

Independent Reporter A
Reporter Mandate – ICMv2 Audit
Final Report

Halcrow Group Limited

Halcrow Group Limited
Vineyard House 44 Brook Green London W6 7BY
Tel +44 (0)20 7602 7282 Fax +44 (0)20 7603 0095
www.halcrow.com

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2 Introduction

2.1 Details of mandate

- 2.1.1 As part of its role as Independent Reporter, Halcrow has been appointed jointly by Network Rail and ORR to undertake a detailed technical audit of version 2 of Network Rail's Infrastructure Cost Model (ICM).
- 2.1.2 Network Rail has developed the ICM to produce long-term forecasts of activity, expenditure and outputs for different specifications of usage and capability. Version 2 of the ICM underpins the costs within Network Rail's strategic business plan published in October 2007¹.
- 2.1.3 The purpose of this audit was to satisfy ORR, Network Rail and its key stakeholders that the overall modelling process was robust, that any specific errors were identified and that any other key weaknesses were recognised.
- 2.1.4 ORR will refer to the key conclusions from this audit as part of its review of Network Rail's October 2007 strategic business plan.
- 2.1.5 The remit for this mandate was agreed with ORR and Network Rail on the 11 December 2007, which set out the prime objective of the study as follows:

"Perform a detailed "forensic" audit of the formulae and macros that constitute ICM v2 in order to be able to confirm that they correctly carry out the calculations described in the Functional Specification and to identify any computational errors."

- 2.1.6 As a secondary objective, we were asked to express views on the methodology used and provide:

"an audit report on the computational accuracy of the model, identifying any areas where the Reporter believes that the model does not correctly complete the calculations defined in the detailed functional specification"

2.2 Previous Independent Reporter audits of ICM

- 2.2.1 Asset Management Consultancy Ltd (AMCL), the Independent Reporters for Asset Management systems, has carried out two previous audits on the ICM.
- 2.2.2 Their first report, "ICM Phase 1 Audit Report Version 1.2" (25 July 2006), assessed the accuracy of some of the more important spreadsheet-based calculations of version 1 of the ICM by independently repeating the calculations required by the functional specification and verifying that results were the same. It did not cover calculations carried out in the MS-Access back end of the large model components covering track and civil engineering costs. It concluded that the model was generally working according to their independent interpretation of the functional specification.
- 2.2.3 AMCL's second report, "ICM Phase 2 Audit Report Version 1.1" (25 September 2006) considered the theoretical basis of the modelling approach, rather than the way the model itself implements it.
- 2.2.4 The focus of our current audit was to complement rather than repeat AMCL's previous work. In particular, it required detailed examination of the mechanics of the spreadsheets, MS-Access databases and controlling macro code to ensure that the published functional specification was being met and that individual calculations were correctly coded.

¹ Details of OCT 07 SBP available on NR's Website at <http://www.networkrail.co.uk/asp/4355.aspx>

2.3 Scope of the audit

2.3.1 In the preliminary discussion with Network Rail and ORR, NR presented a block diagram of the model and gave their view of the most effective scope of the audit, shown here as Figure 2.3.1.

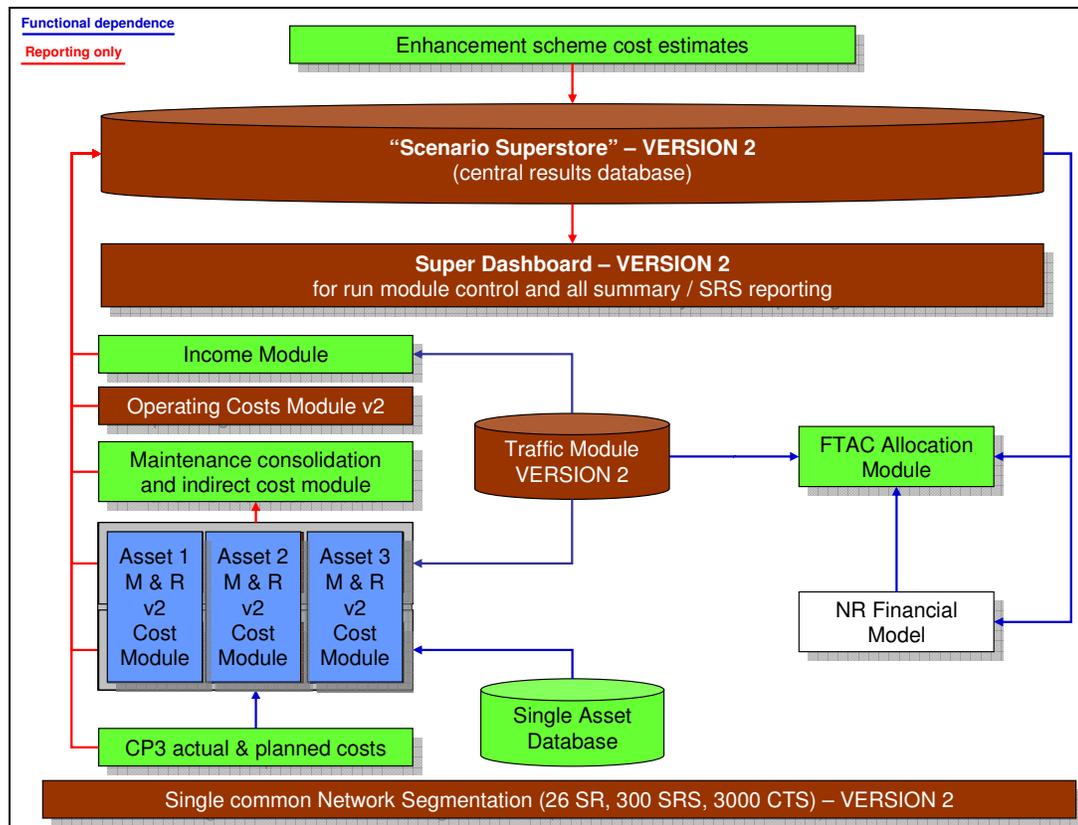


Figure 2.3.1 Model Structure and Scope as provided by Network Rail

2.3.2 Network Rail defined the audit scope as being all the asset-specific modules (shown in blue), the operating cost and income modules and the FTAC (Fixed Track Access Charge) module.

