

Office of Rail Regulation,
Network Rail

**Part A Reporter
Mandate AO/004: Data
Assurance for
Possession Disruption
Indices**

Computational Checks
and Documentation
Review

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Job number

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1 Background and Introduction

1.1 Background

While it is essential that the maintenance, renewal and enhancement of the railway network is conducted efficiently and safely, trends in recent years towards longer engineering possessions and route blockades have led to increasing levels of disruption to passenger and freight rail services, and it has been agreed within the industry that these levels of disruption are no longer acceptable.

In order to improve network availability and move towards a 'seven-day railway', and as part of ORR's 2008 Periodic Review of Network Rail's outputs and funding for Control Period 4 (2009-2014), Network Rail is required to produce Possession Disruption Indices (PDIs), to ensure these are reduced from 2009/10 for passenger traffic, to ensure no increase for freight traffic, and to specify in its Delivery Plan how these targets will be achieved. A draft Network Availability Delivery Plan has been published by Network Rail, and the company has started producing Possession Indicator Reports, covering the recorded and target PDI values and the values of the associated KPIs, and also providing a Commentary on the results and details of the planned Programme of Improvements.

The Possession Disruption Indices for Passenger and Freight services (PDI-P and PDI-F, respectively) are calculated using the Network Availability model developed by Steer Davies Gleave (SDG) for ORR, and subsequently adapted by both ORR and Network Rail for their respective purposes and use. In addition to the spreadsheet forming the main/forecast Network Availability model, several additional databases and spreadsheets are used to calculate historic PDI-P and PDI-F values, based on actual historic data, rather than the predicted levels of possession activity that provide much of the input to the PDI forecast model.

1.2 Introduction

The PDIs and associated KPIs are reviewed by ORR, and will routinely be checked by Arup on behalf of ORR and Network Rail in our role as Independent Reporter (Part A). However, the comparative novelty of the PDIs and some of the supporting KPIs has led to some queries about the data and calculations used. In order to provide confidence and assurance for industry stakeholders, ORR asked Arup to conduct a full review of the PDI models, data and associated KPI data, building upon and incorporating the findings of the work already conducted under the terms of mandate AO/002: Network Availability, for which we familiarised ourselves with the Network Availability model, and resolved some problems experienced by Network Rail in the reproduction of the historic freight PDI (i.e. PDI-F) values.

The project remit was set out in Mandate AO/004, received by Arup on October 5, 2009. The objective of the project is "to provide assurance [to ORR] as to the quality, accuracy and reliability of Network Rail's data used in the computation of the Possession Disruption Indices for both Passenger and Freight."

The agreed specific objectives of the mandate are as follows:

1. To ascertain whether the data input to the Network Availability model and used to generate the PDIs and associated KPIs accurately reflect the possession-related situation 'on the ground';
2. To check that the input data are being correctly manipulated and processed by the Network Availability model and associated databases, spreadsheets and processes;
3. To verify that the contents of the Possession Indicator Report accurately reflect the underlying data, models and processes used; and

4. To describe the processes used in the checking process and the findings obtained, and to present these in a report suitable for publication on the ORR website.

The mandate has been divided into two sub-components: Data Assurance, covering objective 1, above, and Computational Checks, covering objective 2; both components cover elements of objectives 3 and 4, in that both the underlying data and the computational processes used feed the Possession Indicator Report, and the checking processes used, and the findings obtained, are being recorded and presented for both components.

This report covers the Computational Checks component of the mandate. The Reporter's assessment of confidence ratings for the PDIs will be presented in the subsequent Data Assurance Report, due for issue on Monday, November 16, and will draw on the evidence in this report.

Following this introduction, the specified process for calculating PDI values is described in Section 2. Section 3 describes the checking procedures adopted for the computational and documentary elements of the PDI calculation process. Section 4 then presents our findings, and is followed in Section 5 by our conclusions and recommendations.

2 Description of Specified PDI Calculation Procedure

The PDI calculations are described in ORR's *Network Availability Model User Guide* (ORR Document #324345-v1), and, in greater detail, in the agreed specification documents produced by SDG: *NETWORK AVAILABILITY KPI Final Summary Report November 2007*, and *NETWORK AVAILABILITY KPI Network Availability Reporting Suite (NARS) - Outline Technical Specification November 2007*; both documents are available on ORR's website: <http://www.rail-reg.gov.uk/server/show/nav.2001>.

The detailed processes used for the computation of the historic indices are described in Network Rail's internal documentation.

