Office of Rail Regulation

Schedule 8 Payment Rates Recalibration

Phase B

HALCROW/ITS Technical Report

December 2013

Halcrow

Document history

Technical Report

Schedule 8 Payment Rates Recalibration – Phase B

ORR

This document has been issued and amended as follows:

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Contents

Glossary

AML: Average Minutes Late.

ATOC: Association of Train Operating Companies;

Bugle: A performance management system used by train operators.

CPx: Control Period x. The funding of Network Rail is managed in 5-year-long Control Periods. CP4 runs from 1st April 2009 to 31st March 2014; CP5 runs from 1st April 2014 to 31st March 2019.

DML: Deemed Minutes Late. Calculated measure of the impact of cancellations in terms of equivalent minutes of lateness.

GJT: Generalised Journey Time, a measure of weighted journey time which combines all time-related elements of an average journey;

IPPR: Industry Performance Period Report produced by Network Rail;

LENNON: The rail industry's central ticketing system. LENNON holds information on the vast majority of national rail tickets purchased in Great Britain and is used to allocate the revenue from ticket sales between train operating companies;

MRE: Marginal revenue effect, the forecast loss of fare box revenue to a passenger train operator resulting from one minute of lateness;

NR: Network Rail;

NRPR: Network Rail pays compensation to (receives a bonus from) a passenger train operator in relation to a particular service group when it underperforms against (outperforms) its benchmark; Network Rail Payment Rates;

NALCO: The location code used to define the origin or destination of a passenger journey as on the passengers ticket in Lennon;

OD: Origin/Destination;

ORR: Office of Rail Regulation;

PEARS: Network Rail performance reporting system, used to calculate periodic Schedule 8 payments.

PSS: Performance Systems Strategy. Network Rail performance reporting system which acts as a data warehouse for performance data.

Schedule 8: Schedule 8 to the template track access agreement between a TOC and Network Rail, containing the elements of the performance regime

Service Code: means the third, fourth and fifth digits of an eight character train service code applied in the Performance Monitoring System to Trains and used to identify them;

Service Group (SG): means a collection of related rail services;

SQL: Structured Query Language, a programming language designed for managing data held in a relational database management system;

TOC: a Passenger Train Operating Company;

TRUST: Train Running System TOPS. A computer system operated by Network Rail which records the timings of trains passing particular points on the network and compares these with the timetabled times.

1 Introduction & summary

1.1 Executive summary

The Office of Rail Regulation (ORR) and Network Rail (NR) commissioned Halcrow and ITS in November 2012, to recalibrate the payment rates and performance benchmarks in Schedule 8 of passenger train operators' track access contracts.

The work has been structured in two Phases. Phase A covered the calculation of Network Rail payment rates; Phase B covers the calculation of Network Rail and Operator benchmarks and Operator payment rates. This report covers Phase B of the work.

For Phase B our key activities were to:

1) Calculate historic Network Rail and Operator performance levels for each Schedule 8 service group for the period from 01/04/2010 to 31/03/2012.
2) Calculate Operator Schedule 8 payment rates for CP5 based on the Network Rail payment rates calculated in Phase A of this work.

- Historic performance levels ("Benchmarks")

Historic performance levels, expressed in Average Minutes Late (AML) for Network Rail and Operator, were calculated for each Schedule 8 service group and peak/off-peak subdivision based on detailed data from the NR "PEARS" system which is used to calculate actual Schedule 8 payments. The daily calculation used by PEARS was replicated for each day of the agreed benchmark period, using the most up-to-date values for monitoring point weightings and other parameters available.

Some adjustments were made to the basic PEARS results to account for changes in circumstances which would have made the results inapplicable to CP5. These were:

1) Adjustments to the date range used, to account for timetable changes during the benchmark period or disruptions which affected specific service groups over defined date ranges
2) Adjustments to the measured lateness of trains at monitoring points to account for changes in TRUST berthing offsets[1] which occurred during or after the benchmark period
3) Adjustments to the allocation of responsibility for some categories of delay cause, to take account of operator-level agreements with Network Rail
4) Adjustments to delay and train stops information to cater for groups of trains moving between operators during the benchmark period.

[1] Trains are timed by the performance monitoring system TRUST at timing points which may not be positioned at stations. Offsets are applied to raw TRUST times to allow for the difference between recorded times and actual arrival times at stations.

These benchmark results were delivered to ORR / NR on 2nd July 2013. Updates were sent later for two operators (LOROL and Chiltern) following discussion on applicable date ranges.

At the request of Network rail further calculations were carried out to pick up later berthing offset changes to help them calculate CP5 benchmarks. These benchmarks were calculated using updated Berth Offset figures provided on the 26th of September and 14th October. Results of these calculations were delivered to NR and ORR on the 8th of November.

- Responsibility Matrix

The Responsibility Matrix is used in the calculation of TOC payment rates. For each victim service group and responsible TOC, it assigns the financial penalty associated with TOC-on-TOC delays and cancellations to the responsible service group.

In previous determinations of TOC payment rates, the matrix has been based on estimated levels of interaction between service groups based on metrics such as shared route and track mileages. For this determination, we have calculated a completely new matrix based on observed interactions as recorded in Network Rail's PSS performance database. In industry-wide consultations and in discussion with individual operators there has been widespread support for this approach.

Separate matrices have been constructed for Weekdays, Saturdays, and Sundays; and for Delays and Cancellations: a total of six matrices.

The Responsibility Matrix calculation works out what proportion of actual historic TOC on TOC delays have been directly allocated to a responsible service group for each Victim/Perpetrator combination. If this proportion lies below a set threshold value, it uses a fall-back TOC-on-Self proportioning mechanism rather than the actual allocated proportions. Each perpetrating operator has had the opportunity to set the threshold at a value that suits them; several have made use of that opportunity.

- TOC Payment Rates

We calculated the TOC Payment rates using essentially the same methodology as in previous determinations, but using our own Responsibility Matrix as noted above. The source data for the calculations – delays and cancellations over the benchmark period – were taken from the Network Rail PSS system.

Since the level of TOC rates is very sensitive to the absolute amounts of Network Rail and TOC-on-TOC delay and cancellations, we carried out a number of sense-checking exercises to verify that the numbers of delay minutes and cancellation events corresponded to known industry sources such as IPPR and operators' performance systems such as Bugle.

These payment rates were delivered to ORR / NR on 24th October 2013.

- Verification and Checking

  We are conscious of the financial significance of the results of this work to Network Rail and TOCs and so have taken care to ensure that the results we produce are based on accurate data and correct calculations. Particular approaches we have used throughout the work are:

  - Verification of row counts and totals when loading raw data supplied by Network Rail to our database.
  - Extensive use of check totals and other logical checks at each stage of the data processing pipeline, including in each spreadsheet model.
  - Comparisons and benchmarking with other data sources to verify completeness and accuracy.
  - Use of spreadsheet design best practice to reduce the likelihood of inadvertent calculation errors.
  - Independent checking of spreadsheet logic and calculations.
  - A comprehensive internal audit on all formal deliverables.

- Stakeholder Consultation and Process Openness

  The results of the benchmark and TOC rate calculation process have to be robust, based on correct input data and comprehensible by the parties affected. To help ensure this, we have consulted with TOCs and ORR / Network Rail at all key parts of the process and have shared our calculation methods and spreadsheets. In particular, we have offered the opportunity to TOCs to engage with us at the following stages in the process:

  - At the time of the initial questionnaire in December 2012: we gathered information about the specific features of each operator that might have an impact on their benchmark calculation
  - When we calculated and shared the draft Benchmarks in May 2013. At this stage we explained how the benchmarks were calculated and made adjustments to the procedure for each operator to cover their specific circumstances
  - When we produced the prototype of the new Responsibility Matrix which covered a subset of operators (those responsible for creating or suffering between them the top 80% of the TOC on TOC delay) in July 2013
  - When we produced the draft TOC Payment Rates in September 2013. At this stage we produced several additional reports and a guidance note to help clarify the calculation and enable TOCs to understand the reasons for the differences, sometimes substantial, between the TOC rates we have calculated and the previous CP4 rates.

- Acknowledgements

Network Rail's Performance Reporting team, in particular Stephen Draper and Elliot Hind, have dealt patiently and promptly with all our requests for information and clarification. Stephen has been generous with his great experience in this area and given us useful guidance on many occasions.

ORR's Paul Hadley has supported our approach and given us important guidance on what is important and what is not.

ORR's Robert Mills and Network Rail's Joel Strange have encouraged and supported us in many different ways throughout the complex process; and helped us in interactions with the TOCs.

The results of our work are much more robust than they would have been because of the careful scrutiny given to them by all the TOC performance managers too numerous to mention, but especially by Robert Moss of First Capital Connect, George Thomas of First Transpennine and Martin Thornley of First Great Western.

- Conclusions and Suggestions

We have made some suggestions for improving the process based on our experience in carrying out this work. The main ones concern:

- Changes to content and method of delivery of data from Network Rail, to improve accuracy.
- Additional guidance from ORR to improve consistency of approach
- Refinements to the calculation of the Responsibility Matrix.

1.2 Process Overview

The work in Phase B formally has two distinct tasks: the calculation of benchmarks and the calculation of TOC payment rates. In terms of the work carried out, though, the derivation of the new Responsibility Matrix, part of the TOC payment rates task, represented a significant element of work on its own.

Figure 1 shows the overall process flow for the Phase B work.

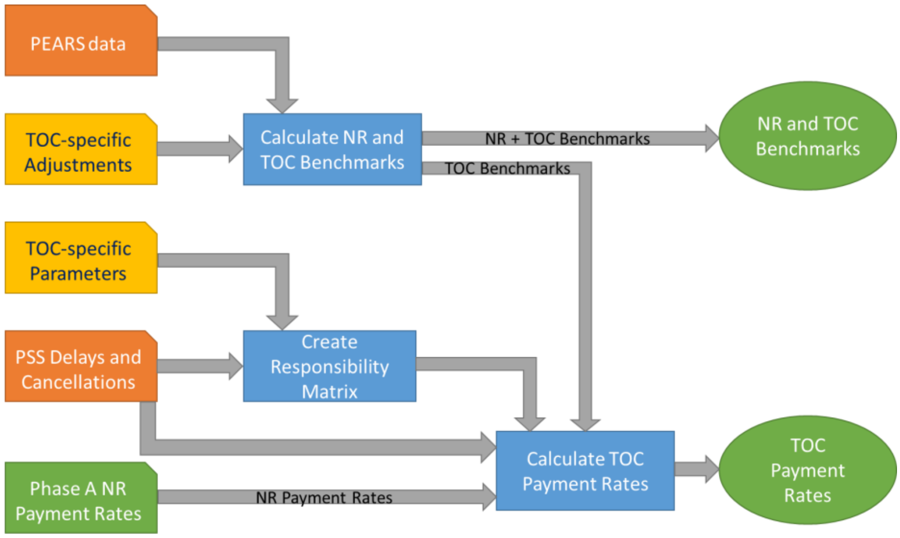


Figure 1 Phase B Overall Process Flow

PEARS data, in the form of reference data, daily totals of train calls and lateness at monitoring points and daily delay minutes by NR and TOC responsibility, are used to calculate Average Minute Late benchmarks for NR and TOC. The base figures are adjusted by TOC-specific factors to allow for date anomalies, berthing offset changes and delay responsibility arrangements.

Delays and cancellations data from PSS are used to calculate the Responsibility Matrix which assigns TOC-level TOC-on-TOC delays and cancellations to specific service groups within the causing TOC. The exact behaviour of the assignment process is configured by TOC-specific parameters. These do not change the overall allocation of delay or the financial penalty to be paid by the perpetrator; they simply fine-tune the service-group level responsibility within the causing TOC.

The outputs of the Responsibility Matrix are combined with total TOC on TOC delay and cancellations figures from PSS, the Network Rail payment rates for the victim service groups calculated in Phase A of this project and the TOC benchmarks for the causing service groups to calculate the TOC payment rates.

1.3 Prototyping Exercise

At the start of the project we carried out a prototyping exercise based around a short-term set of data (3 periods' worth) for a single TOC. The purpose of this was to trial our calculation process, work out a detailed methodology and give comfort to ORR and NR that we were able to understand and take account of all the different types of issue that we would be likely to encounter in a full-scale operation.

The prototype involved two main tasks:

- Replicating the calculation of Average Minutes Late and Schedule 8 payments carried out by PEARS using the same source data, to verify that we understood the calculation methodology. Part of this was assessing the amount of delay and cancellations where the responsibility between TOC and Network Rail was in dispute.

- Doing a parallel calculation of these quantities based on detailed train timings data sourced from the Network Rail's PSS performance data warehouse, to see how well we could match the PEARS results from this source. The advantage of using PSS is that the data are at a high enough level of detail to handle any likely scenario associated with movement of train services between service groups or operators.

We presented the results of this exercise in January 2013. The key findings were:

- We managed to replicate the PEARS calculation from its source data to within a very high order of precision (within rounding errors in the 6th decimal place)
- It was not possible readily to replicate the PEARS calculation with acceptable volumes of PSS data. In particular, timing point data for a very large number of locations would be necessary, not just the data for nominated monitoring points; and we had difficulty matching up the number of cancelled stops in PSS with PEARS.
- There has been relatively little adjustment of service groups and TOC boundaries in CP4 compared to CP3. Therefore a PEARS-based approach would not lead to significant inaccuracy.
- It was therefore decided, in discussion with experts at Network Rail, that the benchmarks would be calculated based on daily PEARS data rather than the raw PSS data as originally intended.
- There was no need to adopt any special handling of disputed responsibility for delay and cancellations, since the amount in dispute was very small.

