data or forecasts might allow the calculations to be simplified, as we discuss below.
- 5.28 In summary, given the uncertainties in fleet, deployment and level of activity, Network Rail's approach seems broadly reasonable, but there may be scope to improve it with the data available.

Electrification asset usage charge

- 5.29 We initially identified two errors in the calculation of the electrification asset usage charge (EUAC) in which formulae had not been correctly copied down the sheet. In the revised version of the spreadsheet provided on 10 September 2013 these errors had been corrected.

Flow

- 5.30 The spreadsheet has not been developed to best practice and the calculations were not always carried out in the clearest and most logical location and order, but were sufficiently simple that it was possible to identify rapidly the exact sequence of calculation.
- 5.31 The spreadsheet included a number of inputs, calculations and outputs which were not relevant to the charges calculation and which we did not examine in detail.

Summary

- 5.32 On the basis of the checks carried out, we are satisfied that the spreadsheet correctly performs the calculations.

Recommendations

- 5.33 We note that the output EAUC for four routes does not correspond with the inputs to the FTAC sheet. Network Rail are aware of this discrepancy and we understand that it has been addressed.
- 5.34 We have a number of minor concerns with the spreadsheet:
- Some of the key input data can no longer be traced to known sources.
 - There is no specification of how it should perform the calculations, and in particular on what assumptions of fleet, deployment and mileage it should be based.
- 5.35 We also note that it may be possible to make better use of the available input data, in that detailed information on changes in variable usage charges between CP4 and CP5 is available and could in principle be used, subject to the assumption that fleet mix by service group will not change (see 5.27). Conversely, if there is no intention to make use of some of the detail available at a disaggregate level, it may be possible to simplify the calculations by carrying them out at a more aggregate level.
- 5.36 However, we suggest that best practice would be to:
- Identify the size and nature of the inherent uncertainties in any element of forecasting.
 - From this, identify what level of detail and disaggregation in other parts of the process would be appropriate but not excessive.
 - From this, carry out the calculation in the simplest possible way consistent with the uncertainties.
- 5.37 We discuss our recommendations further in Section 8 below.

6 Fixed track access charge (FTAC)

Version development

- 6.1 Network Rail provided a copy of the FTAC spreadsheet on 23 July 2013, and all our comments relate to this version of the spreadsheet²⁷.
- 6.2 Network Rail also provided a high level functional specification of the spreadsheet on 18 July 2013 and an update to it on 24 July 2013.
- 6.3 Network Rail indicated that it did not require a check of the Indicative Route RABs, and so we did not examine this part of the calculation.

Purpose

- 6.4 Network Rail summarised the purpose of the spreadsheet as shown below.

Fixed track access charges (FTAC) are payable by franchised passenger operators and recover our net revenue requirement. The net revenue requirement is the revenue required to run our business, after accounting for the income we expect to receive from charges, other single till income and the network grant.

The model essentially:

- Uses each line of input from our SBP tier 0 model, which includes all costs and income forecasts at route level (as used in the SBP)
- Uses RAB related costs input (RAB return and amortisation) from the financial model
- Allocates each line of cost (less income) to operator using the traffic metrics set out in Annex A of our conclusions document²⁸
- Pro-rates RAB-related costs by funder to route and asset level based on the pre-efficient long-run renewals forecast (as used in the SBP) and then allocates them to operator using the aforementioned traffic metrics

The output is the FTAC in £ million for each:

- Route
- Operator
- WACC scenario

To increase cost reflectivity, we also concluded that we would exclude TOC-specific income, such as facility and stations charges, from the overall calculation and net these off the individual TOCs' FTACs.