2.1 Possession Disruption Index – Passenger (PDI-P)

As noted in ORR's *Network Availability Model User Guide*, PDI-P

measures the impact of engineering possessions in terms of the economic value of the excess journey time passengers experience, normalised by total train-km.

The formal definition of the measure is included in section 4 of SDG's *Final Summary Report*, which defines it as EPJwVT, or

Excess Passenger Journey Time and Weighted Cancellation Minutes (EPJ), weighted by Busyness, Passenger Journeys and User Value of Time (wVT).

The measurement unit is £/train-km, which represents "the value of the excess journey time per train-km per period." The report also explains that the metric

measures the value of the impact of possessions on the excess journey time as experienced by the passenger, normalised to total train-km [and that] it takes account of the effect of cancellations and reflects the economic value of the additional journey time incurred.

The formula used in the calculation is shown below:

$$EPJwVT = \frac{\sum_{SG} \left[\sum_d \{ (NREJT_{SG,d} + WACM_{SG,d}) \cdot BF_{SG,d} \cdot PASS_{SG,d} \cdot ToDW \} \cdot VoT_{SG} \right]}{\sum_{SG} PT_{SG}}$$

The first two terms in the numerator are derived from S4CS (the Schedule 4 Compensation System), where

- *NREJT_{SG,d} is the average extended Journey Time per train as a result of a possession (Network Rail Restriction of Use) in respect of the relevant Service Group(s) calculated daily; and*
- *WACM_{SG,d} is the weighted average of Cancellation Minutes per train for the relevant Service Group(s) calculated daily.*

The values of NREJT and WACM are calculated in accordance with the definitions in Part 3 of Schedule 4, paragraphs 3.4 (c) and (b) respectively.

The next three terms of the numerator provide a weighting to reflect the numbers of passenger journeys affected by Service Group, and are defined by SDG as follows:

- *BF_{SG,d} is the busyness factor applicable to the relevant day and Service Group(s), as defined in Schedule 4, Part 3, para 3.4 (d);*
- *PASS_{SG,d} is the average number of passenger journeys per day for the relevant Service Group(s);*

- *ToDW is a pre-determined fraction representing the percentage of passenger journeys for the relevant Service Group during the time of day (average values for each hour of the day) and day of week (three average values: for weekdays, Saturdays and Sundays) affected by the corresponding possession.*

The results of the daily calculations are then aggregated by Service Group and period, and, for each Service Group, multiplied by VoT_{SG} , where

VoT_{SG} is the value of time for the relevant Service Group(s), reflecting the ratios of business, commuter and leisure traffic and associated values of time for each passenger group (as defined in DfT WebTAG appraisal guidelines).

Finally, the calculation is

normalised against changes in train service level by dividing the whole by the sum of scheduled passenger train-km across all Service Groups (shown in calculation as PT_{SG}). This normalisation will offset the tendency of the numerator in the expression to increase with the number of train services regardless of any change in the underlying pattern of possessions.

These calculations are performed in the spreadsheet-based Network Availability model, originally supplied by SDG to ORR (ORR Document #314258-v7), and subsequently updated by both ORR and Network Rail for their own use.

As noted in ORR's *User Guide*, PDI-P was indexed to 1, based on the average of the historic metric for 2007-08, so that 1.16 in the historic passenger index became $PDI-P = 1$.