2 Calculation of Network Rail and TOC Benchmarks

2.1 Introduction

For each Schedule 8 operator, we calculated a set of "benchmarks" reflecting the actual measured train performance over the benchmark period, from 1st April 2010 to 31st March 2012.

The performance levels are expressed in Average Minutes Late for Network Rail and the Operator, for each Schedule 8 Service Group, and, where so split, for Peak and Off-Peak trains.

The results calculated are more correctly styled "Measures of Historic Performance" since they do not actually represent the Schedule 8 Performance Minutes benchmarks to be applied in CP5. In particular, they may differ for any of these reasons:

- Network Rail may make an adjustment to allow for differences in actual performance or specific circumstances of the service group between 31st March 2012 and the start of CP5 on 1st April 2014;
- ORR may apply an adjustment to the benchmark to support its regulatory function of improving network performance
- The Operator and Network Rail may come to an arrangement of their own for Schedule 8.

2.2 Overview of the Calculation Method

The benchmarks have been calculated by replicating the PEARS daily AML calculation for every day of the benchmark period to arrive at an overall historic AML for each service group. The calculation is based on a combination of three input data sets:

- Static reference data from PEARS, which includes the service group definitions, service-group data such as Cancellation Minutes (the number of minutes delay deemed to be the equivalent of a cancellation) and monitoring data for each service group
- Daily data for each service group from PEARS, comprising stops made, stops missed and lateness minutes at each monitoring point; plus delay minutes and cancelled stops allocated to Network Rail and Operator responsibility
- TOC-specific adjustments which could apply to the reference data or to the daily data to correct for circumstances where the PEARS-only approach would be incorrect or out of date.

We have used a combination of database and spreadsheet technologies to carry out the calculation.

The database approach enables all the data for the determination to be loaded together and all the bulk data processing steps to be carried out using simple re-usable and auditable code. The database module – hosted on Microsoft SQL Server – is used to:

- accept the raw data from Network Rail PEARS

- apply data quality screens to remove inconsistent data
- apply consistent and legible naming of variables
- store and apply TOC-specific overrides to the raw data
- present the conditioned data to the spreadsheet module in a simple format
- calculate and present check totals and data consistency

Spreadsheets enable the key benchmark calculations to be done in a transparent way that can be widely verified and the results to be presented and distributed in a form readily used by recipients. The spreadsheet module – in Microsoft Excel 2003 – is used to:

- control the generation of benchmarks, iterating through TOCs and their service groups as required for any given run
- bring in the required data from the database module for a specified service group
- calculate the benchmark for that service group using a replica of the PEARS calculation method for each date in the benchmark period and consolidate over the entire benchmark period
- generate an output workbook for the service group showing the entire calculation
- generate a summary output sheet for the TOC showing all its service groups
- generate an overall summary workbook for NR/ORR with all TOCs' results on a single sheet.

As far as possible, the data processing pipeline is automated to maximise repeatability and productivity and reduce the likelihood of errors caused by manual data handling such as copying / pasting between data sources and targets.

The overall calculation mechanism is shown in Figure 2.

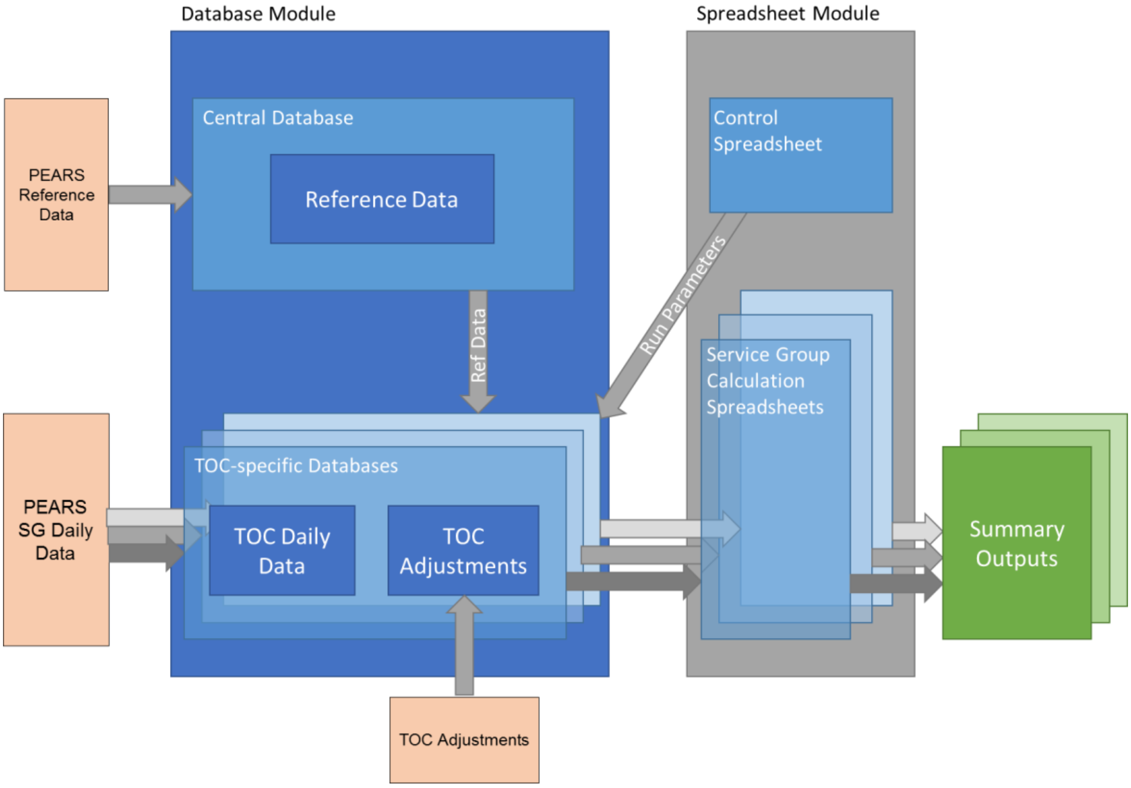


Figure 2 Benchmark Calculation - Overall Application Structure

The blocks of the benchmark calculation application are:

Database Module / Central Database. This holds the reference data for the whole process, mostly sourced from PEARS. We used an extract of PEARS reference data dated 17th July 2012 as supplied by Network Rail. Details of the data are given in section 2.3.

Database Module / TOC-Specific Databases. Each TOC has its own database, into which is loaded the daily PEARS data supplied by Network Rail for each of its service groups and monitoring points. Also in each TOC's database are the adjustments made for that TOC: these overlay the PEARS data as required. Details of the adjustments are given in section 2.4.

A set of standard SQL views joins up the daily data with the adjustments and the relevant reference data to create the outputs used by the Spreadsheet Module. The views are structured so that their results can be set to include the TOC-specific adjustments or exclude them, as required by the Spreadsheet Module.

There is one additional database in here which is for a test TOC: we used this to set up fake daily data for which we created expected results against which we could compare the actual output to verify that the calculations were correct.

Spreadsheet Module / Control Spreadsheet. This holds configuration data and details of the TOCs / service groups to be used in any specific run. For each such run, it is possible to define which of the different types of TOC adjustment are to be included. If all are excluded, the results are based on the raw PEARS data. This feature enabled us to identify the impacts of the various types of adjustment for each TOC to verify that these were reasonable.

Spreadsheet Module / Service Group Calculation Spreadsheets. The Control Spreadsheet creates a new spreadsheet for each service group during the run, based on a template, populating it with that service group's data queried from the SQL database by a set of data queries embedded in the spreadsheet. This means that every such spreadsheet is identical except for the data it contains, so we are confident that the same calculation is being applied to every service group. The structure of the calculation is described in Section 2.5.

From the detailed service group spreadsheets, summaries are built for each TOC and for the whole run.

2.3 Data Sources and Processing

Data for the benchmark calculation were supplied by Network Rail's Performance Team as extracts from the PEARS databases used to calculate Schedule 8 payments. Each extract came in the form of an MS-Access database.

- PEARS Reference data

Reference data was supplied in a single extract database from PEARS for all TOCs. Table 1 describes the data supplied.

Table 1 PEARS reference data tables

Table	Description
tblBusiness	1 row for each TOC
tblCapri	1 row for each CAPRI service code (usually 3 numeric digits but occasionally with a fourth character)
tblCapriCapriDirection	Pairs of STANOX location codes which define the Reverse direction of trains of each CAPRI code. If the train doesn't pass through any of these pairs in order, it is a Forward train.
tblCapriDMP1	Monitoring point locations for each CAPRI code and direction, with weightings for off-peak and, if applicable, peak trains.
tblCapriDMP2	STANOX codes of the monitoring point locations in tblCapriDMP1
tblCapriPeak	Time bands and locations of departure or arrival for each CAPRI code and day of week pattern which

Table	Description
	determine whether trains should be deemed Peak.
tblEventChangeChangeType	Not used
tblEventChangeEventTypeLookup	Not used
tblEventChangeStannox	Not used
tblServiceGroup	1 row for each Schedule 8 service group / Peak-Off-Peak combination. Specifies current Benchmarks, Payment Rates and Cancellation Minutes for the Service Group.
tblTOUHoliday	List of bank holidays appropriate to each Schedule 8 operator
tblTrainServiceCode	Train Service Codes (8-digit such as 24648001) belonging to each CAPRI Code.

- Other Reference Data

The following additional reference data tables were set up:

Table 2 Other Reference Data Tables

Table	Description
refCalendar	1 row for each calendar date of relevance. Contains a flag to indicate whether the date was inside the benchmark period or not.
refPeriods	1 row for industry period. Used to indicate the number of days in each period and to support translation between PSS and PEARS period codes which have different formats.

- PEARS daily data

Network Rail supplied us with an MS-Access extract from PEARS for each TOC, containing daily data for each date within the benchmark period; or for which data was to be used in calculating benchmarks. The data tables used from those supplied are listed in Table 3.

Table 3 PEARS Daily Data Tables

Table	Description
tbl_H_MP_Headers	1 row for each monitoring point in each service group, for each date in the benchmark period, showing the number of train stops, minutes lateness, cancelled stops due to Network Rail and TOC. This table is used to calculate the AML.
tbl_H_SGT_Headers	1 row for each service group for each date in the benchmark period, showing (among many other data items) the delay minutes allocated to Network Rail and TOC for that service group. This table is used to split the AML by Network Rail and TOC.

- Handling of data in dispute

All the PEARS daily data items appear twice in the tables – once with "TOC Bias" and once with "Railtrack Bias"[2]. The difference between them reflects the impact of minutes or other data items in dispute. Each set of data items shows what would happen if all such disputed items were allocated to the TOC or to Network Rail respectively.

In previous determinations, a process has been followed to correct for minutes in dispute by apportioning them between Network Rail and the TOC in proportion to a historic distribution of settlements, to come up with an expected final position.

In our prototyping exercise we investigated the extent of minutes in dispute and found there to be exceedingly few. This is largely because of the passage of sufficient time between the end of the benchmark period in March 2012 and the generation of the data extracts in January 2013. There are currently no known unresolved issues outstanding. We have therefore made no adjustment to our calculation for this reason. We have done all our calculations with the "Railtrack Bias" data items, which in nearly all cases are identical to the "TOC Bias" ones.

- Other data processing steps

The only other step taken during the data load process for PEARS data was to correct for a small number data items where there were inconsistencies between the quoted date of the data item and the quoted industry period. These inconsistencies occurred sometimes at the very end of a period. The correction we applied was to override the PEARS period with the period in which the quoted date fell according to our calendar table refCalendar.

[2] The PEARS database is a legacy system, so it refers to "Railtrack bias" in field headings. This in all cases is taken to mean "Network Rail Bias"

2.4 TOC-Specific Adjustments

A number of circumstances required the raw PEARS data for some service groups to be adjusted to take account of changes since the benchmark period or anomalies that occurred within it. Typical changes to be adjusted for were:

- Monitoring Point and Weighting changes. Each monitoring point for a service group and peak type has a weighting based on the number of passengers alighting at the monitoring point and, in some cases, the cost of delay to them. The sum of all weightings for each service group and peak type is 1. Operators in many cases had agreed with NR/ORR to change weightings or to add new monitoring points to match changes in passenger flows or timetables.
- Cancellation Minutes changes. Each service group has a Cancellation Minutes parameter which states how many minutes of delay a cancellation is deemed to be equivalent to. This is driven by service frequency, reflecting the length of time a passenger is effectively delayed till they can get the next train. Operators may agree with NR/ORR to change this value if service frequencies change.
- TRUST Berthing Offset changes. These have the effect of shifting the recorded arrival times for trains at particular monitoring points and so the minutes of lateness for late trains.
- Movement of groups of trains between service groups or between operators.
- Local arrangements for the allocation of responsibility for categories of delay and cancellation which shifted the proportions due to Network Rail and the Operator.
- Disruption during the benchmark period, such as due to blockades, causing the service pattern to change significantly for a period of time.
- Significant timetable change during or after the benchmark period, which meant that the benchmark calculation should be done over a different range dates than the standard one.

