New City Court
20 St Thomas Street
London SE1 9RS
United Kingdom
T +44 (0)20 7939 6100
F +44 (0)20 7939 6103
www.jacobs.com

Jack Grigg
High Speed Two Limited
One Canada Square
Canary Wharf
London
E14 5AD

13 October 2015 B2041200

Audit of development of the PLANET Framework Model versions 4.3 to 5.2 and use for the HS2 Phase 2a Outline Business Case

Dear Jack

Jacobs has audited the transport demand modelling framework developed on behalf of High Speed Two Limited (HS2 Ltd) for the demand forecasting and business case work for the High Speed Two project. This is known as the PLANET Framework Model (PFM).

The aim of the audit was to provide independent verification to HS2 Ltd that the model processes and inputs and the use of PFM version 5.2 for the economic assessment of HS2 meet the specification for the PFM and the Phase 2a Strategic Outline Business Case.

From the information that we have reviewed and ***subject to the specific details raised in this letter*** and in exercising the degree of skill and care to be expected from a competent professional consultant experienced in undertaking such services, we confirm that users of the model and its results can be confident the implementation of the model updates leading to PFM v5.2 correctly reflects the documented methodology.

The rest of this letter provides background information on our audit, describes our main audit processes, and summarises our audit results. There are also extensive annexes which provide this information in detail.

Background.

Our initial audit report[1] was published in October 2013, relating to PFM version 4.3 and its use for the economic case for HS2. Since then, further development of the PFM has taken place and we have audited each interim version during 2014 and 2015.

The subject of this letter is the audit of model development resulting in PFM version 5.2 and its use for the economic case of HS2 Phase 2a. The model developers have documented the updates between versions 4.3 and 5.2 and this letter brings together the findings of all the accompanying audit activity between these versions.

[1] PLANET Framework Model Audit Report, Model Implementation and Standard Case Forecast, October 2013

The updates undertaken by the model developers between versions 4.3 and 5.2 are described in the model development report[2].

Audit Process

Our audit focussed on reviewing the implementation of the specified methodology rather than a review of the methodology itself. The model developers were the primary source of the documentation for the required methodology. Where possible we also checked this against HS2 Ltd and DfT specifications and our own experience of PFM and other model development. For each new model version we have only audited elements of the model that have changed in that model version rather than re-auditing the whole PFM model.

During parts of the audit process, we had an embedded auditor working with Systra and Mott MacDonald. The embedded auditor checked outputs for each task against the audit criteria. The audit criteria were produced before each task was completed and drew from task specification notes produced by Systra and Mott MacDonald. A number of oversights were therefore corrected whilst the tasks were being undertaken, saving considerable time compared to a retrospective audit.

The audit involved a range of updates covering different parts of the modelling suite. It has included all sub-models within the framework, the appraisal benefits spreadsheet and the operating cost model. The embedded auditor was therefore assisted by our audit team that comprised of experienced personnel with previous involvement in the audit of those elements.

The audit process is described in detail in appendix A for the development of the individual model versions and in appendix B for the use of the model for the Phase 2a Strategic Outline Business Case. The following list illustrates some of the checks we have carried out:

- line by line checks of new computer codes to verify that it was in line with the documented method;
- reviewing the model outputs and also undertaking full model runs to ensure we could independently replicate reported results;
- testing automations including by the deliberate input of erroneous inputs;
- checking new demand growth inputs are consistent with stated sources and by comparison with previous inputs and other sense checks;
- verification of the calculation of the demand cap year;
- confirmation that PFM and its inputs are in line with HS2 Ltd's documented use of DfT's transport modelling and appraisal guidance, WebTAG;
- verification that the implemented "do-minimum" network assumptions are those specified by DfT and that the "do-something" rail network is consistent with that specified by HS2 Ltd;
- confirmation that significant implementation errors identified by audit or other quality assurance processes have been corrected during later model development; and
- tests of overall model robustness by sensitivity testing and consistency checks between model components.