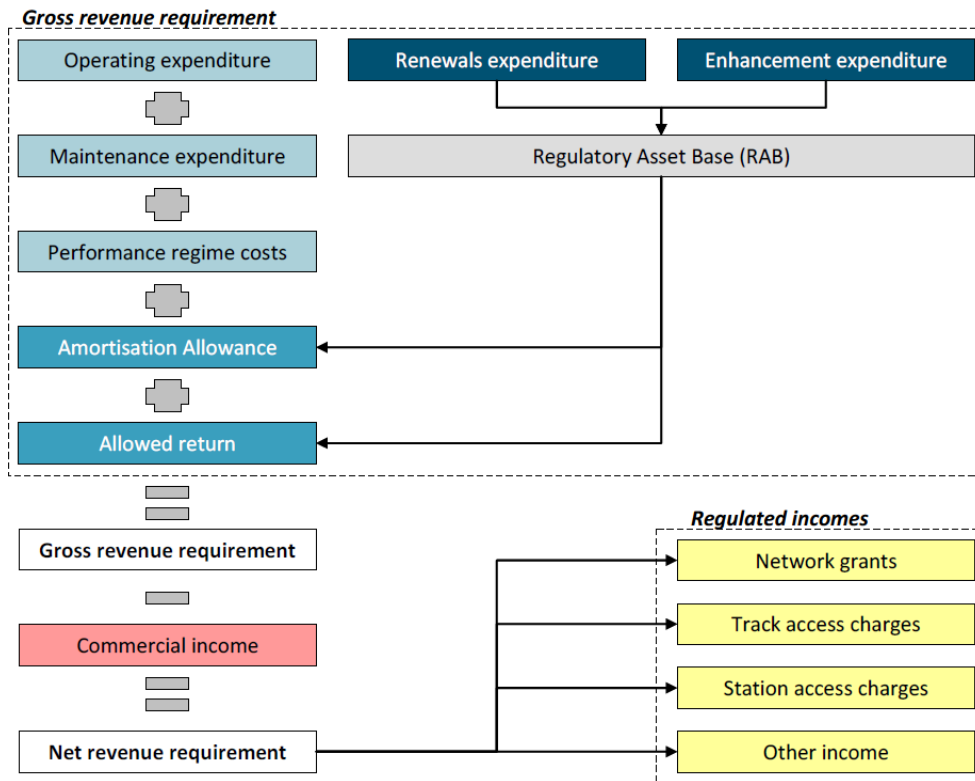
We have also made the policy decision for the FTAC in Scotland to be recovered from ScotRail.

²⁷ "FTAC_v19.xls" provided on 23 July 2013 at 09:52

²⁸ <http://www.networkrail.co.uk/fixed-track-access-charges-consultation.pdf>

FIGURE 6.1 DERIVATION OF NET REVENUE REQUIREMENT AND HENCE FTAC

Figure 1: Building block approach



Source: Network Rail²⁹

6.5 Total FTAC by funder (that is, for England and Wales, and for Scotland) is fixed by the process summarised in Figure 6.1. The purpose of the spreadsheet is to calculate the share of:

- FTAC by TOC
- FTAC by route

on the basis of costs, income and traffic forecasts.

6.6 The spreadsheet uses data from a number of sources:

- Infrastructure costs, derived from the Infrastructure Cost Model (ICM)
- Traffic forecasts
- Other income
- TOC specific income
- Draft Determination FTAC figure
- Financial model (Hyperion)

6.7 Each cost or income type within each route is allocated to the TOCs running over that route in accordance with one of five allocation metrics. These metrics are:

- Train-kilometres
- Vehicle-kilometres

²⁹ <http://www.networkrail.co.uk/fixed-track-access-charges-consultation.pdf>

- Tonne-kilometres
 - EMGTPA (a measure of tonnage)
 - Electric train-kilometres
- 6.8 The allocation metrics used are set out in Annex A of Network Rail’s March 2013 document “Periodic Review 2013: Fixed Charges in CP5 - Conclusions”.
- 6.9 The allocations are summed by TOC, and TOC specific income is then subtracted from the sum.
- 6.10 Network Rail informed us that:
- Following ORR’s Draft Determination, estimates of FTAC by TOC and route prepared in the SBP were pro-rated so that the total by funder is equal to the Draft Determination figure.
 - This approach was agreed by parties as being the most pragmatic, given the short timescales required to publish draft CP5 price lists.