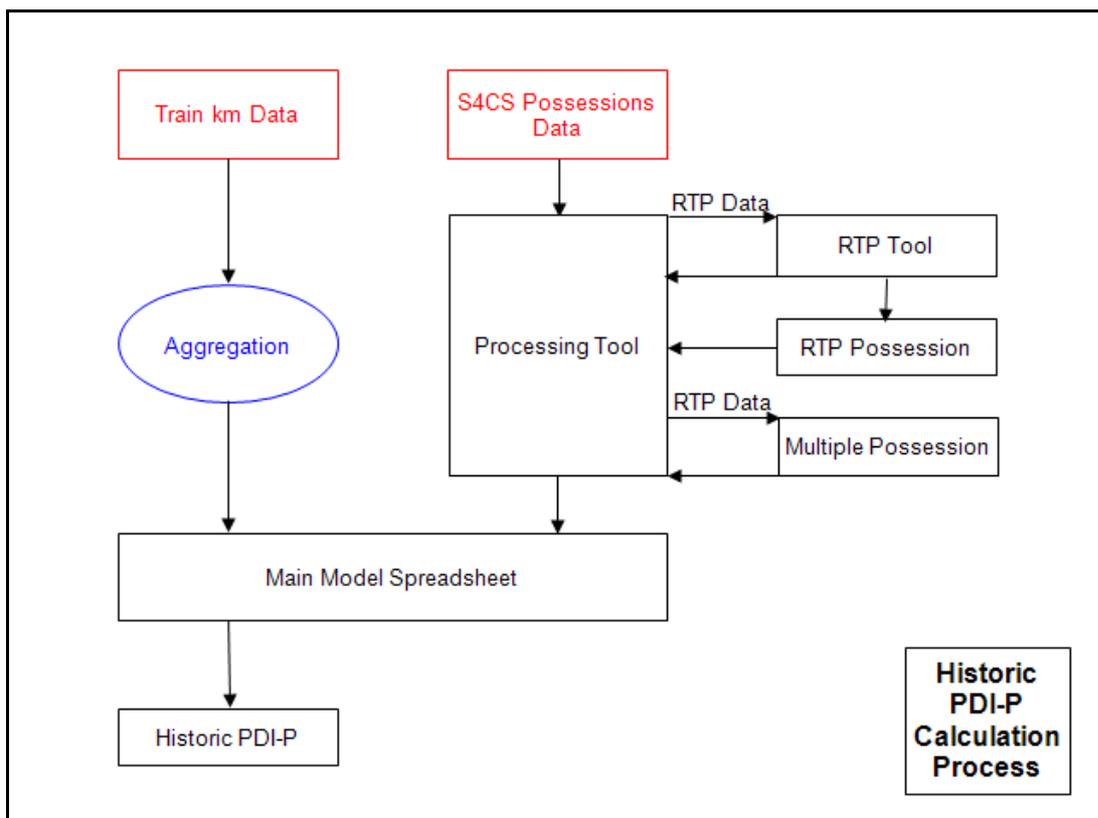
2.1.1 Historic PDI-P Values

The calculation of historic PDI-P values requires significant pre-processing of data outside the main/forecast Network Availability model, using several spreadsheets to process possessions data; some fairly straightforward pre-processing is also undertaken of the train km data.

The train km data, which are provided by Service Group by day, are aggregated to produce periodic totals by Service Group. Some Service Groups (EM01 and EM02; EJ02 and EJ03) are also combined to produce single, aggregate values. The results are then pasted into the appropriate input worksheet of the historic PDI-P Main Model spreadsheet.

Possession data are obtained from standard S4CS (Schedule 4 Compensation Scheme) outputs. Most of these data are derived from the Possessions Planning System (PPS), and can be input to the main model with only a limited degree of pre-processing. However, the data also include RTP (i.e. manually-entered) records: these include data for multiple possessions (i.e. possessions of a single route section that are taken repeatedly over several days, weeks, or months, with the route re-opening between repeated possessions), and lack the corresponding start and finish times for each 'sub-element' of the possession; the other RTP records also lack this information. These records therefore require significant and fairly complex pre-processing, with the data passing between several different spreadsheets, before they can be transferred to the Main Model.

Since this process is complex, and apparently undocumented apart from Network Rail's internal guidance, it is summarised in the flowchart below.



2.1.2 Forecast PDI-P Values

The forecast PDI-P values, based on planned possession activities, are generated using the updated version of SDG's forecast Network Availability model. Unlike the Periodic production of the historic indices, this activity is performed only occasionally by Network Rail.

In contrast to the processes used for preparing the historic PDI values, the SDG and ORR versions of the main model are reasonably well documented, both externally and within the model spreadsheet itself, making use of the conventions of 'Spreadsheet Best Practice'. The Network Rail version is considerably 'cut down' relative to the original, in order to make it easier to use, and as a result has lost some of the explanatory best practice elements, although it is still quite clearly laid out.

In the SDG and ORR versions of the model, forecasts are generated for three different scenarios: 'Business as Usual', 'Baseline/Stage 1' (where the same amount of work is done in a greater number of possessions of shorter duration), and 'Seven-Day Railway/Stage 2', where additional investment enables the number of shorter possessions to be increased relative to Baseline/Stage 1. The forecasts are based on Network Rail's future possession plans, with the possessions being weighted by duration and time band to reflect the resulting level of disruption. For the passenger index, the weights are derived from MOIRA. In the Network Rail version of the model, the forecasts appear to incorporate the selected strategy (i.e. Business as Usual, Baseline or Seven-Day Railway) for each strategic route, with the effects of the chosen strategy being reflected from the year of implementation onwards.