2.3.3 Out of scope would be all input data, the NR Financial Model and the Traffic Module.

2.3.4 Following discussion with Network Rail on the importance of the calculations of the Traffic Module to the Income and Track modules in particular, the Traffic Module was brought into the scope of the audit.

2.4 Halcrow's approach

2.4.1 In response to this remit, Halcrow's approach has been to address in detail as many of the key calculations, with the greatest potential impact on the model's results, as possible in the time available. The approach has involved the following steps:

- Devising a productive method of assessing, controlling, recording and reporting on the work of the audit
- Identifying tools to help with the task
- Finding and training staff members to carry out the audits

- Carrying out the audits in an iterative manner, improving the focus and speed of the process as it has unfolded
- Reviewing potential issues with the model's developers at Network Rail to ensure common understanding
- Analysing and documenting the results.

2.4.2 A key focus of the work has been the areas not covered in detail by the previous AMCL reports. The most important of these is the track module, whose calculations are nearly all done in an MS-Access database rather than, as most of the model, an MS-Excel spreadsheet.

2.5 This document

2.5.1 This document is the Final Report required by the NR/ORR mandate. It is structured as follows:

- Section 3 describes the ICM from the auditors' perspective;
- Section 4 describes the audit process followed;
- Section 5 sets out our results and the issues arising;
- Section 6 contains our conclusions and recommendations.

3 The Model

3.1 Structure

- 3.1.1 The model is constructed as series of modules, each responsible for modelling future volumes of renewals and maintenance and thence costs of one Network Rail asset category. The results of each module's calculations are consolidated into a single database for analysis and reporting.
- 3.1.2 Each module requires data inputs. Some, such as traffic levels and details of the network geography, are shared and taken from a common source; others are specific to the module itself.
- 3.1.3 Each module is centred round an MS-Excel workbook which handles the key model functions:
- Input of data: reference to common sources such as the network segregation, the year / CP calendar, and the traffic volume forecaster via MS-Query queries of the relevant MS-Access databases; direct input into spreadsheet cells.
 - Parameters to control the model: switches and metadata used by the spreadsheet macros.
 - Management of calculations: named ranges and template formulae used to do the key model tasks of renewal and maintenance volume and cost calculation.
 - Assembly and presentation of results: lookup functions, presentations and charts to summarise and filter the totals for analysis, extract and reporting.
- 3.1.4 The larger modules, particularly those that analyse costs and activities at the most detailed level of breakdown of the network, use an MS-Access database to store their data and carry out their calculations. This is principally to get around the 65,536-row limit of MS-Excel.
- 3.1.5 Control of the process flow of the model is done by VBA code and macros, mostly in the workbooks but also in some cases in the MS-Access databases.

3.2 Scale

- 3.2.1 By any standards the ICM is a large model. In total, the calculation modules are about 1.2 Gigabytes in size, with a further 300Mb of input traffic and asset data. Figure 3.2.1 below shows some statistics about each module, gathered during our analysis of the audit task.

Module	Data volume (Mb)	MS-Excel Worksheets	Distinct MS-Excel Formulae	MS-Access databases	MS-Access queries
Civils	79	17	281	3	89
Electrification	139	53	3,108	1	57
FTAC	3	11	67	1	56
Income	43	44	1,032	1	6
Maintenance consolidation	18	36	626	-	-
Maintenance indirects	9	13	469	-	-
OPEX	10	31	1,389	-	-
Operational Property	21	42	1,289	-	-
Other renewals	6	17	475	-	-

Module	Data volume (Mb)	MS-Excel Worksheets	Distinct MS-Excel Formulae	MS-Access databases	MS-Access queries
Plant & Machinery	22	51	1,808	-	-
Signalling Renewals	45	23	388	2	79
Signalling Maintenance	11	33	415	1	27
Telecoms	37	63	3,164	1	35
Track	780	17	598	3	496
TOTAL	1,224	451	15,109	13	845

Figure 3.2.1 ICM Module sizes

3.2.2 The Track module is by far the largest in terms of data volume. It is also quite different in character from the other modules since by far the bulk of the calculation of renewal and maintenance volumes and costs is carried out in MS-Access queries rather than spreadsheet formulae.

3.3 Focus of the audit

3.3.1 The mandate for this work required us to concentrate in detail on the calculations contained in the model, to verify that they follow the functional specification (ICM v2 functional specification DRAFT 191107.pdf).

3.3.2 As can be seen in Figure 3.2.1, the volume of spreadsheet formulae and Access queries that embody the calculations is very large. Given the tight budget and timescale for this audit, we have therefore had to adopt a tightly-focussed approach.

3.3.3 There are two aspects to the focus:

- Concentration on key formulae and queries. As discussed in more detail below, we identified the most important formulae within each worksheet: those that embody the intention of the model and are directly responsible for modifying the volume and cost figures. Many other formulae, such as those responsible for deriving sheet, row and column headings or summaries of data for dashboards and reports specific to each module, have not been audited in depth. Similarly, for the MS-Access database components, we identified the queries which are in the direct flow of data from inputs to outputs and concentrated on these, leaving aside other queries which assemble lookup data or prepare output tables for subsidiary reports, for example.
- Concentration on the modules responsible for most expenditure. We grouped the modules into three tiers by proportion of total expenditure they represent, as follows:

Tier 1:	Track, Signalling, OPEX	61% of total cost
Tier 2:	Civils, Operational Property, Telecoms	24% of total cost
Tier 3:	Remainder	15% of total cost

3.3.4 Our goal was to complete the modules in Tiers 1 and 2 in time for the final report, thus covering 85% of Network Rail's total expenditure.