For each of the model versions audited, we ran a random sample of selected scenarios to confirm that we could reproduce the model developers' results.

[2] Model Development Report, PLANET Framework Model Version 4.3 - 5.2, Systra

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Audit Results

At each stage of the model update and audit process, we produced detailed technical notes of our findings that were summarised in an audit letter for each completed model version.

Where differences between the model and its documented methodology could not be addressed in time for the release of a model version, the issues identified were added to the Development Opportunity Log (DOL) held centrally by HS2 Ltd. Often these issues were then resolved in subsequent release versions of the model. Of the remaining DOL items,

- the majority are small network coding errors affecting either the journey time, frequency or stopping patterns of individual trains or the preload process (the process of transferring demand from one sub-model to another). From our experience of network models and our understanding of the PFM set-up, we do not expect that any of these issues will materially affect the business case for the HS2 scheme;
- we noted a small number of errors in the application of the Heathrow access model, which we know makes a very small contribution to the HS2 business case;
- we identified one error in the application of fares growth within PFM which the model developers were able to address through post-model processing of results;
- finally we noted some items that are concerned with model coding good practice to reduce the scope of future errors. These have no impact on model results within the current use of the model.

All the model runs we undertook successfully reproduced the results reported by the model developers.

Yours sincerely

Hermann Maier
Technical Director
0207 939 6280
Hermann.Maier@jacobs.com

Appendix A: Summary of Audit Process, PFMv4.4 to v5.2

Version 4.4

Model Updates

The scope of the model updates from version 4.3 to 4.4 included:

- Updates to service coding in PLANET Long Distance (PLD) and the regional PLANET models;
- A correction to the Heathrow Airport Access Model (HAM);
- Correction to the representation of the public transport (PT) catchment in the Station Choice Model (SCM);
- Correcting issues with the preload spreadsheets and the wormhole process (the processes to transfer demand between PLD and the Regional PLANET Models; and
- The automation of the Numerical Integration process.

Audit Process

Our audit of the model updates involved reviewing the various elements of the modelling suite in isolation. The aim was to identify whether code was implemented in line with the documented and intended specification. Our checks included:

- Line by line checks of new code to verify that it was in line with the documented method;
- File comparison of network files and other inputs to identify what had changed between model versions and verify the documented changes had been correctly implemented; and
- Reviews of batch files, macros and spreadsheets to check that the pre-load and wormhole process is operating as intended.

We did not undertake full model run checks but where appropriate we ran some individual modules of the suite to replicate results and processes.

Version 4.5

Model Updates

The scope of the model updates from version 4.4 to 4.5 included:

- Modifications to preloads;
- Changes to the public transport algorithm within the Station Choice Model;
- An update of the appraisal pre-programming program;
- Adjustment to the HS2 link in the PLANET South model;
- Updates to the wormholes and ensembles process;
- Minor corrections of the network;
- Automation of the file checking process;
- Automation of the production of the standard output files; and
- Automation of the outputs required for the calculation of Wider Impacts (WITA).

Audit Process

Our audit process for v4.5 included:

- reviewing the scripting line by line to verify that it was in line with the documented method;
- reviewing the model outputs and also undertaking full model runs to ensure we could replicate the reported results;
- testing the error checking process to ensure its robustness including the deliberate input of erroneous files to ensure the error detection worked.

Version 4.6

Model Updates

PFM v4.6 incorporated minor model improvements to resolve some of the issues raised by the audit and quality assurance process. There were also a number of changes designed to improve the usability and efficiency of the model.

Audit Process

The scope of the updates and hence the audit included:

- Development work undertaken prior to the release of PFMv4.5, but not included in PFMv4.5 model release. This included a number of automation items as well as some minor transit line items from the DOL;
- Appraisal spreadsheet updates and improvements, including strengthening the accuracy of use of financial year and calendar year data;
- Updates to the wormhole process, ensembles and to Transfer.exe (the mechanisms by which data is passed between the PLANET long distance model and the regional models and vice versa);
- Minor network corrections emanating from Network Review process; and
- Other minor DOL updates, automations and corrections / improvements based our auditor review of interim model versions v4.5.1 to v4.5.4.