To enable suitable adjustments to be made for these causes, we created a set of override mechanisms and additional calculation steps. These are described in the sections below. The actual data used in the overrides for each service group are attached in Appendix F.

Each class of override could be switched on or off as required, under the control of the Spreadsheet Module described below. This allowed benchmark values to be calculated either including or excluding the override. This enabled the impact of overrides on the benchmarks to be determined. As part of the information supplied to operators, we carried out two runs – one with no overrides at all; and another with them all.

▪ Service Group Parameter Overrides

For each Service Group, we enabled overrides to the raw PEARS parameters to be defined. If an override were present, it would be used; if not, the value from the PEARS reference data extract would be used. The only relevant parameter which required overrides was Cancellation Minutes.

- Monitoring Point Weighting Overrides – existing MPs

  For each Service Group / Monitoring point, we enabled overrides to the PEARS data to be defined. Similarly to the Service Group Parameters, if an override value were present, it would be used; if not, the PEARS value would be used.

  This override mechanism only worked for existing monitoring points. Where new monitoring points were to be defined, we had to adopt the more radical approach described below.

- Addition of new Monitoring Points

  Where the operator wished to add a new monitoring point to a service group, we had to "construct" PEARS-like data for the new point since PEARS itself had no data for it. The data required were numbers of stops, minutes of lateness, number of cancellations due to Network Rail and number of cancellations due to the Operator.

  We used an extract of train timing data from PSS for the relevant train services and locations to do the calculation. The key elements of the calculation were:

  - The number of stops, which was taken directly from PSS timing data.
  - PSS-derived lateness data for the new monitoring point and adjacent existing ones used by the same trains was used to derive a "lateness ratio" – the proportion that the trains were more or less late at the new monitoring point than the existing ones. This ratio was then multiplied by the actual AML at the existing monitoring points to arrive at an assumed minutes late figure for the new monitoring point. This approach was used because PEARS / PSS differences meant a direct calculation of lateness minutes from PSS was unlikely to be sufficiently accurate.
  - The number of cancelled stops was taken to be the same as for its adjacent monitoring points (on the grounds that if a train missed one such point, it would likely miss the other as well).

- Berthing Offset changes

  Berthing offset changes have the effect of changing the average lateness of trains at the monitoring points. We modelled this by calculating a factor for each monitoring point based on the cumulative effect of all the offset changes for that location / service group, and multiplying the raw PEARS minutes lateness figure by that factor.

  Berthing offset change data were supplied to us by Alex Kenney of Network Rail, in the form of extracts from the "Ready Reckoner" used to calculate the financial impacts and required benchmark adjustments of the changes. Each offset change was represented in this data in the form Service Group / Location / Percentage Change.

Several offset changes could impact the same Service Group / Location. This is because several different adjustments could be made over time; or in some cases it is because of limitations within the Ready Reckoner which mean that for large stations with many platforms or berths, several different analyses must be done to cover all the possibilities. We have therefore had to come up with a method of combining the different impacts into a single lateness change percentage. The method had these steps:

1) Add 1 to each percentage change supplied by Ready Reckoner, so that it changed from, for example, +1.3% to a multiplier 1.013.
2) Take the natural logarithm of the multipliers: ln(1.013) -> 0.012916225
3) Sum the natural logarithms of all of the offsets for each service group / location. (This is equivalent of multiplying them together, but using this technique enables it to be done using a pivot table in MS-Excel, thus coping easily with any number of offset changes for a given service group / location). (e.g. 0.012916225 + 0.0009995 - 0.044997366 -> -0.03108164)
4) Take the exponent of the result: exp(-0.03108164) -> 0.969396428. This is the overall factor by which lateness will change based on all the offset changes.

The resulting lateness adjustment factor is applied to all monitoring points at that location for that service group. There may be several of these, since the same location may appear as a monitoring point for different CAPRI codes and directions.

The data supplied from the Ready Reckoner had some quality issues which we had to check for and correct. Specifically:

- Some invalid TOC / Service Group combinations were found
- Some locations had invalid names or did not correspond to known stations

We also found some issues with PEARS reference data when matching up the service groups / locations:

- Monitoring point locations have different names in different service groups, although they correspond to the same place.

Date Overrides

To adjust for blockades or to use a different date period to calculate the benchmarks, we created a Date Override mechanism which enabled any of the dates in the benchmark period optionally to use PEARS data for a different specified date. Typical applications of this mechanism were:

- For blockades, we overrode the dates of the blockade to use data from an equivalent date in the other benchmark year.
- For significant timetable changes, we overrode some or all of the benchmark period dates to use data from an equivalent different date within a range agreed with the operator.

The principles used to identify “equivalent dates” were:

- For normal service days, use data from the same day of the week and the same week of the industry year
- For bank holidays which fall on the same day of the week each year (e.g. Easter), use data from the equivalent day in an adjacent year
- For bank holidays which shift days of the week (e.g. Christmas, New Year), use data from days which have an equivalent relationship to the holiday (e.g. day before, day after).

As with the other overrides, the principle was that if an override had been defined for a date, it would be used; otherwise the raw PEARS data for that actual date would be used.

- Responsibility Adjustments

For any service group and date in the benchmark period, we set up a mechanism where the minutes of delay due to Network Rail and Operator or the number of cancelled stops ditto could be added to or subtracted from as required. This mechanism allowed potentially any change to minutes / cancellations and responsibilities to be made.

In practice, this mechanism was only used to cater for local arrangements, where responsibility for a number of minutes of delay per period were shifted from Network Rail to the Operator. In these cases we adjusted the daily minutes by the proportion of total periodic minutes implied by this responsibility shift, for the dates in each period in the benchmark date range.

- Shift of trains between operators or service groups

The movement of trains between service groups was handled by a combination of the override methods described above. In the event, only one such shift was necessary: that of the Oxford-Bicester services from First Great Western to Chiltern during the benchmark period. The data were set up to make it appear as though these services had been operated by Chiltern throughout the benchmark period. This required the following adjustments:

  - Creation of “fake” monitoring point train calls, latenesses and cancelled stops for the dates prior to the transfer. This was done by copying the PEARS data from the “old” monitoring points in their FGW service groups to the “new” ones in the Chiltern service groups.
  - Creation of “fake” service group delays for Chiltern for the dates prior to the transfer. This was done by taking the pattern of periodic delay observed on the service group after the transfer and applying it to dates prior. Care had to be taken because the small number of trains in the service group and the sporadic nature of delays meant that a daily average of periodic delay would not be appropriate. Delays were created for the same number of days in each period as in the original data.
  - Correction of service group delays for FGW for the dates prior to the transfer. The same delay as was added to Chiltern was subtracted from the appropriate FGW service group for

the days prior to the transfer. Care had to be taken to do this in a way that didn't result in any date having negative delay.

2.5 Benchmark Calculation: Spreadsheet Module

The benchmark calculation was undertaken in a spreadsheet model which used the processed data from the SQL database for the benchmark period. Section 2.2 and 2.3 above provide a full description of the steps we followed in processing the data, using our SQL database.

The overall structure of the benchmark recalibration model is based on 2 main components: a "control master" spreadsheet and an "SG calculation spreadsheet template". The control master spreadsheet allows users to choose multiple TOCs to be calculated in any specific run; and to set which of the override types should be enabled. It automatically loads the SG specific information for each selected TOC to the SG calculation spreadsheet template; returns the SGs benchmark results after calculation and saves the results as an individual TOC output spreadsheet. The name of the saved spreadsheet reflects the parameters used to do the run: it includes description and a set of four Y/N flags indicating whether each of the four adjustment types – service group overrides + monitoring point weighting changes / berthing offset changes / date overrides / responsibility changes – were switched on for the run.

The main purpose of setting up this branching type of model structure is to minimise the individual spreadsheet size and processing time and to make the process easier to communicate and to comprehend. The process is illustrated in Figure 3 below.

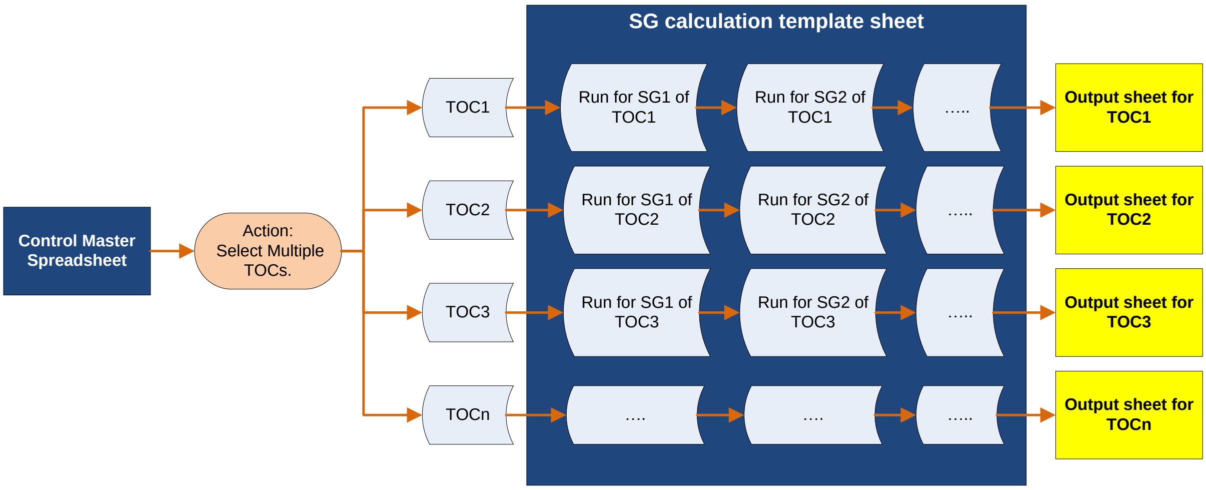


Figure 3 Benchmark Model Structure

The control master spreadsheet application talks to the SG template spreadsheet, collects and presents the results in a clear and organised format. The SG template spreadsheet carries out the whole calculation process based on the information given by the control master spreadsheet. It also sets options on whether the calculation should include TOC-specific overrides to the PEARS data or not.

The SG template can be further divided into three elements, in accordance with acknowledged spreadsheet design best practice. These are:

1) An input area, where the data inputs for the spreadsheet calculation are placed. The data are extracted from the database by ODBC queries of the SQL database views which can easily be refreshed according to the SG information given by the control master spreadsheet. At one time, the SG template spreadsheet only contains one SG's data. The types of input data used are listed below:

    i. SG information

    ii. Monitoring point weightings

    iii. NR delay minutes and TOC delay minutes by date

    iv. Recorded stops, total lateness minutes, NR cancellation minutes and TOC cancellation minutes by MP and date

    v. Current NR and TOC benchmarks, used just for comparison in the output

2) A calculation area, where the actual calculations are done. The model undertakes calculations of benchmarks based on the process set out in Figure 4 Service Group Specific Calculation below.

3) An output summary page which contains new calibrated NR and TOC benchmarks. The results will be automatically returned to the control master spreadsheet which will present all calculated results for a TOC and compare them with current figures in the chart.

The basic process followed by Halcrow to calculate the service group specific benchmark is shown in the diagram below.