2.2 Possession Disruption Index – Freight (PDI-F)

As described in ORR's *Network Availability Model User Guide*, PDI-F

measures the 'unavailability' of track for freight use, weighted by the level of freight traffic operated over each section of track.

The use of 'track unavailability' is a change from SDG's originally-proposed freight measure, whose formal definition in section 4 of SDG's *Final Summary Report* is

Track km Availability Weighted by Freight Traffic Level (TwF).

The measurement unit is (or was) the weighted percentage of track km available per period. SDG's report explains that this metric

measures the availability of track-km weighted by the level of freight traffic operated over each ELR [Engineers' Line Reference]. The measure takes the level of non-availability by ELR and applies a weighting to reflect the intensity of freight traffic scheduled over that section on the relevant day of the week. It is calculated daily taking account of the proportion of freight traffic operating by day of the week and aggregated to give a measure per period.

The formula used in the calculation is shown below:

$$TwF = 1 - \left[\frac{\sum_{ELR} \left\{ \sum_d (TU_{ELR,d} \cdot FTW_{ELR,d}) \right\}}{\sum_{ELR} \left\{ \sum_d (TT_{ELR,d} \cdot FTW_{ELR,d}) \right\}} \right]$$

The terms in the formula are defined in SDG's *Final Summary Report* as follows:

- $TU_{ELR,d}$ is the track-km hours unavailable due to possessions for the relevant ELR on the relevant day;
- $TT_{ELR,d}$ is the total track-km hours for the relevant ELR for the relevant day;
- $FTW_{ELR,d}$ is freight traffic weightings⁵, calculated as:

$$FTW_{ELR,d} = \frac{DwFT_{ELR,d}}{\sum_{ELR} \sum_d DwFT_{ELR,d}}$$

where $DwFT_{ELR}$ is the average freight train movements per day attributed to a relevant ELR. The value is then weighted by the proportion of freight trains operated for the relevant day of the week for that ELR (such that the sum of the weightings for the seven days Sunday to Saturday would equal 1).

The report notes that

the values of $DwFT_{ELR,d}$ would be pre-determined as a fixed input, although these could be updated from time to time to reflect changes in freight traffic flows.

As in the case of the PDI-P measure, these calculations are performed in the spreadsheet-based Network Availability model, originally supplied by SDG to ORR, and subsequently adapted by both ORR and Network Rail.

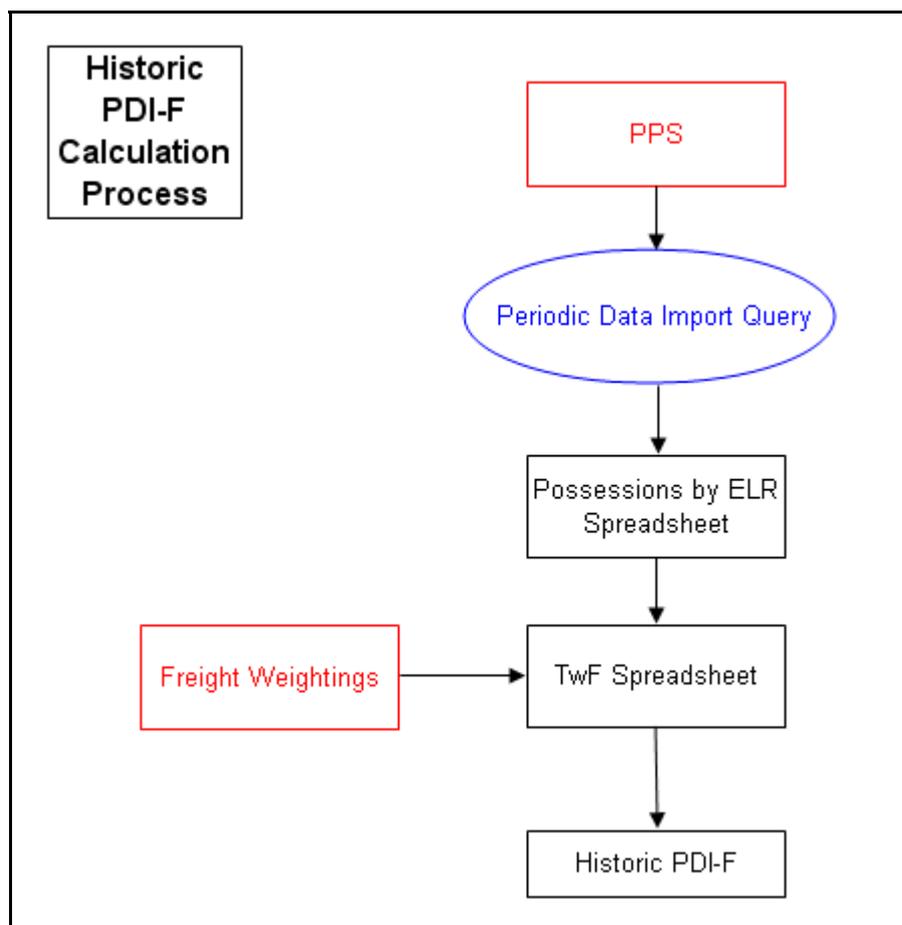
As noted above, and described in ORR's *User Guide* (paragraphs 1.6, 1.12-1.13), the PDI-F measure was modified by ORR in 2008 so as to represent 'track unavailability', instead of track availability. The *User Guide* describes the amended measure as being the reciprocal of the original measure, but we understand that it is in fact the original measure subtracted from 1 (i.e. $1 - TwF$), since the use of the reciprocal (i.e. $1 / TwF$) would produce a network unavailability value greater than or equal to 100%, implying zero availability.