Version 4.7

Model Updates

PFM v4.7 was built on the previous release version of PFM v4.6 and was created in three steps:

- PFM v4.6.1 incorporated non-economic growth related updates from the latest release version of WebTAG (November 2014);
- PFM v4.6.2 incorporated updates to economic growth driver inputs from the same WebTAG release, alongside revised assumptions regarding the growth of rail fares; and
- PFM v4.7 includes an update to trip matrices in the two forecast years, a change to the cap year, updates to the control matrices, highway network, air transit lines, together with a number of fixes to small bugs within the model.

The scope of the audit of work to update the exogenous forecasts principally covered the estimation of new future year matrices. This included amendments to the previous rail demand forecast methodology and parameters referred to as the "correction stage".

Audit Process

The audit process included the following:

- Verification of the automations and improvements to the process to apply new exogenous forecasts.
- Sense check of the new demand driver data for October 2014 and how they compare with the October 2012 forecasts.
- Check if the demand driver comparison spreadsheet is the same as the demand driver inputs into EDGE.
- Review of the updates from the "correction stage", including:
    - Correct implementation of updated distances in the EDGE process for PLANET Long Distance (PLD);
    - Application of either the population elasticity or relative population elasticity in EDGE;
    - PLANET South (PS) airport adjustment in terms of resulting demand in the matrices;
    - Re-basing of car availability redistribution factors to a 2010 base year;
    - EDGE inputs for PS zone 5013 and 905013 in the EDGE log files and output trip ends;
    - Fare elasticities in the EDGE logs file match DfT advice;
    - Comparison of the corrections matrices with PDFH 5.1 matrices;
    - Matrix totals;
    - Changes in individual origin-destination movements; and
    - Compare trip end changes for both trip origin and destinations between 2010 and future years and between corrections and PDFH 5.1 equivalent scenarios and sense check.
- Checks of rail matrices, including:
    - Comparison of updated central forecast matrices that have the new demand driver data with the corrections stage matrices;
    - Trip end changes of updated central forecast matrices that have the new demand driver data with the corrections stage matrices;
    - Matrix totals of updated central forecast matrices that have the new demand driver data with the corrections stage matrices;
    - Individual origin destination (OD) movements that change significantly in absolute terms;
    - Elasticities are consistent with the corrections stage; and
    - Matrix changes against demand driver changes are consistent.
- Checks of aviation matrices & networks file:

    - Updated air services coding in terms of headway and fares;
    - Updated air services coding in terms of journey times by direction to ensure they are the same in each direction;
    - All flights are in the lines files as per the supply side spreadsheet;
    - Air demand matrix totals are logical comparing previous and updated central forecasts;
    - Air matrix trip ends change between previous and updated central forecasts are sensible; and
    - Individual air OD changes are sensible, checking for any unexplained outliers.
- Checks of highway matrices, including preloads:
    - Preload growth is correct between 2010 and 2026 and to the cap year;
    - Highway matrix totals are logical comparing previous and updated central forecasts;
    - Highway matrix trips end change between previous and updated central forecasts are sensible; and
    - Individual highway demand OD changes are sensible, checking for any unexplained outliers.
- Confirmation Atkins have correctly calculated the cap year:
    - Import matrix process works correctly;
    - Calculation of cap year is correct when using dummy inputs;
    - Check that the calculation process is transparent;
    - Check that the labelling of new and previous matrices is robust;
    - Check the macro; and
    - Review the outputs.