4 The Audit

4.1 Process and Automation

4.1.1 The size of the ICM and the requirement to complete the current audit within a tight timescale meant that the audit process had to be carefully thought through, documented and prioritised.

4.1.2 In particular, as much use as possible was made of automation and technical support to ensure that the audit team, which of necessity of time were drawn from Halcrow's worldwide resource pool and working from their home offices, are fully briefed to carry out the correct work in the most efficient manner.

4.1.3 The first step was the procurement and construction of tools to assist with the audit. These were:

- A spreadsheet auditing tool, "Spreadsheet Detective". This tool was chosen from several examined because of the way in which it groups together the distinct formulae from each worksheet into a separate report which can be easily used as the basis of an audit plan. A sample of this type of report is shown in Appendix A.
- An MS-Access query dependency tracking tool, "Query Tree Editor". This tool enables the complex nest of queries, particularly those used by the Track module, to be traced and examined clearly. A sample of its presentation is shown in Appendix A.
- A specially-developed MS-Access database to hold the details of the elements of the ICM to be audited, the checks to be carried out for each one and any issues raised as a result of the audit. Appendix A shows some screenshots of the database.
- Some specially-developed VBA code to analyse the spreadsheets and MS-Access databases to extract their formulae and query definitions for automatic loading to the audit database. (This code enabled the figures showing the scale of the model in Figure 3.2.1 above to be calculated).

4.1.4 Once the raw data about the worksheets and formulae had been captured, the next step was the analysis and categorisation of all the formulae and calculations to identify which ones should be the focus of the audit work. This was done using both "top-down" and "bottom-up" approaches.

4.1.5 Top-down, the worksheets and spreadsheet formulae in the model were categorised by purpose, using consultations and discussions with the modellers at Network Rail as required to clarify. This is a manual process, working from the requirements of the model and the broad structure and layout of the spreadsheets. We identified this list of formula / query purposes:

- Data input;
- Categorisation and dimensions (e.g. creation of time / asset / geography axes to spreadsheet tables);
- Calculation. These formulae are the ones focussed on most heavily by the audit;
- Data transfer: movement / reference of data from one part of the model to another;
- Summary: grouping of detailed data to more consolidated levels;
- Output and data assembly: formatting and organisation of data for reporting;
- Furniture: headings, titles, data preparation and system control functions.

4.1.6 In parallel with this top-down categorisation, the bottom-up categorisation was done based on the contents of the formulae. This was done automatically using the specially-developed VBA code. The formula categories were:

- Text manipulation;

- MS Query;
- Lookup (for referencing data items in other ranges or other worksheets);
- “Purple Formula” calculation. These are the key formulae for calculating renewal dates, renewal volumes and costs for each type of asset in the most standard template spreadsheet. They are so named because of the cells in which their reference copies are stored prior to being applied to their target ranges by a macro;
- “Purple Formula” target range. These are the ranges over which the “Purple Formulae” apply;
- Summary: consolidation of many values into a single one;
- Other: miscellaneous formulae.

4.1.7 For the MS-Access queries, we categorised them by purpose:

- Delete query, used to remove rows from tables
- Append query, used to add rows of data to tables
- Update query, used to change the values of rows of data
- Select query, used to list data from the tables
- Crosstab query, used to present the data in “dashboard”-style format.

4.1.8 By parsing the text of the queries, we were also able to identify other possible points for auditing:

- If the query had a “WHERE” clause, meaning that it had a filter restricting the rows involved.
- If the query did any arithmetic calculations
- If the query summarised data from many rows to few, i.e. it had a “GROUP BY” clause

4.1.9 As a result of the categorisation, we were able to prioritise the work of the auditing team to particular types of formula on particular worksheets; and to particular queries in the MS-Access databases.. This prioritisation was set up in the auditing database.

4.1.10 For each category of formula or query, a list of required checks was set up to guide the auditing team. Snippets of the list are shown in Figure 4.1.1 (worksheet and query-level checks) and Figure 4.1.2 (formula or column-level checks) below; the full tables are in Appendix B.