Structure

- 6.11 The spreadsheet comprises:
- Input sheets with traffic, cost and income data
 - An input sheet specifying the allocation metrics to be used
 - An input sheet showing the total FTAC by funder
 - Calculation sheets allocating costs and income to TOCs
 - Output sheets setting out FTAC by TOC and by route

Inputs

- 6.12 The inputs data are held in a variety of spreadsheets and Access databases. Documentation provided with the spreadsheet includes a comprehensive list of the inputs.
- 6.13 We have examined the spreadsheet data and outputs of Access queries which feed directly into the FTAC spreadsheet, and these have all been transferred correctly.

Formulae

- 6.14 We found no errors in the formulae and, as a check, created an independent calculation of the relevant functionality of the spreadsheet from the input data to the final outputs. The results were identical.
- 6.15 Our ability to duplicate the entire calculation of the spreadsheet and achieve identical results confirmed that the core calculation was sound, and accordingly we did not carry out detailed bottom-up checks of the formulae.
- 6.16 We did however run the Spreadsheet Professional tool, and identified a number of minor issues, a report of which has been provided to Network Rail.

Flow

- 6.17 The spreadsheet has not been developed to best practice and the calculations are not always carried out in the clearest and most logical location and order, but are sufficiently simple that it was possible to identify rapidly the exact sequence of calculation.

Summary

6.18 On the basis of the checks carried out, we are satisfied that the core calculations in the spreadsheet were correct.

Recommendations

6.19 We note that there is a discrepancy between the metrics used in the FTAC spreadsheet and those in the variable charges income spreadsheet (Section 5). We understand that this was partly driven by the availability of data at the time that the FTAC spreadsheet was developed.

TABLE 6.1 METRICS USED

Description	Metric used in variable charges income spreadsheet	Metric used in FTAC spreadsheet
Capacity charge	Train-kilometres	Vehicle-kilometres
Electrification asset usage Electric traction	Electric vehicle-kilometres	Electric train-kilometres

6.20 These different metrics could lead to different allocations of FTAC to TOCs. We recommend that consistent metrics (the metrics used in the variable charges income spreadsheet would appear to be more appropriate) are used in both spreadsheets.

6.21 We discuss our recommendations further in Section 8 below.

7 Spreadsheet Modelling Best Practice

7.1 Figure 7.1, drawn from our internal training programme on Spreadsheet Modelling Best Practice (SMBP), summarised the ideal sequence of development and use of a spreadsheet model. Best practice is desirable, even if, as with some of the charge calculations, spreadsheets are used only once, to perform a specific calculation.

FIGURE 7.1 SPREADSHEET MODELLING BEST PRACTICE: KEY STAGES



7.2 Table 7.1 summarises in slightly greater detail the rationale for each step.

TABLE 7.1 SPREADSHEET MODELLING BEST PRACTICE: KEY STAGES

Stage	Rationale
Scope	Assess the nature, scale and complexity of the spreadsheet required
Specify	Define the logic of the model in terms of the exact sequence of calculations required to convert defined inputs into required outputs Specification also includes diagnostics and checks to support testing and use, and potentially graphics to support comprehension and sense-checking
Design	Identify the most effective structure for the spreadsheet: what are rows and what are columns, what calculations are carried out on each sheet
Build	Code the spreadsheet to the specification and design
Test	Test the model to confirm that it performs according to the specification
Document	Explain to potential users what the model is intended to do and what it is not intended to do, and how inputs may and should be changed
Use	Produce outputs for a given set of inputs or assumptions

7.3 For a number of reasons, Network Rail has not been able to comply with all aspects of SMBP in a logical sequence.

7.4 In Section 8 we set out a “long list” of recommendations, based on the SMBP structure set out above, as to how the calculation processes could be improved.