Version 4.8

Model Updates

PFM v4.8 was built on the previous release version of PFM v4.7. In v4.8, the reliability assumptions applied to the HS2 timetable were reviewed and updated. As a result both the Phase 1 and Phase 2 transit line files were updated to include the revised HS2 coding. No other changes were implemented in v4.8.

Audit Process

The scope of the audit included the following:

- Check if the developers have used the correct transit line coding for the Phase One and Phase Two (Y network) model;
- Check that the updates to create v4.8 have a logical impact on model outputs when compared to PFMV4.7; and
- Check the scripts to make sure all the additions in v4.8 have been correctly combined and not caused any additional issues.

Our audit focussed on reviewing the implementation of the specified methodology rather than a review of the methodology itself.

Version 5.0 and 5.0.1

Model Updates

PFM v5.0 was built on the previous release version of PFM v4.8 which was developed in December 2014. It includes a partial update of the Do Minimum (DM) network specification within the four PLANET models. These updates are based on a comprehensive network review on the DM networks undertaken by the model developers and updates of the underlying specification provided by the DfT. Updates to the DM networks are also passed into the Do Something (DS) networks where appropriate.

Corrections resulting from the network review were:

- Midland Mainline – updated frequencies, capacities and journey times for services in the areas of Lincoln, Nottingham, Newark, Peterborough, Grimsby, and Skegness; and
- Cross Country – frequency, capacity and the inclusion of new services for multiple routes within the network.

Updates resulting from the updated specification provided by DfT were:

- West Coast Main Line –full DM specification update;
- TransPennine Express – update to Scotland services benefitting from Carstairs acceleration;
- Midland Main Line – partial specification update focussing on the electrification of Leicester to Sheffield; and
- Crossrail – representation of service extension to Reading.

In addition to the service coding updates, v5.0 has implemented a number of cosmetic changes (labelling and colour coding) and minor corrections that have no significant impact on model results. These included updates to the following model items:

- The PS, PM and PN to PLD Preload spreadsheets;
- Growth drivers in the Heathrow spreadsheet;
- Elasticity values in the PLD macro modesplit.mac;
- Winners and Losers database output automation;
- HS21 and HS22 service times; and
- Inconsistent DM transit lines files in Y26 and D26.

PFM v5.0 was re-issued as v5.0.1 in April 2015 to include corrections to classic rail networks in the Do Something scenarios.

Audit Process

The audit was undertaken in three steps:

- A review of the updated network coding files in isolation;
- An audit of the implemented model v5.0; and
- An audit of the further updates to the WCML coding.

The scope of the audit of the network coding files included:

- Check that the lines files include all services included in the specification as supplied;
- Check that any transit lines marked as deleted have been correctly recoded; and
- Check that all amendments transit lines are correctly coded as per the specification supplied.

The audit procedure for these was as follows.

- Lines file imported into excel spreadsheet;
- Visual check of headway where amended in specification;

- Additional calculation added to spreadsheet to identify and highlight calling points and enable easy validations of amendments to section times and calling points in specification;
- Summary audit log spreadsheets completed showing checks by transit line number by file;
- Potential errors and mismatches were checked back with the model developers and specification or transit lines were amended as necessary; and
- Final audit check of amended transit lines.

Where appropriate[3] we have also reviewed original DfT timetable information and how this has been interpreted in the model developers' coding specification.

The audit of the implemented model version 5.0 included:

- Check all the pre-load spreadsheets to see whether all the transit line revisions have been incorporated into them;
- Run the model to check the model results replicate the run versions of the model;
- Check the updates to v5.0 have a logical impact on model outputs when compared to PFMV4.8; and
- Check the scripts to make sure all the additions in v5.0 have been correctly combined and not caused any additional issues.

This was followed by an audit of the further updates to the WCML coding that led to the release of PFM v5.0.1. These updates were initially supplied and reviewed in isolation. A full run check of the implemented version of PFM v5.0.1 to verify we can replicate the model developers' results was undertaken only for one sample network.