Worksheet Category	Check	Check Description
Asset_AgeProfile	Name	Worksheet name in line with content and vice versa
Asset_AgeProfile	Set-up	Set-up corresponds to general pattern / diagram
Asset_AgeProfile	Asset Reference	Cell A1 contains the right Asset Reference (i.e. Asset_N), or S or H
Asset_AgeProfile	PF_ReplacementYear	Should be present along with corresponding range of operation
Asset_AgeProfile	PF_ReplacementVolume	Should be present along with corresponding range of operation
Asset_AgeProfile	PF_ReplacementCost	Should be present along with corresponding range of operation
Asset_AgeProfile	AnnualReplacementCostSummary	Table should be present
Asset_AgeProfile	Output1_AssetN	Named Range based on AnnualReplacementCostSummary should be present
Asset_AgeProfile	Output2_AssetN	Named Range based on AnnualReplacementCostSummary should be present
Asset_CostProfileLinkedToAP	Name	Worksheet name in line with content and vice versa
Asset_CostProfileLinkedToAP	Set-up	Set-up corresponds to general pattern / diagram
Asset_CostProfileLinkedToAP	Asset Reference	Cell A1 contains the right Asset Reference (i.e. Asset_N), or S or H
Asset_CostProfileLinkedToAP	PF_AnnualPreEfficientSpend	Should be present along with corresponding range of operation
Asset_CostProfileLinkedToAP	PF_AnnualPreEfficientSpendReportFormat	Should be present along with corresponding range of operation
Asset_CostProfileLinkedToAP	PF_AnnualPostEfficientSpend	Should be present along with corresponding range of operation
Asset_CostProfileLinkedToAP	PF_AnnualPostEfficientSpendReportFormat	Should be present along with corresponding range of operation
Asset_CostProfileLinkedToAP	TotalAnnualCostSummary	Table should be present, with averages from CP6 onwards
Asset_CostProfileLinkedToAP	AnnualPlannedSpend	Should come from Output2_AssetN from corresponding Asset_AgeProfile sheet - this will be output going into Pre-Dashboard
Asset_CostProfileOnly	Name	Worksheet name in line with content and vice versa
Asset_CostProfileOnly	Set-up	Set-up corresponds to general pattern / diagram
Asset_CostProfileOnly	Asset Reference	Cell A1 contains the right Asset Reference (i.e. Asset_N), or S or H
Asset_CostProfileOnly	PF_AnnualPreEfficientSpend	Should be present along with corresponding range of operation
Asset_CostProfileOnly	PF_AnnualPreEfficientSpendReportFormat	Should be present along with corresponding range of operation
Asset_CostProfileOnly	PF_AnnualPostEfficientSpend	Should be present along with corresponding range of operation
Asset_CostProfileOnly	PF_AnnualPostEfficientSpendReportFormat	Should be present along with corresponding range of operation
Asset_CostProfileOnly	TotalAnnualCostSummary	Table should be present, with averages from CP6 onwards - this will be output going into Pre-Dashboard
Asset_CostProfileOnly	AnnualPlannedSpend	Should be simple input not linked to another worksheet

Figure 4.1.1 Worksheet- and query-level checks

Formula / Range Category	Check	Check Description	Priority
FormulaCalculation	MatchesSpec	Matches the functional specification requirement	High
FormulaCalculation	ReferencesOK	Refers to correct data ranges of correct size	High
FormulaCalculation	SizeOK	Size in rows and columns is appropriate to the purpose	High
FormulaLookup	DataReferenceOK	Reference values conform to specification	Medium
FormulaLookup	ReferenceOK	Refers to the correct data range of the correct size	Medium
FormulaLookup	SizeOK	Size in rows and columns is appropriate to the purpose	Medium
FormulaPurple	MatchesSpec	Matches the functional specification requirement	High
FormulaPurple	RangeNamedOK	Is in correctly-named range FORMULA_n	High
FormulaPurple	ReferencesOK	Refers to correct data ranges of correct size	High
FormulaPurple	TargetRangeOK	Has target range	High
FormulaPurple	TemplateMatchOK	Conforms to template for formula type	High
FormulaSimple	ReferenceOK	Refers to the correct data range of the correct size	Low
FormulaSimple	SizeOK	Size in rows and columns is appropriate to the purpose	Low
FormulaSummary	MatchesSpec	Matches the functional specification requirement	High
FormulaSummary	ReferencesOK	Refers to correct data ranges of correct size	High
FormulaSummary	SizeOK	Size in rows and columns is appropriate to the purpose	High
FormulaText	NoObviousErrors	Formula appears to be correct	Low
Range	ReferenceOK	Refers to the correct data range of the correct size	Low
Range	SizeOK	Size in rows and columns is appropriate to the purpose	Low
RangeMSQuery	OptionsOK	Query options are appropriate to type of query and target area	Medium

Figure 4.1.2 Formula- and column-level Checks

- 4.1.11 Each audit team member was allocated a number of module components to work on. With each component came a “module pack” containing the following:
- A copy of the sections of the functional specification document pertinent to the module.
 - A copy of the code of the module. The spreadsheets were “frozen” into an auditable mode rather than their default “live” mode: this means that automatic macros were turned off, all the worksheets were made visible and all the hidden MS-Excel screen furniture such as worksheet tabs, formula bar, scrollbars and gridlines were turned on. The password protection for the worksheets and the VB code was also removed to allow access for the auditing tools.
 - A copy of the “Spreadsheet Detective” audit report for the module, which highlighted the distinct formulae and named ranges in each worksheet of the module spreadsheet. Figure 7.1.1 below shows a sample Spreadsheet Detective report).
 - A copy of the audit Access database which indicated to the auditor the work that needs to be done and enabled them to record the audit checks as they were made and to make any notes or comments that may be required. Some screenshots from this database are shown in Appendix B.
 - A detailed procedure guide which indicated how the audit was to be done. A copy of this is included in Appendix B.
- 4.1.12 To maximise productivity, each auditor was provided with an additional screen for their computer so that the audit database and the spreadsheet being audited can be displayed simultaneously.
- 4.1.13 Every two or three days, face-to-face and telephone conferences were held with all the auditors to share insights and best practice as it evolved while the work proceeded.

4.2 Feedback and issues

- 4.2.1 Each auditor raised questions and requests for clarification as they worked. Each such question was reviewed by the core project team. Some were simple misunderstandings; others resulted in the discovery of genuine issues for the model.
- 4.2.2 The questions were raised by the auditor as notes or queries that they entered into their MS-Access data capture database. This database was returned to the project team each day and its data merged with the master database.
- 4.2.3 The Project Lead analysed the notes raised by auditors and either resolved them by clarification with the auditor concerned, or raised an "Issue" in the MS-Access audit database if the matter cannot readily be clarified.
- 4.2.4 Emerging issues were discussed with the Network Rail modelling team, either in person or by telephone. A key consideration has been the need for the modelling team to start addressing substantive issues in good time for the next release of the model.
- 4.2.5 Importance and urgency of issues was decided on whether the issue compromises the accuracy of the current results of the ICM and by how much.
- 4.2.6 The most significant issues are discussed in the text below; a complete list of all issues found appears in Appendix C.