As noted in ORR's *User Guide*, PDI-F was also indexed to 1, based on the average of the historic metric for 2007-08.

2.2.1 Historic PDI-F Values

As in the case of PDI-P, the historic PDI-F values are calculated outside the main Network Availability model. Possessions data for a specified Period are imported from a PPS (Possessions Planning System) Access database to an Excel spreadsheet by means of a VBA (Visual Basic for Applications) macro in the spreadsheet which is also used to identify route sections that are affected by possessions, and to remove any duplications caused by simultaneous multiple possessions on single ELRs. The TU and TT terms in the TwF equation above are thus calculated. SDG's original version of this spreadsheet has been updated by Network Rail to meet their requirements, particularly for the handling of more, and more recent, Periods than could originally be handled, and also to provide 'error trapping' functionality and to reduce processing times.

These results are then copied into another Excel spreadsheet, which combines them with the freight traffic data represented by the Freight Traffic Weightings term in the TwF equation, and calculates the TwF (or 1-TwF) index for the Period (the freight traffic data are obtained from another spreadsheet, in which ORR's Single-Line Weighting factors can be activated). Again, because of its limited documentation, this process is summarised in the flowchart below.



2.2.2 Forecast PDI-F Values

As for the Passenger Index, the forecast PDI-F values, based on planned possession activities, are generated using the updated version of SDG's forecast Network Availability model. Again, in contrast to the regular production of the historic indices, this activity is performed only occasionally by Network Rail, and is reasonably well documented. The

procedure for the freight index is similar to that for the passenger index, although some of the weightings are based on data from ACTRAFF (freight Actual Traffic records), rather than MOIRA.

2.3 Single, Unified Measure

As noted in ORR's *User Guide*, SDG proposed a single, unified measure ('Revenue at Risk', abbreviated to RR) in addition to the two market-specific PDI-P and PDI-F measures, but it was decided not to make use of it.

3 Checking Process

This section of the report described the checking processes applied to the computational procedures used to generate PDI-P and PDI-F, and to the documentation. The checking processes used reflect the calculation procedures described in the previous section.

3.1 Computation Checks

For the computation checks, the calculation processes used in the various databases and spreadsheets comprising the historic and forecast elements of the Network Availability model were compared with the formulae and algorithms described in the model Specifications and User Guides.

Given the sizes of the datasets involved, and the extent and complexity of the calculations performed by the model components, it was not feasible to conduct an exhaustive check of the detailed calculations. Instead, a sample of data was chosen, generally using the most recent Periodic data available, and the calculations performed on the data were traced through the model and checked. In the case of the historic PDI-F values, our findings are based on the extensive checks conducted in the course of mandate AO/002: Network Availability.

3.1.1 PDI – P

Checks were performed on the calculation processes and results for the historic and forecast Passenger PDI values, as described below.

3.1.2 Historic PDI-P Values

For the purposes of checking the historic passenger indices, a sample of the calculations for 2010 Period 06 was reviewed, using data provided by Network Rail. The processes used, and the intermediate and final outputs, were assessed for accuracy and for compliance with the specified formulae and algorithms.