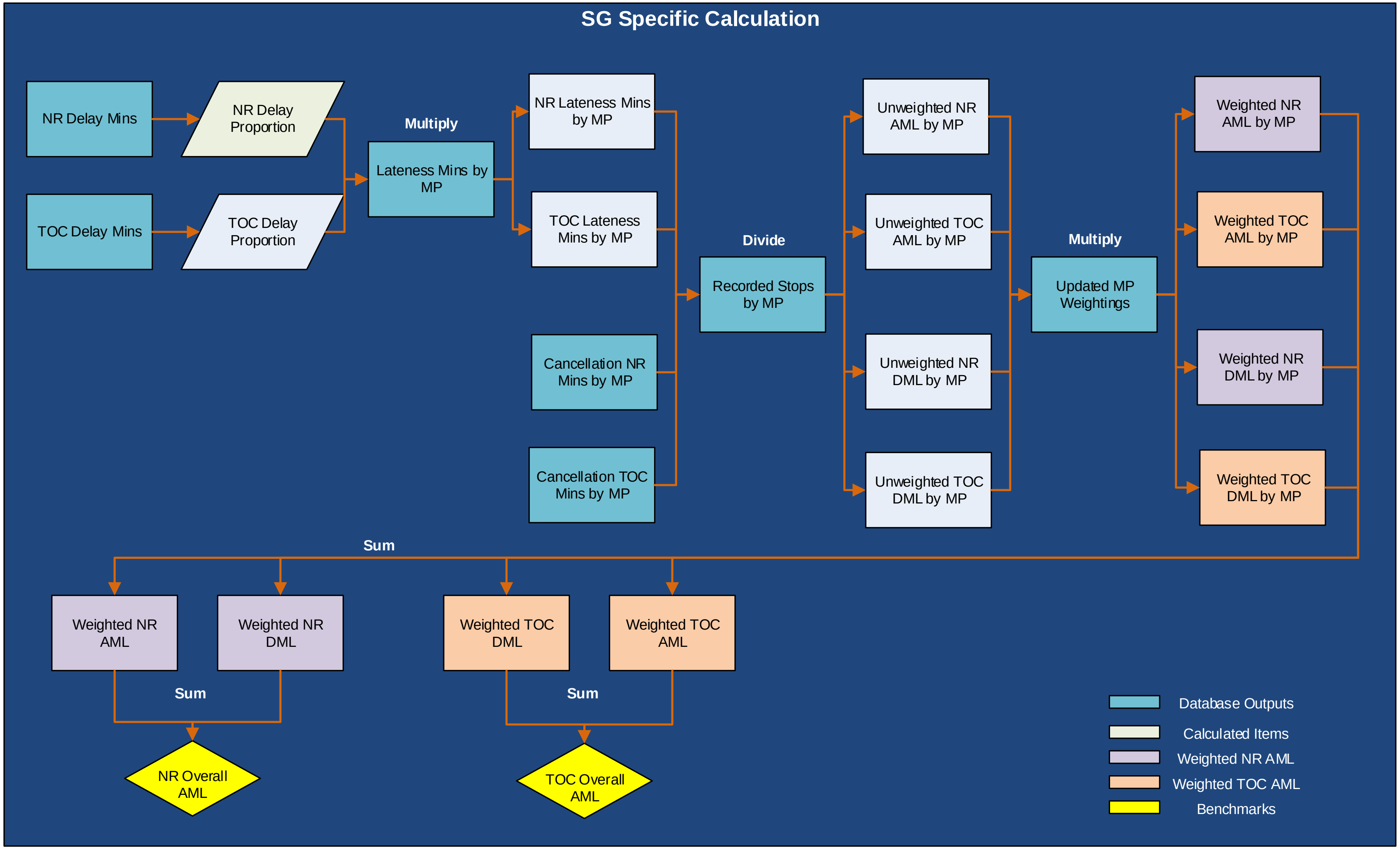


Figure 4 Service Group Specific Calculation

There are five steps in the overall SG level calculation process within the Excel spreadsheet model, described below:

Step 1: Calculate Historical NR/TOC Delay Proportion for each day

$$NR\ Delay\ Proportion_i = \frac{NR\ Delay\ Mins_i}{NR\ Delay\ Mins_i + TOC\ Delay\ Mins_i}$$

$$TOC\ Delay\ Proportion_i = \frac{TOC\ Delay\ Mins_i}{NR\ Delay\ Mins_i + TOC\ Delay\ Mins_i}$$

$$Where\ i \in \{1\ April\ 2010, \dots, 30\ March\ 2012\}$$

Step 2: Calculate actual NR/TOC lateness for each monitoring point for each day

$$NR\ Lateness\ Mins_{i,j} = Total\ Lateness\ Mins_{i,j} * NR\ Delay\ Proportion_i$$

$$TOC\ Lateness\ Mins_{i,j} = Total\ Lateness\ Mins_{i,j} * TOC\ Delay\ Proportion_i$$

$$Where\ i \in \{1\ April\ 2010, \dots, 30\ March\ 2012\}\ and\ \ j \in \{MP_1, \dots, MP_N\}$$

Step 3: Calculate unweighted NR/TOC AML/Deemed Minutes Late (DML) for each monitoring point

$$Unweighted\ NR\ AML_j = \frac{\sum_i NR\ Lateness\ Mins_{i,j}}{\sum_i Recorded\ Stops_{i,j}}$$

$$Unweighted\ TOC\ AML_j = \frac{\sum_i TOC\ Lateness\ Mins_{i,j}}{\sum_i Recorded\ Stops_{i,j}}$$

$$Unweighted\ NR\ DML_j = \frac{\sum_i NR\ Cancellation\ Mins_{i,j}}{\sum_i Recorded\ Stops_{i,j}}$$

$$Unweighted\ TOC\ DML_j = \frac{\sum_i TOC\ Cancellation\ Mins_{i,j}}{\sum_i Recorded\ Stops_{i,j}}$$

$$Where\ i \in \{1\ April\ 2010, \dots, 30\ March\ 2012\}\ and\ \ j \in \{MP_1, \dots, MP_N\}$$

Step 4: Calculate weighted NR/TOC AML/DML for each monitoring point

$$Weighted\ NR\ AML_j = Unweighted\ NR\ AML_j * MP\ Weightings_j$$

$$Weighted\ TOC\ AML_j = Unweighted\ TOC\ AML_j * MP\ Weightings_j$$

$$Weighted\ NR\ DML_j = Unweighted\ NR\ DML_j * MP\ Weightings_j$$

$$Weighted\ TOC\ DML_j = Unweighted\ TOC\ DML_j * MP\ Weightings_j$$

$$Where\ j \in \{MP_1, \dots, MP_N\}$$

Step 5: Calculate the performance minutes benchmarks

$$NR\ Benchmark = \sum_j Weighted\ NR\ AML_j + \sum_j Weighted\ NR\ DML_j$$

$$TOC\ Benchmark = \sum_j Weighted\ TOC\ AML_j + \sum_j Weighted\ TOC\ DML_j$$

$$Where\ j \in \{MP_1, \ldots, MP_N\}$$

2.6 Presentation and Consultation

The results of the benchmarking exercise, in the form of recalculated TOC and NR performance benchmarks by service group, are summarised for each TOC in the presentation spreadsheet.

Figure 5 below shows the summary presentation format which was used to present the benchmark results to TOCs for validation meetings. In addition to the calculated benchmarks for each service group, the presentation also shows the variance from the current figures. Please note that the data shown in the figures below are random numbers and not relevant to the real performance data for any TOC.

Figure 5 Summary Presentation Example

Schedule 8 Recalibration

Operator: **Train Operator 1**

Benchmarks

	Network Rail Average Minutes Late			**Operator** Average Minutes Late		
Service Group	Current Benchmark AML	Calculated Historic Performance AML	Variance %	Current Benchmark AML	Calculated Historic Performance AML	Variance %
SG01 Off-Peak	0.701	0.685	*-2.3%*	0.556	0.365	*-34.4%*
SG01 Peak	0.550	0.501	*-8.9%*	0.322	0.315	*-2.2%*
SG02 All Trains	0.902	0.885	*-1.9%*	0.447	0.398	*-11.0%*
SG03 Off-Peak	0.330	0.378	*14.5%*	0.204	0.178	*-12.7%*
SG03 Peak	0.215	0.334	*55.3%*	0.132	0.141	*6.8%*

For each service group, the detailed presentation shows, for NR and TOC responsibility, the performance numbers used for the benchmark period and the resulting benchmark, with the existing benchmark for comparison.

Figure 6 and 7 below show how these figures are presented in graphical form.

Figure 6 Graph Presentation - NR AML

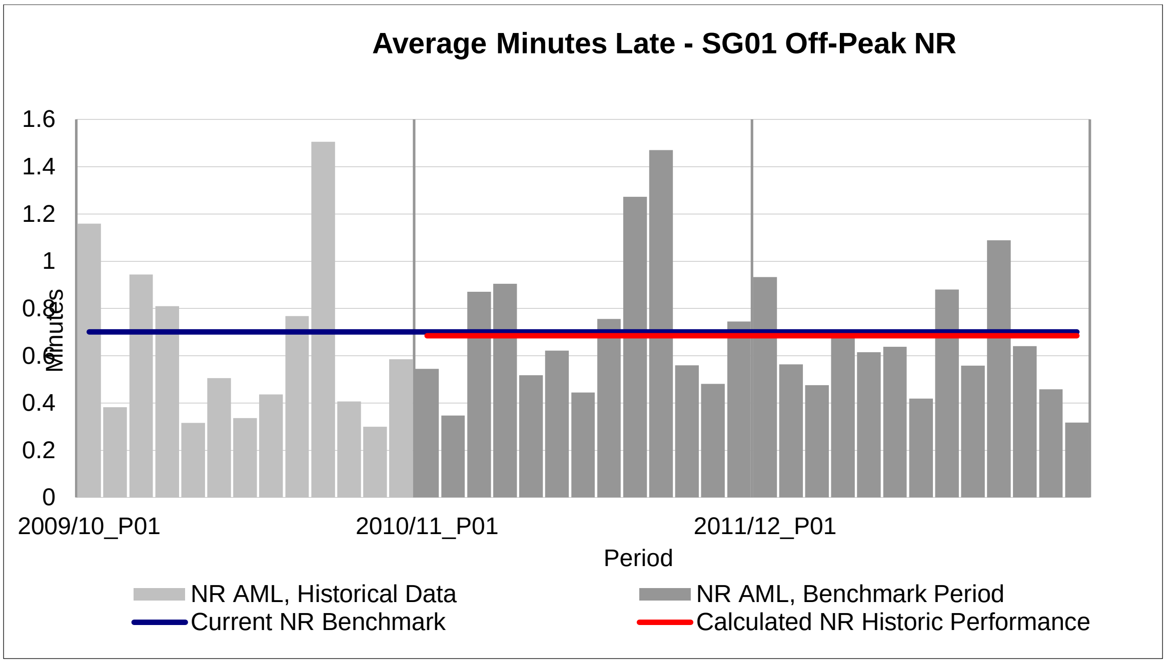
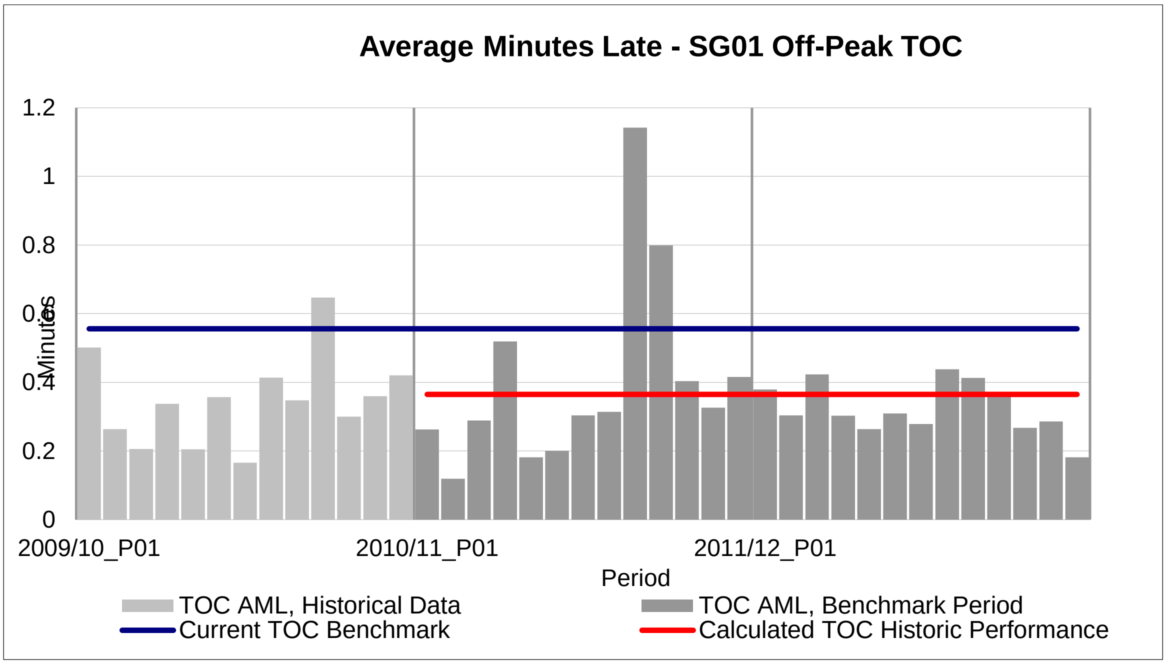


Figure 7 Graph Presentation - TOC AML



We provided each TOC – and ORR - with the detailed outputs shown above from our benchmark analysis and carried out a full set of benchmark validation conference calls with TOCs who were willing to engage in the process. We also disclosed summary benchmarks estimates by service group to NR. Detailed notes of validation meetings have been provided to ORR.

2.7 Quality Assurance

- Database Processing Quality Assurance:

  The database process QA for the benchmark process focussed on ensuring that all required data were present and were being passed right through the processing pipeline. Particular checks done were:

  - Row counts and check totals against raw data sources. Row counts and totals were recorded for each Access database provided by Network Rail; these were checked against totals as loaded to the SQL Server database; and again against totals of the output views passed to the spreadsheet module. Row counts were also taken for the berthing offset data; and verified in the individual TOC databases, for the TOC-specific overrides. Additionally,
  - Consistency checks –specifically, that all monitoring point weightings summed to 1 for their service groups
  - Sanity checks against other data sources – such as delay minutes versus published figures from IPPR – to verify that there were no gross data loading errors.

- Spreadsheet Modelling Quality Assurance:

  We have conducted a comprehensive internal audit of the calculations in the models to make ensure that they have been undertaken correctly and any assumptions made are reasonable.

  The control master spreadsheet contains a self-check totals analysis. It checks the consistency between the data extracted in the database and the data actually used in the calculation process to ensure that there is no data lost or duplicated in the spreadsheet modelling.

- Independent Check:

  During the validation meetings with TOCs, we discussed our findings and obtained clarification or additional information where we had identified either anomalous data or counter-intuitive results. These meetings therefore served as an important sense check to our work.