7.5 We stress, however, that Network Rail had only limited time, between ORRs Draft Determination and the publication of draft price lists, in which to finalise the output benchmarks and price list. Some of our recommendations, while desirable, may be:

- Not have been achievable within the timescales available to Network Rail.
- Not cost-effective, given alternative uses of Network Rail resources. This is particularly an issue for calculations likely to be performed only once and to be replaced by a different process at the next Periodic Review.

8 Recommendations

Introduction

- 8.1 The charges calculation process draws on a mixture of precedent, historic data, forecasts and ORR's Draft Determination, and it may be difficult to ensure that all charges are both mutually consistent and calculated in the most efficient possible way, for a number of reasons:
- The lack of a single published overarching specification of exactly how charges should be calculated, and on the basis of what historic data and forecasts.
 - The range of data, from different sources, required in the calculations.
 - The need to base the calculations on data now available, typically available on a consistent basis for financial year 2012/13, but in some cases older.
 - The need to base at least some calculations on pre-existing systems and tools, rather than always to develop systems and tools to calculate charges in the most efficient way from the source data.
- 8.2 While not a formal requirement of our work, Network Rail invited us make:
- Suggestions as to the overall structure and/or efficiency of the calculations.
 - Recommendations relating to the overall methodology used.
- 8.3 We therefore include in our report a number of observations and suggestions on how the charge calculation process might be improved either later in PR13 or in future periodic reviews.
- 8.4 We deal in turn with:
- Quick wins, which we consider could be implemented rapidly, and in particular for the Final Price List for CP5 due to be published and approved by ORR before the end of 2013.
 - Suggestions as to how the charges calculation process could, if time and resources permitted, be improved in the longer term.
- 8.5 We stress that we have not examined in detail the practical implications of these recommendations, or their cost-effectiveness, and that it will be for Network Rail to decide whether and when to adopt any of them.

Quick wins

8.6 We set out in Table 8.1 a number of “quick wins”, before listing more detailed suggestions overleaf.

TABLE 8.1 “QUICK WIN” RECOMMENDATIONS

Issue	Example	Recommendation
Inputs	3.9, 5.9	<p>“Escrow” copies of all inputs are held with a record of source, date, and approach to updating.</p> <p>Inputs are only required in one place in each spreadsheet, or ideally only on place on the process (see RPI below) to avoid the risk of incomplete updating.</p>
Units	3.5, 4.7	<p>All units should be labelled.</p> <p>Ideally calculations would be on a consistent basis, such as miles or kilometres, or units or thousands.</p> <p>Where this is not possible (different industry systems may use different units), considering converting to the standard unit immediately after input.</p>
Rounding	3.11, 3.21, 4.28	<p>Physical constants (kilometres/mile) are input exactly.</p> <p>All calculations are carried out exactly as specified unless rounding has been agreed and documented.</p> <p>Numbers are transferred between spreadsheets as either links or pasted values.</p> <p>Derived values, such as ratios or reciprocals, are calculated from the originals in each spreadsheet.</p>
RPI	3.14	<p>Historic and forecast RPI (and other common data) are stored in a common file referenced by all spreadsheets.</p> <p>Ratios between RPIs in different years and months are calculated when needed.</p> <p>If necessary, RPI is calculated explicitly for the indexation point which will determine each year’s prices.</p>
Validation	4.28	<p>Text inputs used in Excel functions such as “LOOKUP” or “MATCH” should be validated on input to ensure that typographical errors due not result in calculation errors.</p> <p>Check for such errors regularly within the calculation.</p>
Allocation Metrics	6.20	<p>As far as possible, consistent metrics should be used across calculations.</p>

Scope

8.7 It would be easier for Network Rail to check, and interested parties including operators and funders to understand, the charge calculation if it were explained in a single overarching document. This would need to be based on existing documentation but to set out in a logical and structured order:

- Which inputs were to be historic data and which were to be forecasts.
- The historic data from which the charges are to be calculated (ideally the most recent available, but where production of final data is lagged, earlier data in specific cases, and if relevant processes for dealing with any resulting internal inconsistency).
- The forecasts from which the charges are to be calculated, which might be prepared in accordance with specific assumptions or guidelines or accepted as a standard by the industry.