The process was complicated by the apparent unavailability of any description of the algorithms developed for the processing of RTP possessions data; although the Network Rail internal documentation helpfully describes what the user should do, it does not explain the underlying processes, which can only be ascertained by examination of the procedures and formulae employed. The situation is exacerbated by the use of multiple spreadsheets in this process, by the use of manual examination and identification of multiple possessions, and by the requirement for results to be copied from one stage of the process and then pasted to another as values, meaning that there are then no formulae present for checking purposes.

It should be noted that these manual processes, although they inevitably introduce the possibility of straightforward human error, are subject to simple, common-sense checks, as recommended in Step 2 (i) for KPI – 227 (PDI-P) in the Network Rail User Guide.

3.1.3 Forecast PDI-P Values

The forecast PDI-P values are calculated by Network Rail using a cut-down version of the original SDG/ORR models. This version of the model, and the calculations used to produce the PDI-P forecasts for 2009/10 to 2013/14 were reviewed.

3.1.4 PDI - F

Extensive checks were conducted in the course of mandate AO/002 on the algorithm implementation and calculations for the historic freight indices, as described below. Additional checks were conducted on the forecast indices for the purposes of this mandate.

3.1.5 Historic PDI-F Values

A thorough review of the historic PDI-F calculation process was conducted under the terms of Mandate AO/002, in the course of resolving some difficulties that Network Rail were experiencing in the production of the historic freight indices. In the course of the review, the

computational processes used were checked to ensure that they reflected the formulae, algorithms and processes described in SDG's model specification and ORR's *User Guide*, and the detailed calculations were traced through the process and checked for 2006 Period 01 to 2010 Period 03.

3.1.6 Forecast PDI-F Values

As in the case of PDI-P, the forecast PDI-F values are calculated by Network Rail using a cut-down version of the original SDG/ORR models. This model version, and the formulae and calculations used to produce the PDI-F forecasts for 2009/10 to 2013/14 were reviewed.

3.2 Documentation Checks

The documentation produced by SDG and ORR was made available to us for the purposes of mandate AO/002, together with some internal Network Rail documentation, and was used to gain an understanding of the various components of the Network Availability model. Those documents, together with some additional internal Network Rail material, covering the data sources and calculation processes required for the preparation of the PDIs and the other, accompanying Network Availability KPIs, were read and reviewed for the purposes of this report.

4 Findings

This section of the report sets out our findings in respect of the checks conducted on the PDI computation processes and on the background and user documentation.

4.1 Findings of the Computation Checks

4.1.1 PDI – P

As noted above, the process for calculating the historic PDI-P values is complex, and somewhat ‘opaque’ in some respects. Our checks indicate that the more straightforward elements of the process, namely the handling of the train km and non-RTP possessions data, are being performed correctly and in accordance with the model specification. This is also true of the RTP possession data when it has emerged from the RTP-specific ‘sub-processes’ used to identify multiple possessions and to produce possession start and end times.

We are less confident about the accuracy of those RTP-specific sub-processes themselves, however, since it is not immediately clear exactly what is being done within those processes – there appear to be references to the use of random numbers to assign start and finish times, but further investigation is required to clarify this, and then to fully verify the process. These elements of the model need further, more detailed review, during which the details of the objectives and methodology used should be established and documented.

We understand that possessions taken at short notice (i.e. after the publication of the Weekly Operating Notice) are included in the historic PDI-P calculation, since the data used are taken directly from S4CS, for which the ‘cut-off’ for possessions to be included is the daily upload to the Train Service Database (TSDB) that takes place at 22:00 each day. This is in contrast to PDI-F (see below).

The Busyness Factors, Passenger Journeys, Time of Day Weightings and Values of Time used in the calculations are based on historic data obtained from LENNON, MOIRA and DfT records, and are fixed within the model, and will inevitably become out-of-date: there are no apparent guidelines or documentation for the updating of these datasets, although it would be preferable for them to be updated on a regular basis, for each Control Period, say, if not on an annual basis.

The spreadsheet used by Network Rail for the calculation of forecast PDI-P values is well laid out, although, as noted above, some of the best practice elements present in the SDG and ORR versions have been lost, with the result that the calculations are less easy to follow than previously. Preliminary checks indicate that the results are consistent and sensible, but further, more detailed checks of the calculation process are required to provide full confidence as to their accuracy. These detailed checks are outside the scope of this mandate.