  We have submitted the calculation spreadsheet to ORR and Network Rail for verification of the algorithm used and the correctness of the calculations.

3 Calculation of TOC Payment Rates

3.1 Introduction

The TOC Payment Rate is calculated for each service group based on the cost of the delay or cancellations it causes to other operators' service groups. The cost of these is initially borne by Network Rail; if correctly calibrated, the calculation should result in this cost being recovered from the causing operators.

The calculation is based on several inputs, which we have processed using a hybrid Database / Spreadsheet application similar to that used for the benchmark calculation, with the same essential rationale: the database is excellent for handling large volumes of data and doing standard data-orientated processing tasks on them; the spreadsheet's strengths are in the presentation of the data and the ease with which the calculations and results can be circulated and verified by others.

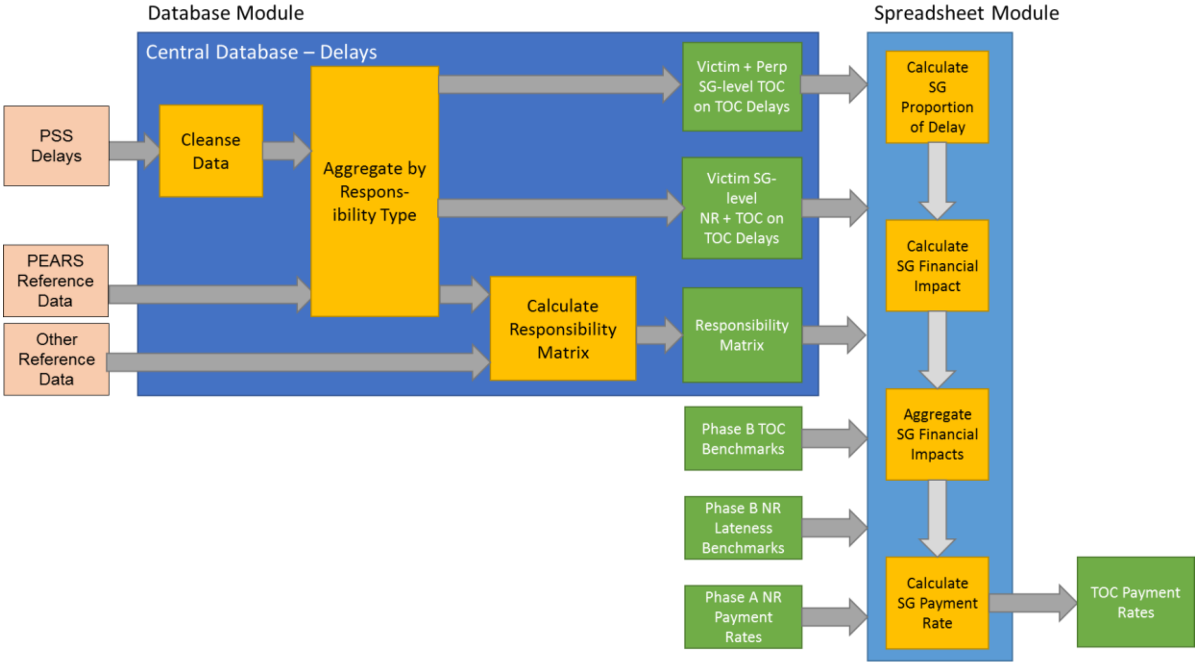


Figure 8 TOC Payment Rate Calculation - Overview

An overview of the whole calculation process is shown in Figure 8. This figure shows the inputs and processing steps for Delays. There is a similar process for Cancellations, not shown for brevity.

The main inputs are:

- Delays to trains, from PSS
- Cancelled trains, from PSS
- Network Rail payment rates, from Phase A of this study
- The Lateness and Deemed components of NR benchmarks, from this Phase
- TOC benchmarks, from this Phase.

The steps in the calculation are described in the following sections. The database-based data handling steps are described in Section

3.2; the calculation of the Responsibility Matrix in Section 0; and the calculation of TOC Payment Rates in the spreadsheet module in Section 3.4

3.2 Data Sources and Processing: Database Module

- Data Sources

PSS Delays. Network Rail provided an extract from PSS comprising all TRUST delay records for the benchmark period for trains belonging to operators for which a payment regime is in place: Schedule 8 operators, plus freight and charter operators. This comprised a total of 6.3 million delay records representing 36.6 million minutes of delay.

The key data items present in the extract and used in the analysis are listed in Table 4.

Table 4 PSS Delays Extract - Data Items

Data Item	Description
FinancialYearPeriod	Period within which Delay occurs. Used to filter data to that within the benchmark period; and to group data for comparison with other data sources such as IPPR
EnglishDayType	Weekday / Saturday / Sunday / Bank Holiday
AttributionStatus	Agreed / Disputed / Merged. We used only Agreed items in the calculation
ResponsibleOrganisation	2-char code of the operator / entity responsible for the incident causing the delay. Used to identify the perpetrator
ResponsibleOrgNR-TOC-FOC-Other	TOC/FOC/Network Rail/Others. Used to identify Network Rail delay rather than operator delay
StartStanox	Location of Delay. Potentially useful to restrict interactions between service groups but not actually used in the analysis
EndStanox	Second location of Delay (where it occurred between two places rather than at one). Potentially useful to restrict interactions between service groups but not actually used in the analysis

Data Item	Description
Operator-Affected	Victim operator
ServiceGroupCode-Affected	Victim service group code
ServiceGroupType-Affected	Victim service group type: PEAK, OFF-PEAK or ALL TRAINS
TSC-Affected	8-char train service code of the Victim train. Potentially useful for restricting interactions between service groups but not actually used in the analysis.
ApplicableTimetableFlag-Affected	Y or N: is the train one of interest to the Schedule 8 regime. Used to filter delays to only those recognised by Schedule 8.
Operator-Resp	Owning operator of the Responsible Train, where populated. If this is the same as ResponsibleOrganisation, the delay was considered to have been Allocated and so used in the Responsibility Matrix.
ServiceGroupCode-Resp	Service Group of the Responsible Train, where populated. Used in the calculation of the Responsibility Matrix
PfPIMinutes	Minutes of Delay.

The extract was presented as a set of Comma Separated Values (CSV) files, one for each victim operator or, in some cases, grouped set of operators such as Freights or Charters.

PSS Cancellations. Similarly to Delays, Network Rail provided a PSS extract in CSV format of all recorded cancellations during the benchmark period for operators for whom there was a payment regime in place. This comprised a total of 576,000 cancellation events.

As well as the data items listed above for Delays, the Cancellations extract also contained some additional items. These are listed in Table 5 below.

Table 5 PSS Cancellations Extract – Additional Data Items

Data Item	Description
EventCount	Number of cancellation events associated with the train. (Nearly always 1; a very small number of trains have 2)
PlannedOriginLocationCode-Affected	Planned origin of the train. Used to determine the type of cancellation
PlannedDestLocationCode-Affected	Planned destination of the train. Used to determine the type of cancellation
ActualOriginLocationCode-Affected	Actual origin of the train. Used to determine the type of cancellation.
ActualDestLocationCode-Affected	Actual destination of the train. Used to determine the type of cancellation.

Reference Data. The main reference data used in the calculation are the list of PEARS service groups and service group types tblServiceGroup (see Table 1). Other reference data used were:

- A list of Operators refOperators containing all the operator codes found in the Delays and Cancellations data, with flags indicating for each one whether it was a Schedule 8 operator, a Freight or Charter operator, a code representing Network Rail or an Other operator. This is a superset of the contents of the PEARS reference table tblBusinesses which only contains Schedule 8 operators.
- A list of Service Group Type Overrides, indicating for some service groups where the PEARS data did not identify that the service group contained only Peak or only Off-Peak trains. (This applies to some operators who have set up service groups whose name indicates that they only contain Peak or Off-Peak trains, but the PEARS service group type indicates "All Trains").
- The Calendar table refCalendar used in the Benchmark calculation which indicates the dates included in the benchmark period.

Processing Steps

Data Cleansing. The data supplied by Network Rail from PSS are generally of very good quality. Some minor adjustments were made to the data to condition it for the TOC Payment Rate calculation. These were:

- Filter out dates outside the Benchmark period

- Filter out delays / cancellations caused to operators with no financial regime
- Filter out trains where the Applicable Timetable flag = N
- Filter out non-standard dates (Bank Holidays and other dates such as Christmas)
- Filter out delays or cancellations which occurred on non-Network Rail infrastructure. (This was done using a list of delay locations which were known not to be on Network Rail track. A more productive approach would have been to have included the Infrastructure Manager data item in the Delays and Cancellations data set, which could have been filtered to include only Network Rail: this is suggested for future calculations)
- Map incorrect operators or service groups to the correct ones. (This was done to correct for incoming data issues, of which there were just two: 1 – service group EE01 for Heathrow Connect was shown as belonging to operator EF rather than EE; 2 – service groups HU06 and HU07 were swapped in PSS, such that HU06 which was supposed to contain Peak trains actually contained Off-Peak ones and HU07 vice versa)

Calculation of Effective Cancellation Events. For the Cancellations data, we scaled the Cancellation Events to take account of partial cancellations. The scaling used is the same as that done in prior determinations, based on an estimate of the proportion of monitoring point stops likely to be missed by trains with different types of partial or full cancellation.

Firstly, the actual train origin and actual train destination locations were compared with the planned locations to determine whether the train was fully or partially cancelled; and, if partial, what type of partial cancellation it was. The logic used was:

- If both Actual Origin and Actual Destination locations are NULL, the train did not run at all and is considered a Full Cancellation; else
- If the Actual Destination differs from the Planned Destination, the train is Partially Cancelled and has a Missed Destination; else
- If the Actual Origin differs from the Planned Origin but the Actual Destination is the same as the Planned Destination, the train is Partially Cancelled and has a Missed Origin.

Secondly, the Event Count was multiplied by a scaling factor as shown below:

Type of Cancellation	Scaling Factor
Full Cancellation	1.00
Partial / Missed Destination	0.45
Partial / Missed Origin	0.15

Aggregation by Responsibility Type. The individual delay records were grouped and summed to provide the benchmark period delay totals used in the spreadsheet module and in the calculation of the Responsibility Matrix.

The **Responsibility Type** of each delay (TOC-on-Self / TOC-on-TOC / Network Rail) was determined based on the data items ResponsibleOrgNR-TOC-FOC-Other, ResponsibleOrganisation and Operator-Affected with this logic:

If ResponsibleOrgNR-TOC-FOC-Other ='TOC' or 'FOC'

And ResponsibleOrganisation = Operator-Affected

Then ResponsibilityType = 'TOC on Self'

Else If ResponsibleOrgNR-TOC-FOC-Other ='TOC' or 'FOC'

And ResponsibleOrganisation <> Operator-Affected

Then ResponsibilityType = 'TOC on TOC'

Else ResponsibilityType = 'Network Rail'

For TOC on TOC delays and cancellations, an **IsAllocated** flag was calculated to indicate whether it could be attributed to a specific causing service group. The delays and cancellations for which this is true are used in the Responsibility Matrix calculation. This flag is set to True with the following logic:

If Operator-Resp = ResponsibleOrganisation

And (ServiceGroup-Resp is a Schedule 8 Service Group)

Then IsAllocated = True

Else IsAllocated = False

Having calculated these additional data items, the following summaries are calculated:

Summary	**Note**
Total TOC on TOC delays for each Victim Service Group and SG Type / Causing TOC by Day Pattern	TOC on TOC delay/cancellations for which financial penalty is to be calculated
Total Network Rail + TOC on TOC delays / cancellations for each Victim Service Group and SG Type by Day Pattern	Total Victim SG delay/cancellations. Used in calculation of financial penalty
Total Allocated TOC on TOC delays / cancellations for each Victim Service Group SG Type / Causing Service Group by Day Pattern	Used in Responsibility Matrix calculation

Summary	Note
Total TOC on Self delays / cancellations by Service Group / SG Type by Day Pattern	Used in Responsibility Matrix calculation

- Data verification and checking

The TOC payment rate calculation is sensitive to the absolute levels of TOC on TOC and Network Rail delay and cancellations, as well as to the other factors involved. It is thus important to be confident that the totals of delay and cancellation are plausible and justifiable.

To verify this, we benchmarked the data used in our calculation against other data sources.

For **Delays**, we carried out two sense checks:

- We compared the total level of Network Rail and TOC on TOC as Perpetrator (TOTP) delay minutes with the published delay minutes statistics from the IPPR reports for the same periods. Agreement was very good – in most cases being within 1%; and for no service group being more than 3% out. (The output we issued to operators containing their TOC payment rates also included the reconciliation of the delay minutes they had inflicted on other operators to the IPPR TOTP figures)
- We compared the total of Network Rail and TOC on TOC delay for each operator with the PEARS figures for each service group, as used in the benchmark calculation. Again, agreement was good.

For **Cancellations**, there is no equivalent to IPPR against which we could benchmark the figures. However, we carried out an item-by-item check against one operator's own cancellations as Victim data for the whole benchmark period, taken from their Bugle system. After correcting for Failed To Stop cancellations which do not appear in the PSS cancellations stream, we got agreement to within 10% in the key ratio TOT / (NR+TOT) which determines the overall level of financial penalty. Given that the number of TOC on TOC cancellations is overall very low and represents a small proportion of the total financial impact of TOC on TOC interactions, we concluded that this was acceptable.