Specification

8.8 Given a clear scope for the calculation process, Network Rail could define a clear and consistent specification for all the charging calculations. This would, inter alia:

- Identify the exact data sources to be used.
- Identify the order in which calculations would be carried out.
- Determine the degree of disaggregation at which calculations would be carried out, which we suggest should be the simplest consistent with the need for internal consistency.
- Include flow diagrams showing the calculation process.
- Reference each element of the process back to consultations or determinations.
- Specify the units in which calculations will be carried out, the way in which common inputs will be shared, the way in which intermediate calculations will be passed between spreadsheets, and any agreement on where rounding is permitted.
- Specify the metrics used for allocation of costs.

8.9 We envisage that the process of developing a detailed specification for the process might raise a number of questions which would need to be clarified with ORR, and that agreement would be incorporated into, and referenced in, the specification.

Design

8.10 Specification of the spreadsheet as set out above would enable Network Rail to develop an efficient and transparent design. We would expect that many of the calculations could be carried out in simpler and smaller spreadsheets, which would not include redundant inputs or calculations or unnecessary disaggregation.

8.11 As an illustration, we were able to reproduce the entire relevant parts of the VUC rate calculation (3.15) in one worksheet and the entire relevant parts of the VUC allocation calculation (4.20) in two sheets.

Construction

- 8.12 Given a clear scope, specification and design, construction of the spreadsheet should be a relatively rapid process. Given the existing input sheets, and an understanding of the calculation process, we reconstructed each of the VUC rate calculation and the VUC allocation calculation within half a working day.

Testing

- 8.13 If well-designed to a clear specification, testing of spreadsheets should be relatively straightforward. Testing can be assisted by a number of simple steps such as:
- Including validation checks on inputs.
 - Carrying out calculations in simple stages, where possible referring to inputs adjacent or near to each formula.
 - Checking that row and column totals of tables are equal.
 - Including checks for errors or implausibly large or small intermediate or final results.
 - Including charts enabling outliers or inconsistencies to be identified rapidly.
- 8.14 Unlike some complex models with a range of functionality which may need to be tested with different input data, parameter values, and other inputs and assumptions, the charges calculations are intended to be used only once, to calculate a definitive set of charges.
- 8.15 Given the speed with which we have been able to reconstruct the core calculations, one potential means of testing future calculations could be for Network Rail staff, working independently, to construct two spreadsheets from the same specification and confirm that they produce identical results.

Documentation

- 8.16 Ideally, each spreadsheet would be supported by user documentation explaining the processes and rules for updating inputs and outputs. Documentation could include a “model map”, cross-referenced to the specification, of where each calculation takes place in the spreadsheet.
- 8.17 Documentation of the spreadsheets would perform a number of functions:
- To ensure that different Network Rail staff could understand the calculations
 - To support ORR’s independent reporters and audit
 - To enable the calculation to be revisited if still relevant in PR18, or to implement any changes required during CP5

Use

- 8.18 Where practicable, future best practice would be for the calculation of definitive charges be deferred until all the stages above, including documentation, are complete. This minimises the risk that retrospective documentation of the processes and spreadsheets involved identifies errors or inconsistencies which have already been incorporated into published charges.

CONTROL SHEET

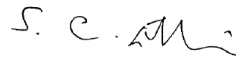
Project/Proposal Name Review of income and Schedule 8 benchmark models
Document Title Draft Final Report
Client Contract/Project No.
SDG Project/Proposal No. P22612801

ISSUE HISTORY

Issue No.	Date	Details
1	23/08/2013	Draft to Network Rail
2	17/09/2013	Draft to Network Rail reflecting comments
3	10/10/2013	Final Draft reflecting Network Rail and ORR comments
4	14/10/2013	Final

REVIEW

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