4.3 Reporting

- 4.3.1 The audit MS-Access database enables us to report on the volume and type of audits carried out and the level of coverage of the model achieved.

4.4 Work done and productivity

- 4.4.1 The timescale for the current audit was always seen as challenging, given the timing of the mandate just before the Christmas break, and the need to mobilise a team of skilled spreadsheet analysts in short order for a very tight deadline.
- 4.4.2 We have managed to organise a team of four spreadsheet auditors and two database auditors. It took longer than anticipated to pull together an audit methodology that was sufficiently focussed to enable us to cover all important areas of the model within the time available, yet sufficiently well-defined and clearly documented to be released to a sizeable and geographically-scattered team.
- 4.4.3 The audit methodology was completed and tested on one of the spreadsheet-based modules (Plant and Machinery) with one of the designated Spreadsheet Auditors. Following the test the methodology was revised and the VBA data extract enhanced to extract more data automatically from the Spreadsheet Detective reports and MS-Access queries. This improvement enhanced the productivity of the auditors by pre-filtering the huge number of formulae down to those with a direct bearing on the results of each workbook.
- 4.4.4 With the improved methodology, more rapid progress could be made. We have completed the audits on modules as follows, in line with the schedule we set in the interim report:

Tier	Module	Component	Audit Status
1	Track	Access database	Complete
		Excel spreadsheet	Complete
	Signalling	Access database	Complete
		Excel spreadsheet	Complete
	Signalling maintenance	Access database	Complete
		Excel spreadsheet	Complete
OPEX	Excel spreadsheet	Complete	

Tier	Module	Component	Audit Status
2	Civils	Excel spreadsheet	Complete
		Access database	Complete
	Operational Property Telecoms	Excel spreadsheet	Complete
		Access database	Complete
3	Plant and Machinery Electrification	Excel spreadsheet	Complete
		Excel spreadsheet	Complete
		Access database	Complete
	Income	Excel spreadsheet	
		Excel spreadsheet	
	Maintenance indirects	Excel spreadsheet	
	Other renewals	Excel spreadsheet	
	FTAC	Excel spreadsheet	
		Access database	

Figure 4.4.1 Status of the audit

- 4.4.5 In terms of our original goal, we have achieved the coverage of Tiers 1 and 2 that we intended to do. We have also covered the Electrification module which is a complex one despite being responsible for a relatively small proportion of total expenditure.
- 4.4.6 Figure 4.4.2 below shows the number of audit checks carried out by the team and the number of items “questioned” or referred for comment. Most of the referred items have given rise to issues for Network Rail, mostly of a minor nature. The most significant issues are discussed in Section 5 below, while a complete list is attached as Appendix C.

Checks Done		Result		
Module	Component	OK	Questioned	Grand Total
Civils	Civils_v2Live	568	47	615
	CivilsCal_vLive.mdb	96	9	105
OPEX	ICMv2 Operating costs_vSBP	243	16	259
OpProp	ICMv2 Operational property_vSBP	74	23	97
P&M	Plant_and_Machinery_vLive	685	18	703
Signalling	Signalling_v2Live	594	34	628
	Sigv2Live_Cal.mdb	181	9	190
Signalling Maintenance	Sig_maintenance_vLive	908	65	973
	Signalling_Maintenance_v2.1.mdb	29	5	34
Telecoms	Telecoms_vLive	1,135	141	1,276
	Telco_Retail.mdb	71	36	107
Track	TrackModule.mdb	440	38	478
	Track_Module_vLIVE	642	121	763
Electrification	Electrification Module vLive	63	31	94
	Electrification_Maintenance_vLive.mdb	113	9	122
FTAC	FTAC_vLive	7		7
Grand Total		5,849	602	6,451

Figure 4.4.2 Checks carried out and questioned

- 4.4.7 The team have carried out a total of over 5,000 specific checks on the formulae and queries in the model.

5 Results of the audit

5.1 Summary

- 5.1.1 In broad terms, the audit has shown the model to be well-designed and well-constructed. The Network Rail team has considerable expertise, not only in modelling and the use of MS-Excel and MS-Access, but also in the asset renewal and maintenance disciplines they seek to model.
- 5.1.2 We are satisfied that the model will correctly process its input data in line with the Functional Specification, subject to resolution of the “Fault” issues we have raised below.
- 5.1.3 Where we have cause to comment, it is on these matters:
- Consistency across the modules. The team have designed a templated structure for the spreadsheets, the MS-Access databases and the linkages between them. When this structure is applied diligently, such as in the Signalling and Civils models, the result is a robust model which is easy to understand, debug and extend (and audit); where there is variation from the structure, such as in the Track and OPEX modules, more issues arise and any correction or change to the model will be much riskier.
 - Linkage with the Functional Specification. Whilst the general level of conformance with the Functional Specification is good, there are significant numbers of undocumented aspects to the calculation such as overlay factors, special processing flags etc whose purpose is unclear.
 - Resilience to change in external circumstances. Many of our audit checks, referrals and issues relate to how easy it will be to adapt the model to cope with different sizes of dimensions, particularly in terms of asset categories and strategic route sections. Experience suggests that however confident the modelling team may be that no such changes will occur, the evolving needs of the business will ensure that they will. Adoption of some best practices will make future adaptation of the model to address these changes much easier.

5.2 Overall results

- 5.2.1 This section gives general results of the audit. Module-by-module comments are given in Section 5.3 below.
- 5.2.2 The audit of the Tier 1 and Tier 2 modules has raised a number of issues of varying degrees of severity, as shown in Figure 5.2.1 below.