[3] Where updates are based on DfT information rather than internally generated reviews

Version 5.1

Model Updates

Version 5.1 was concerned with updates to lines files, covering the following Train Operating Companies (TOCs):

- East Coast Mainline;
- East Midlands;
- Chiltern; and
- London Midland.

Audit Process

For each of these TOCs, our audit covered:

- The model developers' interpretation of timetable information provided by the Department for Transport (DfT) for the future do-minimum coding; and
- The accuracy of the lines file coding against the model developers' specification for the do-minimum, Day 1 and Y networks.

Within the network coding, we reviewed:

- Train frequencies;
- Stopping patterns; and
- Train capacities.

In addition, we looked at the consistency between the constituent models making up the PFM, PLANET Long Distance (PLD), PLANET North (PN), PLANET Midlands (PM) and PLANET South (PS). As part of this audit, we have also undertaken a sample review of the implementation of preloads (the process of allocating demand on relevant links from one of the constituent models to another).

The audit procedure for these was as follows.

- Lines file imported into excel spreadsheet;
- Visual check of headway where amended in specification;
- Additional calculation added to spreadsheet to identify and highlight calling points and enable easy validations of amendments to section times and calling points in specification;
- Summary audit log spreadsheets completed showing checks by transit line number by file;
- Potential errors and mismatches were checked back with the model developers and specification or transit lines were amended as necessary; and
- Final audit check of amended transit lines.

Following the audit of lines files for individual TOCs, we undertook a sample audit of the updates to the preload[4] spreadsheets required to reflect these service updates.

The preload spreadsheet includes a line matching tab which provides a correspondence between the PLD and regional model services and their packet codes. Services are grouped by packet code based on which PLANET region, the train operating company, package code (based on route and stopping pattern) and direction of travel.

However, given the number of preload spreadsheets, their complex nature and the small impacts of errors, it was agreed with HS2 Ltd that a targeted sample preload check would be undertaken on v5.1. This focussed on two of the four service updates, London Midland (LM) and East Coast

[4] Preloads are the transfer of passenger flows for services that operate in both the PLANET Long Distance (PLD) and Regional models (PS, PM, and PN). This only applies to longer distance morning peak services that cross the regional model boundaries and preloads are used in the calculation of crowding.

Mainline and reviewed the consistency of line matching between the individual PLANET models for added services.

The regional PLANET models use a GJT elasticity to estimate changes in demand. In model versions up to PFM v5.0.1, these values are based on the Passenger Demand Forecasting Handbook (PDFH) version 4.1 of June 2005. As part of the PFM model development contract, Mott MacDonald have updated these elasticity values for PFM v5.1 to be in line with advice in DfT's TAG Unit M4, November 2014 to use parameters from PDFH 5.1, issued in April 2013. The change affects EMME macro files in PLANET South (PS), PLANET Midlands (PM) and PLANET North (PN).

The model developers supplied the relevant EMME macro files and a specification of the changes to be implemented in spreadsheet form.

The audit process included:

- Check the model developers' specification of new elasticities against PDFH v5.1;
- Check the new EMME macro files for PS, PM and PN against the specification; and
- Check whether any other, unintended, changes have been made in these macro files.

Atkins was commissioned by HS2 Ltd. to update demand matrices to correct for an error in the employment growth driver supplied by the Department for Transport (DfT), which was used to derive the rail demand forecasts for PFM v5.0.1. Employment growth between 2014 and 2018 used in the forecasting had been based on the Office for Budget Responsibility's (OBR) GDP growth rate rather than the OBR employment growth rate.

The update involved undertaking the EDGE demand forecasting process again using the corrected employment driver and analysing the impact on the demand matrix outputs in 2026 and the cap year for each of the four PLANET models.

The audit process included a review of the updated employment inputs to EDGE, reviewing the log files and changes made to the employment columns, and a comparison of the original PLD matrices with the employment corrected matrices.