3.3 The Responsibility Matrix

- Definition of the Responsibility Matrix

The Responsibility Matrix is used in the Payment Rate calculation to distribute the financial impact incurred by a causing TOC to the correct service groups within that TOC.

It should be pointed out that it does not influence the overall level of a causing TOC's financial liability for delays / cancellations it causes – only the service groups and service group types (Peak / Off-Peak / All Trains) within that causing TOC which pick up that penalty.

Though described as a single matrix, in fact it is a large number of matrices. There are separate matrices for Delays and Cancellations, for each of the three Day Types Weekday / Saturday / Sunday; and the matrix is built separately for each Victim Service Group / Type (of which there are 170) for each Causing Schedule 8 Operator (of which there are 25): a total of 25,500.

Each of these small matrices is therefore defined for a single Victim Service Group / Type, Causing Operator and Day Type, for both Delays and Cancellations. It consists of a list of the Service Groups and SG Types within the Causing Operator, indicating for each the proportion of the delays or cancellations suffered by the Victim SG / SG Type which belong to that Causing Service Group / SG Type. The proportions must always sum to exactly 1.

The volume of data involved, the complexity of the calculations and the need for copious checks of the correctness and consistency of the calculation suggest strongly the use of a database approach to calculate the matrix: this is what we used. A single copy of the full matrix comprises 147,666 data items; and 10 distinct runs of the matrix were done during its development and fine-tuning.

- New method of calculating the matrices

In previous determinations of the TOC Payment Rates, the Responsibility Matrix was based on theoretical relative levels of interoperability between specific victim and causing service groups, calculated on the basis of shared track and route mileages and location usage. The figures to calculate these interoperation coefficients were sourced from the ACTRAFF traffic recording system. At the time of the last determination this was the best data available and so this provided a method of calculating the responsibility matrix which has a justifiable basis in operational reality, however it had three specific drawbacks:

1. It did not reflect actual interactions between service groups.
2. It did not directly cater for indirect impacts between service groups which did not share any track: these had to be calculated using a fallback system based on TOC-on-Self delay proportions.
3. It was based on the ACTRAFF network model, which deviates somewhat from the actual network.

Since the last determination, the quality of recorded performance data has improved considerably: the presence of new IT systems such as PSS have made data easily available in much better detail and with more accurate metadata; and the focus on accuracy of delay attribution in recent years has meant that in many cases it is possible to identify the exact service group and/or train responsible for operator-caused incidents. This opened up the possibility of building the Responsibility Matrix based on actual observed interactions between service groups rather than an assumed one. We decided to adopt this approach and received the backing of the Schedule 8 Working Group for it in March and April 2013 on the basis that it would be straightforward to calculate and would automatically tend to improve in accuracy as the quality of delay attribution improved yet further.

- Level of Allocation

Before committing completely to using this new approach to building the Responsibility Matrix, we considered it wise to do a smaller-scale trial with selected TOCs, investigating along the way how much of the TOC-on-TOC delay and cancellation was allocated to causing service groups and therefore how likely a matrix built this way was to be accurate.

For all the Schedule 8 operators, we calculated the total TOC on TOC delay they caused and the proportion of it that had been allocated to a specific service group. The intention was to verify that there was enough allocated delay to make the new approach viable.

Table 6 Proportions of TOT Delay Allocated

	Minutes of TOC delay			
Perpetrating TOC	**Unallocated**	**Allocated**	**Total**	**Percentage Allocated**
ED	65,223	150,232	215,455	69.7%
HB	47,922	116,428	164,350	70.8%
EF	45,885	95,362	141,247	67.5%
HF	37,307	87,939	125,246	70.2%
EH	37,411	79,212	116,622	67.9%
EJ	29,344	84,827	114,171	74.3%
HW	15,752	83,682	99,434	84.2%
EG	34,283	55,866	90,149	62.0%
EA	19,867	54,944	74,810	73.4%
HL	20,406	43,999	64,405	68.3%
EM	12,898	38,738	51,636	75.0%
HU	14,238	27,548	41,786	65.9%
HA	13,463	25,035	38,498	65.0%
HY	9,976	21,719	31,695	68.5%
HO	13,057	14,022	27,078	51.8%
EK	7,139	11,628	18,766	62.0%
EC	4,759	11,984	16,743	71.6%
PF	10,457	4,562	15,019	30.4%
EB	6,967	6,939	13,906	49.9%
HM	6,328	3,645	9,973	36.6%
GA	5,331	2,339	7,670	30.5%
PG	599	2,484	3,083	80.6%
EE	1,628	601	2,229	27.0%
HE	711	762	1,473	51.7%
HT	210	501	711	70.5%
Total	461,155	1,024,993	1,486,149	69.0%

Table 6 shows the results of that initial exercise. It shows that overall, 69% of TOC on TOC delay is allocated to a specific train or service group; and for none of the top 14 TOCs was the level less than 60%. This was considered to be sufficient for the allocated proportions to be representative of all TOC on TOC delay and thus a sound basis for new Responsibility Matrix.

- Allocation Threshold Parameter

As a result of this investigation, we introduced a parameter into the calculation: the Allocation Threshold. This applied for each Victim Service Group / SG Type / Causing TOC combination. If, for that combination, the proportion of delay (or cancellations) allocated to specific Causing Service Groups was above the threshold, the allocation would be used as the basis of the responsibility matrix; if it was below, the matrix would use proportions based on TOC-on-Self delay instead. This was intended to provide a fallback allocation mechanism if the allocated delay was not deemed to be representative of what would actually happen.

We set a default value for the threshold of 50%, though the perpetrating operators were given the opportunity to set the threshold at any level they liked.

With any setting of the threshold, we were able to calculate what proportion of each operator's TOC on TOC delay was being allocated using actual allocations and, conversely, what remaining proportion was being allocated by the fallback TOC on Self method. At the default level of 50%, in nearly all cases over 80% of delays were being allocated based on actual allocations.

- Pilot Calculation

We carried out a pilot calculation of the Responsibility Matrix, using just Delays on Weekdays for the top 13 TOCs in the list above, with the Allocation Threshold set to its default 50%. We circulated the results round the TOCs and consulted with them on the plausibility and accuracy of the results generated.

As a result of the pilot, three improvements were made to the calculation:

1) The method of handling Peak / Off-Peak splits was improved to cope with "All Trains" service groups that actually contained only Peak or only Off-Peak trains
2) The method was upgraded to recognise correctly whether the Causing TOC had peak services for any of its service groups on the Day Type in question.
3) The Allocation Threshold was lowered for some operators to 40% or 30% at their request. Reductions of this nature had the effect of raising the proportion of TOC on TOC delay allocated based on actual allocations to over 95%. The operators concerned took the view that any allocation, even at a low level of coverage, was likely to be more accurate than a TOC-on-Self split.

- Full Calculation

  The results of the Pilot Calculation were thought by all operators consulted to be sufficiently robust to allow a full calculation to be done using the same mechanism. This calculation covered all Day Types, all operators and included both Delays and Cancellations.

  The steps of the calculation used can be found in Appendix D.

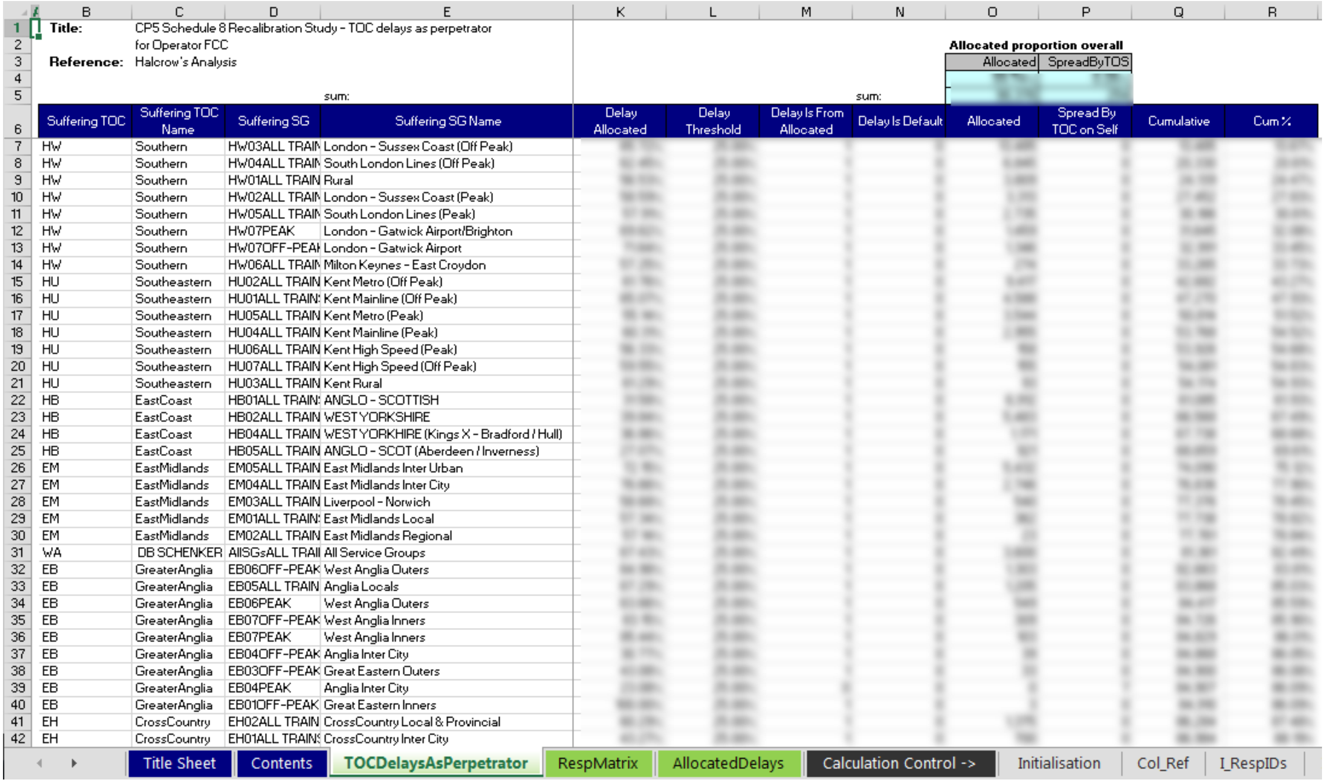
- Presentation of Responsibility Matrix Results

  Since the method of generating the Responsibility Matrix is new, we took the view that it was important to give operators as much information as possible about the working of the Matrix and the impact it would have on the allocation of delay minutes and cancellations.

  We therefore prepared a presentation spreadsheet showing aspects of the Responsibility Matrix. This was circulated to the 13 operators who took part in the pilot study, plus to ORR and to any other operator who requested a copy.

  The spreadsheet contained the following sheets:

TOCDelaysAsPerpetrator	For the selected Operator, a list of all its Victim Service Groups indicating total TOC on TOC delays inflicted on each, the proportion of these allocated to a specific causing service group, plus the overall proportion allocated using direct vs TOC on Self allocation methods. See example in Figure 9.
RespMatrix	The Delays responsibility matrix for the selected Operator, listing all the Victim Service Groups and, for each, the distribution of delays to each of the causing Service Group / SG Types. See example in Figure 10.
AllocatedDelays	The total delay minutes allocated to each Service Group / Type from each Victim Service Group – i.e. the result of applying the RespMatrix sheet proportions to the overall delay minutes in the TOCDelaysAsPerpetrator sheet. The results in here agree with the totals listed in the final TOC Payment Rate presentation workbook for the Operator. See example in Figure 11.