Issue Severity	No of Issues	No of Occurrences
1 Severe Fault	4	10
2 Significant Fault	4	41
3 Minor Fault	7	106
4 Warning	9	102
5 Comment	18	117
6 Suggestion	8	58
Grand Total	50	434

Figure 5.2.1 Issues by Severity

- 5.2.3 The levels of severity assigned to the issues have the following meanings:
- | | |
|---------------------|---|
| 1 Severe Fault | This is a fault in the model design or execution that definitely leads to errors in calculation of model results in the scale of £10s of millions or above. |
| 2 Significant Fault | This is a fault in the model design or execution that definitely leads to errors in the presentation of model results, albeit at a lower level. |
| 3 Minor Fault | This is a fault in the model design or execution that may lead to error in the model results or a contravention of the stated design and development standards. |
| 4 Warning | This is an issue that may result in future errors in calculation if present assumptions or external data change. Spreadsheet models are particularly prone to this type of problem: we have tried to identify where it might strike and what to do about it. |
| 5 Comment | We have commented where the intention of the modeller or the interpretation of the specification is unclear, or where we have seen something in the assumptions or policies of note. |
| 6 Suggestion | We have made suggestions where we believe the reliability and extensibility of the model will be improved by the use of some particular spreadsheet or database technique that represents standard best practice or we have found particularly helpful ourselves. |
- 5.2.4 Each issue that we have raised can apply to a number of different places in different parts of the model. Each such place we have called an “occurrence”. Since the model is built using templated spreadsheet layouts, it is quite common for an issue spotted in one part of the model also to apply to several others. We have tried to identify all such occurrences, but the list should not be seen as exhaustive, and we would recommend that in addressing the issues the modellers use their knowledge of the model’s structure to find other occurrences that we have not listed.
- 5.2.5 The overall number of issues raised is comparatively small given the size of the model and we are satisfied that given the way the model works, the overall impact of the faults found will not invalidate its results.

Issues Involved		Severity						
Module	Component	1 Severe Fault	2 Significant Fault	3 Minor Fault	4 Warning	5 Comment	6 Suggestion	Grand Total
Civils	Civils_v2Live			1	1	2		4
	CivilsCal_vLive.mdb		1		1	2		4
Electrification	Electrification Module vLive	1	3		1	3	1	9
	Electrification_Maintenance_vLive.mdb		2		1	2		5
OPEX	ICMv2 Operating costs_vSBP	1	2		1	1	2	7
OpProp	ICMv2 Operational property_vSBP			3	2		1	6
P&M	Plant_and_Machinery_vLive				2	2	1	5
Signalling	Signalling_v2Live		1	1	4	1	1	8
	Sigv2Live_Cal.mdb			1		2		3
Signalling Maintenance	Sig_maintenance_vLive			2	2	1	1	6
	Signalling_Maintenance_v2.1.mdb					2		2
Telecoms	Telecoms_vLive		1	4	3	3	2	13
	Telco_Retail.mdb	1	1			1		3
Track	Track_Module_vLIVE		1	4	2	4	4	15
	TrackModule.mdb	4	2		1	6	4	17
Grand Total		5	11	21	21	32	17	107

Figure 5.2.2 Issues and Modules

- 5.2.6 Figure 5.2.2 above shows how the issues are distributed around the modules of the model that we have investigated. It should be noted that since each issue can affect more than one module, the totals in this Figure are higher than those in Figure 5.2.1.
- 5.2.7 We can observe the following:
- The Severe Faults are concentrated in the Track module. This is not surprising, since this module not only handles much larger sums of money than other modules, but also contains the most complex calculations and is the most different in structure from the other modules which follow a standard template. We consider these faults individually below. None is difficult to correct and none invalidates the basic concepts of the model.
 - The Significant Faults are also skewed toward the Track module. Again, all are easily put right and do not undermine the overall quality of the model.
 - Suggestions and Comments apply to all modules more or less equally. The apparent concentration on Track reflects the highly detailed analysis this module required to understand how it worked.
- 5.2.8 The audit process was most straightforward for those modules that followed a templated approach most closely. Once the structure and operation of the template had been explained to the audit team, it was possible to tackle the specifics of each module reasonably easily. The team were therefore most productive in working with these modules.
- 5.2.9 These same modules also had the fewest issues, suggesting that the template acts well to ensure a reliable and extensible model.
- 5.2.10 The modules that depart from the standard template presented much greater problems. The hardest were:

- The OPEX module, which has large numbers of hard-coded formulae which in some cases were impossible to check properly;
- The Track module, which does nearly all of its calculation work in a Microsoft Access database, but which also has the least well-structured spreadsheet component;
- The Electrification module, which has a different structure and way of working with Microsoft Access from the other modules.