4.1.2 PDI - F

Our checking of the PDI-F calculation process for mandate AO/002 revealed that, following the amendment by NR of the ‘Possessions by ELR’ spreadsheet to allow additional Periodic updates, some data were no longer being sorted in the order originally intended (but not enforced or apparently documented) by SDG. This was causing double-counting of simultaneous possessions on single ELR route sections, thus causing an overestimate of network unavailability.

Having resolved this problem, we are now satisfied that the computational processes correctly implement the specified calculations, and that the results are correct, as evidenced by the successful reproduction of historic PDI-F values originally produced by ORR. However, the data-sorting problem showed very clearly how an unintended, minor change to the format of a single worksheet in one element of the modelling process could easily produce incorrect results, the cause of which was subsequently difficult to determine. The

problem was exacerbated by the fact that the importance of the data sorting order was not mentioned in the documentation or within the relevant spreadsheet itself, and the source of the error could only be found by careful use of the formulae within the spreadsheet to determine what it was supposed to be doing, and comparing the intended outcome with the results that were actually being produced.

There was some uncertainty about the use in the model of Single-Line Working (SLW) factors introduced by ORR to reflect the increased network availability provided by the use of SLW during possessions, but this has now also been resolved.

In contrast to the historic PDI-P calculation, as noted above, short-notice possessions are excluded from PDI-F, since the measure is based entirely on PPS, for which the cut-off time is the issue of the Weekly Operating Notice, or WON. There is therefore a degree of inconsistency between the two measures as originally defined and developed, although we understand that short-notice possessions are a very small proportion of overall possession activity.

The freight weightings used in the model are based on historic ACTRAFF train movement data, of which the most recent records in the model are for 2006/07. An update may therefore be required, and should perhaps be repeated for each Control Period, if not on an annual basis, to ensure that the PDI-F measure reflects ongoing variations in freight traffic nationally and by route. However, it is not clear how this should be done, as the necessary process appears to be undocumented.

Although the historic PDI-F calculation process is better documented and less complex than that for PDI-P, and requires less in the way of user judgement and intervention, there are still requirements for data to be copied manually between spreadsheets, and thus scope for straightforward user error.

As in the case of the forecast PDI-P values, preliminary checks indicate that the PDI-F forecasts are consistent and sensible, but, for the same reasons, further, more detailed checks are required to provide full confidence in their accuracy; again, these checks are beyond the scope of the current mandate.

4.2 Findings of the Documentation Review

While a review of the documentation is not the primary objective of the PDI Data Assurance exercise, the documentation had to be examined for the purposes of the work, and suitable documentation is essential to the understanding, use, maintenance and upgrading of any modelling tool, particularly one as complex as the Network Availability model. It is therefore appropriate to review and comment upon the quality or otherwise of the documentation, and to recommend any changes whose requirement is identified.

Overall, the documentation is somewhat fragmented, comprising SDG's specification documents, ORR's *User Guide*, and Network Rail's in-house instructions for users of the Network Availability model. While SDG's and ORR's versions of the main Network Availability model contain covers, pages of contents, etc., in accordance with spreadsheet best practice, many of these features seem to have been removed in Network Rail's versions, and the spreadsheets and other elements of the historic PDI calculation process contain very little in the way of user guidance. The result is that there is no obvious single 'starting point' in the documentation, and there are many gaps in its coverage; in particular, while the principles and fundamental formulae are described in the specifications and ORR *User Guide*, and step-by-step calculation instructions are provided for Network Rail staff, there is very little in the way of intermediate material describing the processes and algorithms used, and the flow of data between the different model components; this is particularly problematic in the case of the of the historic index calculations.

4.2.1 PDI – P

As noted above, while the principles of and formulae for the calculation of PDI-P are described in reasonable detail in the specification documents and ORR's *User Guide*, there is no apparent documentation of the calculation and preparation of the historic PDI-P values, for which multiple data sources are used, some of which are essentially fixed in the model, but may require regular (e.g. annual) updating. Network Rail's documentation provides an indispensable guide for model users, but does not contain any background documentation for the preliminary S4CS data processing activities, explaining the principles and processes used. It would be useful to have such information, to ensure that the tools are working as originally intended.

In the case of the forecasting model, Network Rail seems to have removed the table of contents and some of the other aids for finding one's way around it that were originally provided by SDG and ORR. While other elements of spreadsheet modelling best practice have been retained, and the in-house user guide provides significant assistance, it would be preferable to introduce/restore contents sheets, etc. to the spreadsheets used. As things stand, the only way to gain an understanding of the methodology used is to trace data through the calculation processes, which is time-consuming and difficult, given the number of spreadsheets involved, the use of some manual user intervention in the process and the occasional use of pasted values in place of formulae.