Title: CP5 Schedule 8 Recalibration Study - TOC delays as perpetrator for Operator FCC

Reference: Halcrow's Analysis

Suffering TOC	Suffering TOC Name	Suffering SG	Suffering SG Name	Delay Allocated	Delay Threshold	Delay Is From Allocated	Delay Is Default	Allocated	Spread By TOC on Self	Cumulative	Cum %
HW	Southern	HW03ALL TRAIN	London - Sussex Coast (Off Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW04ALL TRAIN	South London Lines (Off Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW01ALL TRAIN	Rural	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW02ALL TRAIN	London - Sussex Coast (Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW05ALL TRAIN	South London Lines (Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW07PEAK	London - Gatwick Airport/Brighton	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW07OFF-PEAK	London - Gatwick Airport	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HW	Southern	HW06ALL TRAIN	Milton Keynes - East Croydon	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU02ALL TRAIN	Kent Metro (Off Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU01ALL TRAIN	Kent Mainline (Off Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU05ALL TRAIN	Kent Metro (Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU04ALL TRAIN	Kent Mainline (Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU06ALL TRAIN	Kent High Speed (Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU07ALL TRAIN	Kent High Speed (Off Peak)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HU	Southeastern	HU03ALL TRAIN	Kent Rural	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HB	EastCoast	HB01ALL TRAIN	ANGLO - SCOTTISH	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HB	EastCoast	HB02ALL TRAIN	WEST YORKSHIRE	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HB	EastCoast	HB04ALL TRAIN	WEST YORKHIRE (Kings X - Bradford / Hull)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HB	EastCoast	HB05ALL TRAIN	ANGLO - SCOT (Aberdeen / Inverness)	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EM	EastMidlands	EM05ALL TRAIN	East Midlands Inter Urban	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EM	EastMidlands	EM04ALL TRAIN	East Midlands Inter City	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EM	EastMidlands	EM03ALL TRAIN	Liverpool - Norwich	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EM	EastMidlands	EM01ALL TRAIN	East Midlands Local	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EM	EastMidlands	EM02ALL TRAIN	East Midlands Regional	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WA	DB SCHENKER	AllSGsALL TRAI	All Service Groups	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB06OFF-PEAK	West Anglia Outers	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB05ALL TRAIN	Anglia Locals	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB06PEAK	West Anglia Outers	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB07OFF-PEAK	West Anglia Inners	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB07PEAK	West Anglia Inners	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB04OFF-PEAK	Anglia Inter City	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB03OFF-PEAK	Great Eastern Outers	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB04PEAK	Anglia Inter City	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EB	GreaterAnglia	EB01OFF-PEAK	Great Eastern Inners	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EH	CrossCountry	EH02ALL TRAIN	CrossCountry Local & Provincial	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
EH	CrossCountry	EH01ALL TRAIN	CrossCountry Inter City	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 9 Sample TOCDelaysAsPerpetrator sheet

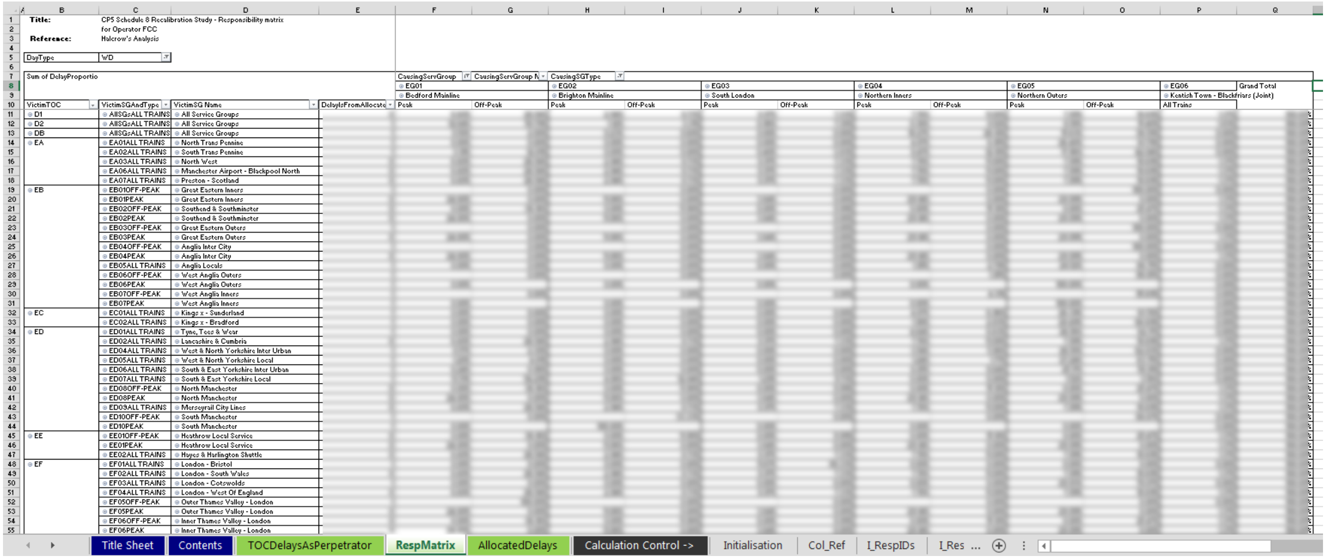
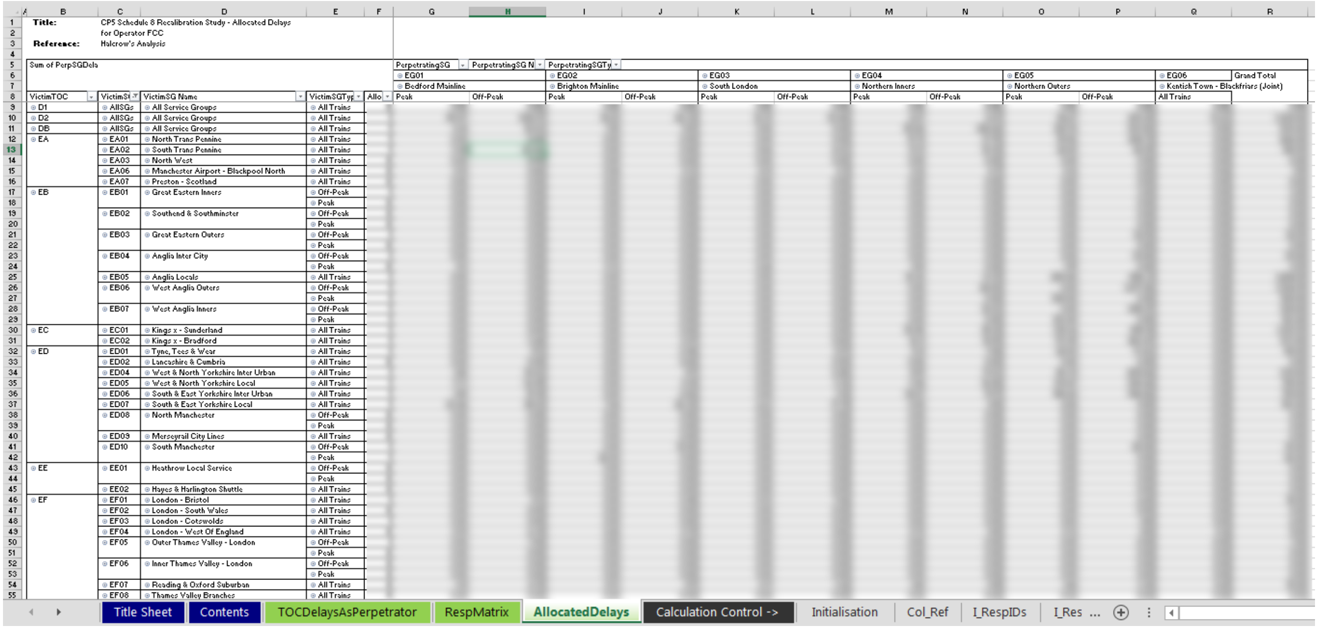


Figure 10 Sample RespMatrix sheet



Title: CP5 Schedule 8 Recalibration Study - Allocated Delays for Operator FCC

Reference: Halcrow's Analysis

Sum of PerpSGDela

VictimTOC	VictimSG	VictimSG Name	VictimSGType
D1	AllSGs	All Service Groups	All Trains
D2	AllSGs	All Service Groups	All Trains
DB	AllSGs	All Service Groups	All Trains
EA	EA01	North Trans Pennine	All Trains
	EA02	South Trans Pennine	All Trains
	EA03	North West	All Trains
	EA06	Manchester Airport - Blackpool North	All Trains
	EA07	Preston - Scotland	All Trains
EB	EB01	Great Eastern Inners	Off-Peak
			Peak
	EB02	Southend & Southminster	Off-Peak
			Peak
	EB03	Great Eastern Outers	Off-Peak
			Peak
	EB04	Anglia Inter City	Off-Peak
			Peak
	EB05	Anglia Locals	All Trains
	EB06	West Anglia Outers	Off-Peak
			Peak
	EB07	West Anglia Inners	Off-Peak
			Peak
EC	EC01	Kings x - Sunderland	All Trains
	EC02	Kings x - Bradford	All Trains
ED	ED01	Tyne, Tees & Wear	All Trains
	ED02	Lancashire & Cumbria	All Trains
	ED04	West & North Yorkshire Inter Urban	All Trains
	ED05	West & North Yorkshire Local	All Trains
	ED06	South & East Yorkshire Inter Urban	All Trains
	ED07	South & East Yorkshire Local	All Trains
	ED08	North Manchester	Off-Peak
			Peak
	ED09	Merseyrail City Lines	All Trains
	ED10	South Manchester	Off-Peak
			Peak
EE	EE01	Heathrow Local Service	Off-Peak
			Peak
	EE02	Hayes & Harlington Shuttle	All Trains
EF	EF01	London - Bristol	All Trains
	EF02	London - South Wales	All Trains
	EF03	London - Cotswolds	All Trains
	EF04	London - West Of England	All Trains
	EF05	Outer Thames Valley - London	Off-Peak
			Peak
	EF06	Inner Thames Valley - London	Off-Peak
			Peak
	EF07	Reading & Oxford Suburban	All Trains
	EF08	Thames Valley Branches	All Trains

Figure 11 Sample AllocatedDelays sheet

3.4 Calculation of Payment Rates: Spreadsheet Module

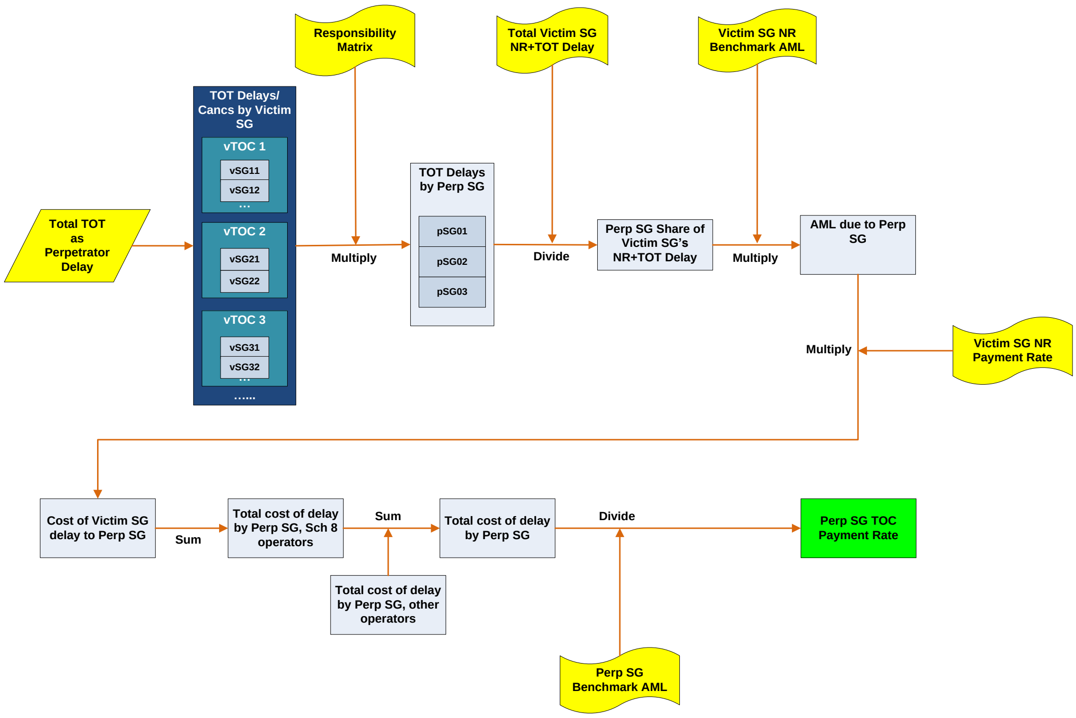


Figure 12 TOC Payment Rate Calculation

Figure 12 TOC Payment Rate Calculation shows the how the calculation is done for Delays. The calculation is similar for Cancellations but not shown here to avoid repetition. The yellow items are data inputs to the calculation which are created by the Database Module described above.

The steps in the calculation for each perpetrating operator are:

- For each of the victim service groups affected by this operator, use the Responsibility Matrix to allocate the delay minutes to the service group responsible.
- Calculate the proportion of the victim service group's total NR+TOT delay these minutes represent for each perpetrating service group.
- Take this same proportion of the victim service group's "performance" Network Rail benchmark AML (i.e. the AML caused by delay minutes rather than cancellations) to work out the Average Minutes Late for which this perpetrating service group is responsible. (For cancellations, the average Deemed Minutes Lateness (DML) is used. DML is a measure of the impact of cancellations using "deemed" NR Cancellation minutes)
- Multiply this AML by the NR payment rate of the victim service group to work out a financial impact per day.
- Sum these impacts for all the victim service groups affected by the causing service group to get a total cost per day for delay for this causing service group caused to other schedule 8 operators.
- Add in the cost per day of delays to non-template operators (Freight and Charter operators) to calculate a total cost for the perpetrating service group.
- Divide this cost by the TOC benchmark for the perpetrating service group to calculate the cost rate per daily AML.

Unlike the Benchmark calculation, which used a separate spreadsheet for each service group, for the TOC Payment Rate calculation a single spreadsheet is used for calculating the rates for all service groups. This design is used to allow the calculation procedure to be shown in the most straightforward way and also to minimise the model processing time.

Similarly to the benchmark model, the TOC payment rates spreadsheet model uses data views on the SQL database to query its input data: these are explained in Sections 3.2 and 3.3. The key components of the spreadsheet model are described in detail below.