An updated v5.1 Appraisal Spreadsheet was developed by the model developers which included a wide range of relatively small modifications as summarised in bullet point form below:

- Amended ramp up assumptions;
- HS2-HS1 Link input re-instated but set to zero;
- Double counting of regional model indirect tax removed. MECC values used;
- Year inputs re-ordered on inputs sheet;
- Extrapolation of RPI indices to allow for later cap years;
- YrBreakdown sheets use first opening year rather than first modelled year to set zeros;
- Highway values extrapolated between 2015 and 2019;
- Years included in row 1 of YRBreakdown sheets and freeze panes applied;
- Inputs warning message if years are out of order;
- Fix to fare strategy on "OtherAssumptions" tab;
- Update to historical VOT to match EDGE;
- Change in formula in column G of VOT sheet; and
- GDP deflators tab included replacing hard coded values in OtherAssumptions tab.

The audit involved a review of the spreadsheet to verify the implementation of the modifications above, and a more general review of compliance with guidance where appropriate.

In addition to auditing the individual elements of the model that have been updated (which were supplied to us in individual model input files), we also reviewed an implemented version of PFM v5.1. The audit of the implemented model included:

- Check that all network coding updates have been imported into the implemented EMME databanks; and
- Run a sample network of the model to check the model results replicate the run versions of the model as well as the documented values in the release notes.

Version 5.2

Model Updates

Most of the updates in v5.2 (with the exception of those described under the headings *'trip matrix updates'* and *'implementation and run checks'* below) were concerned with spreadsheet modules. The following were updated for v5.2:

- Operating Cost Model
- Rail emissions model
- Car emissions model
- Noise Model
- WITA
- Updated appraisal spreadsheet
- Trip Matrix updates

In addition to auditing these, we have undertaken a series of implementation and run checks.

Audit Process

For all spreadsheet modules, the audit process was as undertaken in four main stages as follows.

This audit considers the design, functionality and robustness of the spreadsheet, and its fitness for purpose in the context of the anticipated type, volume and variability of the data processed.

- Housekeeping and good practice;
- Including identification of hardcoded values and scope for improved clarity or simplification;
- General issue identification;
- Including detailed formula checking and data tracing within and between worksheets;
- Input to output sample calculation checks;
- Including changes to user inputs and, where appropriate, embedded parameters;
- Model stress testing; and
- Including tests with extreme and inconsistent data values.

In general, no checks were made on the accuracy or provenance of the input data and assumptions included in the version audited.

Some specific features of the individual model components audited are described below.

The operating cost model is used to assess the present value of the costs of building and operating various options for HS2.

The audit considered the design, functionality and robustness of the operating cost model spreadsheet (version 33) as supplied by HS2 Ltd on 04/08/15, and its fitness for purpose in the context of the anticipated type, volume and variability of the data processed.

We verified the use of the model version 33 for appraisal with opening years as supplied, and have tested operation with other opening years. Comments were also offered on the current state of preparedness for expansion to include a third year of service introduction.

HS2 Limited have developed spreadsheet to estimate the impact of the HS2 project on diesel train emission, car emissions and noise and to process outputs from the Wider Impacts (WITA) assessment.

HS2 Limited have supplied the following files for audit:

- 150804 Diesel train emission estimation_2027 opening_EV QA.xlsm
- 150730 Car emission estimation_2027 opening_EV QA.xlsm
- 150706 Noise appraisal AM QA.xlsx

- WITA_Interpolation V1.4.1_P52AN005_Phase1_Phase2a_Phase2.xlsx

The spreadsheets are populated with data from model outputs and current reference data from WebTAG November 2014 and assumptions.

An updated v5.1B Appraisal Spreadsheet was developed by the model developers which included a number of small modifications as summarised below:

- Two new scenarios have been included: Phase 2 Inc. and Phase 3 Inc.
- The fare growth assumptions have been moved into the 'RunInputs' tab. This enables the modeller to apply a wider fare regime.