5.3 Module-by-module results

Track module

- 5.3.1 The Track module overall implements the Functional Specification, carrying out a sequence of detailed and complicated calculations for renewal volumes and many different maintenance activities based on detailed asset age profiles and service life calculations for over 3100 track sections.
- 5.3.2 However, several aspects of the way the module has been built give cause for concern about the accuracy of its results and its future extensibility and maintainability:
- The MS-Access component has some errors which cause it to calculate incorrect results. (The most serious errors we found are listed below; all are included in Appendix C.)
 - The relationship between the MS-Access and MS-Excel components is not completely clear and documented. This means that debugging and extending the module will be more difficult than necessary.
 - The MS-Excel component has an unclear structure and a significant amount of redundant and superseded code which confuses the logical data flow.
 - The module makes many assumptions and calculations which are not documented clearly, either in the Functional Spec or in the body of the module itself.
 - The module lacks the “polish” of some of the other modules, giving the general appearance of a prototype or work-in-progress.
- 5.3.3 The most significant faults found in the Track module are:
- Issue ID 16: number of S&C Basic and Supervisor inspections incorrectly calculated because of the use of the Count rather than Sum function in the relevant database queries. This issue causes the model to underestimate the volume of these activities by a large factor, typically 26 or 52.
 - Issue ID 17: number of track defects underestimated by about 25% because of truncation of non-integer values to integers at a very detailed geographical level. The likelihood of a defect in any of the short Constant Traffic Sections in a year is very low: much less than 1. If this small value is truncated to an integer value as in the current code, the result will always be 0. When these 0s are summed over the Strategic Route Sections, they result in a lower likelihood of defect in the SRS than if the raw likelihoods are first summed to the SRS level and then truncated (or, better, rounded) to the nearest integer.
 - Issue ID 18: mismatch between the units of maintenance volume calculated by the model and the unit costs for these activities. Identified for three track and sleeper maintenance activities. Typically, unit costs are stated per track km. The volumes appear to have been calculated without including track km in the calculation, thus resulting in units of activity per CTS rather than per track km.
 - Issue ID 19: incorrect table join in one query leading to multiplication by 3 of the volume of crossing replacements. Missing table joins is the single most likely cause of error in an MS-Access based model: it is hard to detect after the model has been built and it inevitably causes results to be out by whole multiples.

-
- 5.3.4 These faults, and the other less serious ones detected, do not invalidate the basic working of the model and can easily be corrected. We recommend a way forward for this module in Section 6.2 below.
- 5.3.5 We note also Network Rail's remark that the overall results of the model are calibrated back to known expenditures in early years to allow for the effect of unmodelled costs. We have not observed this specifically in the module's code. This calibration will tend to reduce the impact of any significant error in the model's algorithm on overall costs, but will not prevent the skewing of the volumes and costs of individual activities.

Signalling module

- 5.3.6 The Signalling module embodies the Functional Specification as it pertains to Signalling renewals. It is a hybrid module using both MS-Excel and MS-Access components. It has been constructed using the templated approach and as a result is well-structured and very easy to follow. As a result, we found no issues categorised as Severe and only one categorised as Significant, which would affect one output line in the Dashboard output.

Signalling Maintenance module

- 5.3.7 The Signalling Maintenance module embodies the Functional Specification. Though the volume of activity and money in the model is large, the calculations are relatively straightforward and the model has been constructed using the templated approach which means that tracing its functionality is simple. The module had no Severe or Significant faults, only exhibiting generic characteristics of the template structure which we have covered in Warnings and Comments.
- 5.3.8 One aspect of the Signalling Maintenance module worthy of comment is that it stands completely alone from the Renewals model. The population of assets on which it works therefore does not reflect the result of renewals and replacements done in the Signalling module. This would be particularly pertinent for Level Crossings and the replacement of lineside signalling by ERTMS.

Operational Expenditure module

- 5.3.9 The Operational Expenditure (OPEX) module embodies the Functional Specification. It is a spreadsheet-only module whose structure relatively loosely follows the templated approach. This module was comparatively hard to audit, in some places having so many distinct and hard-coded formulae that a thorough analysis was impossible.
- 5.3.10 No severe faults were found, however, and only one significant fault which would affect the results of one row of the dashboard output.
- 5.3.11 We have a concern about the future maintainability of this module, given the large number of assumptions encoded within the formulae. In Section 16.2 below we suggest how this might be addressed: basically by applying the same templated approach as used in other modules to this one.

Civils module

- 5.3.12 This module calculates renewal and maintenance costs for civil engineering items: bridges, culverts and large structures. It conforms to the Functional Specification. The module is a hybrid MS-Excel / MS-Access one. It has been constructed using the standard templated approach and is therefore easy and clear to understand.
- 5.3.13 The module has no Severe Faults and one Significant Fault which would affect results. The other audit comments on the module relate to future change and clarification about some undocumented specification matters.

Operational Property module

- 5.3.14 The Operational Property module works according to the Functional Specification. It is a spreadsheet-only module which has been built roughly according to the templated structure.

-
- 5.3.15 The module has no Severe Faults or Significant Faults. The issues raised by auditors concern layout, structure and clarity of presentation and thus impact on future development and maintenance of the module rather than its current operation.
- 5.3.16 One matter worthy of our comment is the use of an arbitrary profile which is applied to the raw volumes and costs for each year of CP4 and CP5. This is not documented in the Functional Specification, there is no obvious source of the profiling factors and there is no evidence from the model that the profile cannot be used to bias the overall volumes upward or downward from the model's predictions.

Plant and Machinery module

- 5.3.17 The Plant and Machinery module works according to the Functional Specification. It is a spreadsheet-only module built according to the templated approach. The structure of the module is thus clear and easy to understand.
- 5.3.18 No Severe Faults or Significant Faults were found in the module. The auditors' findings relate principally to future enhancement of the model and are of a general nature that applies to all the templated modules.
- 5.3.19 This was the first module to be audited. This means that it underwent a large amount of inspection by auditors as we fine-tuned the audit process so that it focussed on the most significant matters.

Telecoms module

- 5.3.20 The Telecoms module broadly works according to the Functional Specification. It uses a templated approach that is shared with the Electrification module but which differs from that used by the other modules. This approach is complex, involving sub-spreadsheets and the executable code being run by both the MS-Excel and MS-Access components.
- 5.3.21 One Severe Fault and two Significant Faults were found in the module. The Severe Fault, Issue 16, results in the incorrect calculation of maintenance volumes and costs by a significant factor. This is caused by the use of an incorrect aggregate in an MS-Access query. The significant faults occur in many places in the module and may result in incorrect totals of costs for several types of asset. They relate to the use of NULL values in the database; and the use of incorrect cell references and range names in lookup formulae in the spreadsheet.
- 5.3.22 The structure of the module's template makes it vulnerable to future changes in the number of strategic route sections: a large number of spreadsheet ranges are sized around the current number of 310 plus an overhead of 10 sections. Any significant change to SRS numbers will generate a large volume of rework on this module.