- Initialisation – user interface area. The model enables the functionality of switching between deflated CP4 Network Rail payment rates and Halcrow new recommended CP5 Network Rail payment rates to be used to calculate the TOC payment rates. It also contains the non-template operator rates for delay and cancellation received from Joel Strange of Network Rail.
- Input sheets. The input sheets contain the specific data variables required to calculate the TOC payment rates. The types of input data used are listed below:

- Total NR +TOC on TOC delays and cancellations for each suffering service group.
- Total TOC on TOC delays and cancellations by causing TOC for each suffering service group.
- Delay responsibility matrices by causing TOC for each suffering service group. There are three delay matrices; one for Weekdays, one for Saturdays, and one for Sundays.
- Cancellation responsibility matrices by causing TOC for each suffering service group. Three cancellation matrices assigned to different day types (Weekday, Saturday, and Sunday).
- Total day counts by causing service group and day type (Weekday, Saturday, and Sunday).
- Deflated CP4 Network Rail payment rates and Halcrow new recommended Network Rail payments rates in 2011/12 price index. Option 5 NRPRs conducted in Aug 2013 were used for most of TOCs except for the following TOCs:
    - First Capital Connect: NRPRs calculated using parameters in the FCC& NR joint proposal;
    - Heathrow Connect: deflated CP4 NRPRs were used since there is a significant variance between the current NRPRs and Option 5 NRPRs due to potential bias in the baseline data and a lack of engagement by BAA in the Phase A process.
    - Chiltern Railway: negotiated Chiltern NRPRs in the Chiltern and NR CP5 proposal which was received from ORR on the 30th Aug.
    - Tyne and Wear Metro: a special rate was used. The exact Network Rail payment rates are included in Appendix E.

- Calculation sheets. The calculation sheets are separated into the following three sections.
    - Calculate the template liabilities
    - Calculate the non-template liabilities
    - Calculate the final TOC payment rates

- The detailed process is described in the figure below.
    - Summary sheet. This presents a comparison table between the deflated CP4 TOC payment rates and new calculated TOC payment rates. The outputs will be further processed into the final presentation spreadsheets which are shared with all TOCs for the validation meetings. The details on the format of the presentation sheet can be found in the section 3.5 below.

3.5 Presentation and Consultation

- Presentation

A presentation sheet was produced for each TOC which contains the key elements of the input data used in the calculation of TOC payment rates. It compares the new consulted TOC Payment Rates calculated using the new recommended Network Rail Payment Rates to the current TOC Payment Rates which have been deflated to 2011/12 prices to make them comparable with the new rates.

The presentation sheet also contains the details of how their TOC on TOC as Perpetrator minutes have been assigned using the Responsibility Matrix.

For each perpetrating operator, the presentation spreadsheet is divided into three sections: summary table; IPPR comparison; and detailed delay allocation. Information shown in each section is listed below.

Summary table (by Perpetrating SG):

1) Total Delays to Schedule 8 Operators
2) Total Cancellations to Schedule 8 Operators
3) Total Delays to Non-Schedule 8 Operators
4) Total Cancellations to Non-Schedule 8 Operators
5) Total Liability to Schedule 8 Operators £/day
6) Total Liability to Non-Schedule 8 Operators £/day
7) Total Liability £/day
8) TOC Benchmark AML
9) TOC Payment Rate £ /day (calculated using new consulted NRPRs)
10) Current TOC Payment Rate £/Day (Deflated PEARS Aug12)
11) TOC Payment Rate £ /day (calculated using CP4 NRPRs)
12) Variance % (New TOCPRs vs Current TOCPRs)

IPPR Comparison:

1) Total TOC on TOC minutes/cancs as Perpetrator from IPPR vs PSS
2) Total minutes breakdown for PSS data
    a. Rejected Minutes / Cancs (Non-Applicable Timetable etc)
    b. Minutes / Cancs caused to other operators, no liability
    c. Minutes / Cancs used in TOC payment rate calculation
3) Consistency check

Detailed delay allocation:

1) TOC delays as Perpetrator by suffering SG (including Schedule 8 delay, non Schedule 8 delay, delay allocated proportion, delay threshold, delay allocation method)
2) Responsibility matrix by day type (Weekday, Saturday and Sunday).
3) Allocated delays by Perpetrating SG and Suffering SG.

- Influencing Factors

The last time the TOC payment rates were fully calculated was in 2005. Since then, levels of train service, congestion on the network and TOC-on-TOC interaction have changed considerably. This means that there have been considerable changes in many TOC payment rates.

To help TOCs understand the factors which influence the TOC payment rate, we list them in Table 7 below. The table shows what impact each factor has on the rate.

Table 7 Factors Affecting TOC Payment Rate

Influencing Factor	Influence
For the Perpetrator	
Perpetrating Service Group's TOC Benchmark	**Inverse**: Lower AML benchmark than previous estimation will drive TOC rate up.
TOC on TOC as perpetrator delay	**Direct**: More TOTP delay in benchmark period than in previous BM period will drive TOC rate up.
For the Perpetrator / Victim interaction	
Spread of this delay to service groups by Responsibility Matrix	**Mixed**: New method of assigning responsibility will not change total TOTP delays or total financial liability but may change the extent each service group is made responsible.
For the Victim	
Relationship between Delay Minutes and AML for Victim Service Group	**Direct**: If the propensity of delay minutes to cause lateness goes up, cost and therefore TOC payment rate will go up.
Victim Service Groups' NR Payment Rate	**Direct**: TOC rate change is driven by change in victim service group rates.

- Consultation

All TOCs were invited to take part in individual phone conference calls to discuss their new TOC payment rates, the delay numbers which drove them and the impact of other factors as listed in Table 7 above.

Most operators were content with the rates and satisfied that they understood the method of calculation and the underlying reasons for the changes in rates since the last determination.

Two operators requested that results be re-run with lower Allocation Thresholds to reduce the number of victim service groups whose delays were allocated using the TOC-on-Self method which was generally seen as less precise than actual allocations.

One operator observed issues with the calculation of peak / off-peak splits which led to improvements in the working of the algorithm which will have improved the quality of results for all operators.

4 Conclusions and Suggestions

Having completed the project successfully, we can draw some conclusions from the process and make some recommendations that will make it easier to repeat the next time.

4.1 Use of PSS vs PEARS data for benchmark calculation

Our initial intention was to use PSS data as the main source for benchmark calculation. In the end, we abandoned this approach, using PEARS data instead. We were able to do this because there were very few perturbing factors such as service group re-allocations or TOC boundary changes which would have invalidated the PEARS approach. In the next determination, it is likely that there will be the need to compensate for more such changes. A PSS-based approach will make this much more straightforward.

There were two main difficulties we found with the PSS approach that could be addressed the next time:

- Volume of data needed. It became clear that timing point data was needed for many more locations than originally envisaged. As well as the monitoring points for which average lateness would need to be calculated, locations used in defining train direction (Forward, Reverse) in PEARS would also be required; and as well as Arrive and Depart events used for stop timing calculation, Pass events would also be needed. Although there is no fundamental problem with handling this data volume in a standard SQL database, the method of data extraction and transfer used by Network Rail was not suitable. A suggestion would be to put in place a more robust data extraction mechanism; or allow direct access to the PSS database for the contractor doing the determination.
- Reconciliation of delays: responsibility and quantity. The precision to which delay minutes are held in PSS is less than in PEARS, which means that exact reconciliation of total delay minutes is not possible. Also, negotiated divisions of responsibility for delay shown in PEARS are not always reflected in PSS. In terms of the prototype work we did, we were not able to determine the overall level of materiality of the differences. A suggestion would be to investigate this separately to see whether any correction technique is required; or whether there is a case for amending NR systems and processes to improve the correspondence between PSS and PEARS.

4.2 Guidelines on TOC-specific overrides

We carried out adjustments to the benchmark calculation for some TOCs to allow for disruptions and distortions of various kinds. Various other TOCs requested adjustments for reasons such as weather-related service disruption which we declined. We were acting on guidance from ORR on what should and should not be considered for this type of adjustment. Notwithstanding that, a significant part of the discussion with TOCs during consultations and at other times was around the question of what types of disruption we would consider. It would be helpful in future if there was a clear statement of policy on this matter from ORR/NR, which TOCs would be made aware of and to which reference could be made during consultation.

4.3 Data for TOC Payment Rate calculation

The calculation of TOC payment rates was by-and-large straightforward. There are two suggestions we could make on the data supplied which would improve the process:

- Inclusion of Infrastructure Manager column in the delay records. This would have made it much easier for us to identify delays occurring off the Network Rail infrastructure, for which the causing TOC is not liable under Schedule 8.
- Supply of a recognised industry source of Cancellations data for comparison purposes. For delays, we were able to compare our PSS-sourced data with published IPPR statistics and thereby gain comfort that our calculations were accurate. We had no such comparison for cancellations and so had to carry out a detailed reconciliation exercise to verify that our cancellation numbers were satisfactory.

4.4 Supply of Monitoring Point update data

We applied overrides to PEARS-sourced monitoring point weightings to pick up changes agreed with TOCs. We found it difficult to get these correct because of the wide variety of formats in which the data were supplied – in some cases in spreadsheets with incorrect calculations. It would make this part of the process more robust if there were a standard template for TOCs to supply monitoring point change requests.

4.5 Refinement of Responsibility Matrix

The new method of calculating the Responsibility Matrix based on PSS data was a success. There are refinements which could be made to the calculation we did, however, to correct for characteristics of the PSS data and to improve accuracy where direct allocation of responsibility was not adequate:

- Adjust the victim service group and peak status based on train changes en route. PSS records the service group and peak status of the train at its origin; it does not reflect any changes to these en route. This particularly affects operators such as First Capital Connect, whose trains change both service group and peak status as they pass through central London. To do this would require an additional data source such as a full train timetable, to enable the changes-en-route to be identified.

- Refine the "TOC-on-Self" method used to allocated delay in the absence of direct allocations. In some circumstances it may be possible to make this more accurate by adopting a principle of reciprocity – that the split of responsibility as perpetrator would match that of impact as victim between the service groups of a given pair of TOCs.

5 Appendices

5.1 Appendix A Network Rail and TOC Benchmarks

Confidential

5.2 Appendix B TOC Payment Rates

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5.3 Appendix C Detailed Processes

5.3.1 Responsibility Matrix

For each Day Type / Victim Service Group / SG Type

For each Causing Operator

If the proportion of total TOC on TOC delay/cancellation is greater than the Causing Operator's Allocation Threshold

Then Build Resp Matrix Using Actual Allocation Proportions

Else Build Resp Matrix Using TOC on Self Proportions

Build Resp Matrix Using Actual Allocation Proportions:

For each Service Group / SG Type in Causing Operator:

If Perpetrator has Peak trains on this Day Type

Then

If Causing Service Group type is "All Trains"

Then Resp Matrix Proportion = Actual Allocated Proportion

Else

If Causing Service Group Type = Victim Service Group Type

/ CSGT and VSGT are both either Peak or Off-Peak */*

Then Resp Matrix Proportion = Actual Allocated Proportion

Else

/ Victim SG Type is All Trains */*

If Override Victim SG Type = Causing SG Type

/ CSGT gets whole allocation*/*

Then Resp Matrix Proportion = Actual Allocated Proportion

Else If Override Victim SG Type = "All Trains"

Then Resp Matrix Proportion = Actual Allocated Proportion x SGType proportion of SG TOC on Self

Else Resp Matrix Proportion = 0

Else / no peak on this day type */*

If Causing Service Group Type = "Peak"

Then Resp Matrix Proportion = 0

Else Resp Matrix Proportion = Actual Allocated Proportion

Build Resp Matrix Using TOC on Self Proportions:

For each Service Group / SG Type in Causing Operator:

If Perpetrator has Peak trains on this Day Type

Then

If Override Causing Victim SG Type = "All Trains"

*Then Resp Matrix Proportion = TOS Proportion All Trains**

If Override Causing Victim SG Type = "Peak"

*Then Resp Matrix Proportion = TOS Proportion Peak**

If Override Causing Victim SG Type = "Off Peak"

*Then Resp Matrix Proportion = TOS Proportion Off Peak**

Else

/ No peak trains on this day type */*

If Override Causing Victim SG Type = "All Trains"

*Then Resp Matrix Proportion = TOS Proportion All Trains**

If Override Causing Victim SG Type = "Peak"

*Then Resp Matrix Proportion = TOS Proportion Off Peak**

If Override Causing Victim SG Type = "Off Peak"

*Then Resp Matrix Proportion = TOS Proportion Off Peak**

* The various TOS Proportions referred to here are:

TOS Proportion All Trains: The proportions of TOC on Self delay or cancellations where the victim is All Trains. This means distribution to all Causing Service Groups / SG Types in proportion to their TOC on Self delays or cancellations.

TOS Proportion Peak: The proportions of TOC on Self delay or cancellations where the victim is Peak. This means distribution to All Trains or Peak Service Group / Types only in proportion to TOC on Self – i.e. nothing goes to Peak SG Types.

TOS Proportion Off-Peak: The proportions of TOC on Self delay or cancellations where the victim is Off-Peak. This means distribution to All Trains or Off-Peak Service Group / Types only in proportion to TOC on Self – i.e. nothing goes to Off-Peak SG Types.

5.4 Appendix D Responsibility Matrices

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5.5 Appendix E Data Sources

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5.6 Appendix F TOC-Specific Adjustments – Data

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5.7 Appendix G Consultation Record

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5.8 Appendix H Database Processing Scripts

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