4.2.2 PDI – F

The situation for PDI-F is similar to that for PDI-P, although there is a brief description in Appendix 2 of the ORR *User Guide* of the processes to be followed, which, though less complex than for PDI-P, are still not particularly straightforward (our understanding of this process was greatly improved by the experience gained in mandate AO/002).

5 Conclusions and Recommendations

This section of the report summarises the conclusions drawn on the basis of the foregoing analysis and findings, and sets out our recommendations.

5.1 Conclusions

While most of the documentation and the main spreadsheet model are geared towards the generation of forecast PDI values, most of the day-to-day calculations conducted by Network Rail relate to the production of the historic indices, which is done using a range of disparate databases and spreadsheets, which are comparatively poorly linked and documented.

The various components of the historic PDI models appear to be functioning correctly and producing the required results (although there is some uncertainty about this), despite the multiplicity of data sources, databases and spreadsheets used, the complexity of the processes involved, the reliance on user intervention in these processes, and the absence of comprehensive documentation of the data, algorithms and processes employed. These factors all result in the models being quite 'fragile', in that inadvertent, minor changes to one or more components can result in the production of incorrect outputs (as previously found in the case of the historic PDI-F calculations), and that they are difficult to use, maintain and update.

Specific issues that require consideration/attention include the following:

- The fixed nature of some of the historic data used (ACTRAFF, LENNON, etc.);
- Inconsistent handling of short-notice possessions; and
- Appropriate values for the SLW Factors for use with PDI-F.

Because of these issues, and although the models appear to be correctly producing the required outputs, our overall conclusion is that the historic models, especially, are not particularly robust, and that all the model components would benefit greatly from improved integration and documentation, as specified in the following section.

5.2 Recommendations

To ensure that the PDI calculation process is robust, transparent, maintainable and updatable, the integration and documentation of the Network Availability model should be improved.

Network Rail's planned migration of the model from its current mixture of applications to 'Business Objects' should provide improved integration and transparency of the modelling process. We understand that Network Rail is hoping to undertake this work by the end of the current financial year (i.e. by the end of March, 2010), in which case it is probably not worth the effort required to update the existing models. However, if the planned migration is significantly delayed for any reason, explanatory information should be added to the spreadsheets, etc. comprising the existing models, to assist their users and improve compliance with spreadsheet best practices. When the planned migration of the PDI calculations to Business Objects is implemented, the functionality and outputs should be reviewed for compliance with the model specification, and for consistency with historic outputs and previous forecasts.

The PDI and Network Availability model documentation should be reviewed and updated to provide a comprehensive and detailed account of the PDI calculation process and the algorithms used, for the benefit of model users, maintainers and developers, and to avoid the need for the 'reverse engineering' of the processes involved when issues arise. This would help to provide enhanced 'business continuity' within Network Rail and ORR by capturing and combining the various currently-available sources of documentation and user

experience in a single, unified and updatable source of information, which would be of particular benefit to new users of the model, and in the event of the transfer or departure of experienced staff members. It would also assist in the development of a new, integrated version of the PDI models. While the responsibility for the model documentation at this stage lies primarily with Network Rail, the complexity and historical development of the model are such that assistance from ORR is likely to be required.

In addition to the general improvements to the integration, transparency and documentation of the overall modelling process, there are several specific issues that may merit further investigation in the longer term. Consideration should be given to enabling the updating of the model to allow the automatic incorporation on a regular basis (e.g. each Control Period) of the most recently-available ACTRAFF, MOIRA, LENNON and Value of Time data used in the PDI calculations. Similarly, the apparent discrepancy of scope between the possessions data used for the Passenger and Freight PDIs (i.e. where the Passenger Index includes the effects of short-notice possessions, but the Freight index does not) may require further investigation, and, if then deemed necessary, the modelling process should be updated to enable the two indices to be calculated in a more consistent manner. The appropriate values and application of the Single-Line Working factors for PDI-F is also a potential area for further investigation.

Our recommendations are summarised in Table 5.1.

Table 5.1: Recommendations, Champion and Recommended Due Date

Recommendation	Data Champions	Due Date
Model Migration to Business Objects (or, if no definite migration date has been established, provision of improved user guidance within the existing model components)	Tony Roberts (NR)	April 2010
Comprehensive Model Documentation	Tony Roberts (NR), Paul Hadley (ORR)	July 2010