Systra supplied the following file for audit:

- HS2 Economic Appraisal Spreadsheet v5_1B Template_QES_PFMv52b_HASH.xlsm

The updated appraisal spreadsheet was supplied, together with an email summary of the updates as outlined above. The spreadsheet available for audit was populated based on the 'Phase 1, 2 and 3' appraisal type.

The audit involved a review of the spreadsheet to verify the implementation of the modifications above, and a more general review of compliance with guidance where appropriate.

HS2 Ltd. commissioned Atkins to use DfT's Exogenous Demand Growth Estimation Tool (EDGE) to provide three sets of new PLANET Framework Model (PFM) future year rail demand matrices, on the basis of three new rail fares policy scenarios.

A similar process for Highway and Air trip matrices was not completed for implementation in PFM v5.2. Instead, Systra set up a process of matrix interpolation to create a consistent set of matrices.

Atkins supplied the following for the rail demand matrices:

- Updated EDGE input files and log files; and
- Updated matrices.

For the highway and air trip matrix interpolation process, Systra made available an Excel workbook.

The audit process included:

- Reviewing the updated inputs to EDGE;
- Reviewing the log files and the changes made, in particular with regards to the largest changes;
- Comparison of the original PLD matrices with the updated matrices, for both the base year and cap year; and
- Reviewing and testing the highway and air matrix interpolation spreadsheet.

The following implementation and run checks were carried out to audit this task:

- Run a sample of available model scenarios to check the model results replicate the run versions of the model;
- Check that impacts of model outputs of the updates to v5.2 when compared to PFMv5.1 can be explained by the changes to inputs; and
- Check the script to make sure all the additions in v5.2 have been correctly combined and not caused any additional issues.

Appendix B: Use of PFM v5.2 for the HS2 Phase 2a SOBC

Background

The model was used to produce the forecasting and economic inputs to the Phase 2a Strategic Outline Business Case.

HS2 Ltd supplied the populated appraisal spreadsheets used for the business case:

- WITA Interpolation Tool;
- Noise Appraisal;
- Car Emissions Estimation;
- Diesel Train Emissions Estimation;
- Cost Estimates;
- Economic Appraisal Spreadsheet; and
- Overall BCR Template;

We also received the location on eB (enterprise Bridge, HS2 Ltd's file sharing system) of all the output data from PFM v5.2:

- Appraisal spreadsheets (8) by phase and with NI turned on and off
- Sector benefits spreadsheet which provides crowded time and revenue benefits by purpose in sector matrices
- Standard outputs spreadsheet which contains information such as boarders and alighters on HS2 services, kms and boarders by TOC, high level changes in demand
- OD Benefits spreadsheet which provides information on annualised/deannaulised benefits and revenue between PLD zones pairs
- Key indicators spreadsheet which provides information on total benefits, revenues, total HS2 boarders and total rail, car and air trips plus passenger kms for rail and HS2.

Audit Process

The audit process involved cross checking the appraisal spreadsheets used for the business case with the model output provided on eB to ensure consistency. The following checks were undertaken:

- Noise, car and train emissions – checks were undertaken that the noise and emissions outputs were consistent between the noise appraisal and the 8 appraisal spreadsheets in addition vehicle kilometres were cross checked with the standard outputs
- WITA Interpolation tool was checked against the model outputs and consistency with the 8 appraisal spreadsheets for each phase in terms of agglomeration and labour supply impact.
- Cost estimates were compared against the appraisal spreadsheet coupled with checks on maintenance costs inputs such as HS2 network kms with standard outputs
- The economic appraisal spreadsheet was checked against the sector benefits, the standard outputs, the key indicators and the OD benefits spreadsheet to check the benefits and demand were consistent.
- In addition checks were undertaken that the 8 appraisal spreadsheets had been correctly run with the correct phase, opening year, numerical integration run, fares growth and cap.

This showed that the data items could be matched.