Electrification module

- 5.3.23 The Electrification module broadly works according to the Functional Specification. It has been built using a similar templated approach to the Telecoms module, but it has several unique features not shared by that module.
- 5.3.24 The standard of documentation and the overall clarity of the working of this module are worse than most of the other modules. Auditing and debugging of the module was thus comparatively time-consuming and difficult; and future work on the module will be more difficult than in most of the rest of the module for the same reasons.
- 5.3.25 Having said that, there were no Severe Faults and three Significant Faults in the module. Most of the audit comments on this module relate to more minor failings which include hard-coded cell references and undocumented formulae. Some relatively minor calculation errors were also discovered.
- 5.3.26 Other matters worthy of comment in this module are:
- Range sizes hard-wired to the present number of Strategic Route Sections.

- A significant number of constant figures hard-coded into formulae rather than being exposed as reference data. These include numbers of years lifespan, start years for particular initiatives etc
- A large number of unnecessarily complex formulae throughout. There are several key formulae that use a complex structure of nested “if()” functions whose logical behaviour is not clear.

6 Conclusions and Recommendations

6.1 Conclusions

- 6.1.1 **Overall reliability of the model's results.** The model works according to the requirements of the Functional Specification, subject to the small number of key issues we have identified. It has been built using good practice and sound techniques in most places and clearly is the result of hard and dedicated work by Network Rail's team.
- 6.1.2 **Consistency of the modules.** There is some variability between approaches taken in the functional modules of the model. The best modules follow a sound templated approach; others are more "bespoke" in nature and as a result harder to understand and debug. They will also be harder to modify in future to meet enhancement requirements or changes in the external circumstances or business demands.
- 6.1.3 **Quality of documentation.** The Functional Specification is an adequate description of the overall functionality of the model. However, each module has its own specific functions which are not so well-recorded. A large proportion of the comments raised by the auditors related to this undocumented functionality. Given the complexity of the model, it would also benefit greatly from a Technical Specification document which would describe and mandate how the spreadsheet modules and MS-Access databases should be constructed, linked and operated.
- 6.1.4 **Network Rail development process.** The different modules of the model have been built by different people, though they share a common framework and key common data sources and targets. Where the auditors' work has been hardest (and, therefore, where we believe future modelling work will also be hardest) is where the modules' developers have introduced most of their own methodology which differs from or cuts across the standard template. We believe this one-person-per-module approach presents a significant continuity risk as the normal turnover of modelling staff proceeds.

6.2 Recommendations

- 6.2.1 Network Rail should correct the Severe Faults and Significant Faults immediately. We hope enough information has been given to Network Rail for this to be done without undue difficulty.
- 6.2.2 Network Rail should address the specific structural issues of the Track module before the next major run of the ICM. In particular:
- They should rebuild the module using the standard templated method of structuring the MS-Access database, naming the queries, using macros to group together and run linked sets of queries and invoking the macros from the spreadsheet module.
 - They should apply the documented visual standards to the spreadsheet part of the module, particularly in terms of identifying inputs, calculated cells and (not presently defined in the standard styles) ranges which pass data to the MS-Access module.
 - They should ensure that experimental and superseded code and data are removed from the live version of the spreadsheet and the Access database.
- 6.2.3 Network Rail should take actions to reduce their dependency on the specific knowledge of individual module developers:
- They should start work on a Technical Specification which will define the model structure and that of each individual module and Excel, Access or VBA component of the module.
 - They should adopt a "second pair of eyes" development process which ensures that understanding of each model element is shared and that conformance with standards

is enforced, specifically by e.g. a QA check of any change by another modeller than the main developer.

- They should ensure that all assumptions and internal calculations are documented, both on the worksheets and in the Functional Specification document. We hope that their comments will be helpful as a starting point in this regard.

6.2.4 Network Rail should take actions to “future-proof” the model against changes in the business environment. The most difficult of these to deal with will be changes in model dimensions such as the number or definition of strategic route sections (which are subject to change from any change to the network layout, shifting of territorial boundaries or traffic flow patterns) or asset grouping categories. Others that will appear will be the need to re-base cost and efficiency values against a different year, or to change the date groupings of years and Control Periods. Specific techniques exist to help with this:

- Use of dynamic range names which automatically stretch to fit the number of rows of data.
- Data query options which cause whole rows to be inserted rather than cells, so preventing query results from “crashing into” other data ranges below as the number of rows increases; or which automatically copy down formulae in adjacent columns.
- Fuller use of MS-Access to hold changing data volumes, using the spreadsheets more for standard summarised data entry and presentation. Databases are intrinsically better able to cope with changes in dimension sizes than spreadsheets.

6.2.5 Network Rail should consider migrating the database elements of the model from MS-Access to, say, SQL-Server. This would reduce several risks which we have observed already occurring with the use of MS-Access:

- Missed query joins. SQL Server does not suffer from the bugs which cause Access to lose joins in some circumstances.
- Hard-coded table path names. Since the tables are stored on a database, no file system path is required to access them.
- Performance. SQL Server runs much more quickly than Access when data volumes increase, particularly in the circumstance where the Access database is stored on a network drive.
- Case-indifference. SQL Server can be set up to require case-sensitive comparisons which will eliminate this cause of uncertainty.

7 Appendix A: Auditing Tools

7.1 Spreadsheet Detective

7.1.1 The Spreadsheet Detective tool, supplied by Southern Cross, www.spreadshestdetective.com, was the key auditing tool used for the spreadsheet elements of the module.

7.1.2 The tool has many functions, but the one we used most on this audit was the Formula Report, an example of which is shown in Figure 7.1.1 Spreadsheet Detective report below.

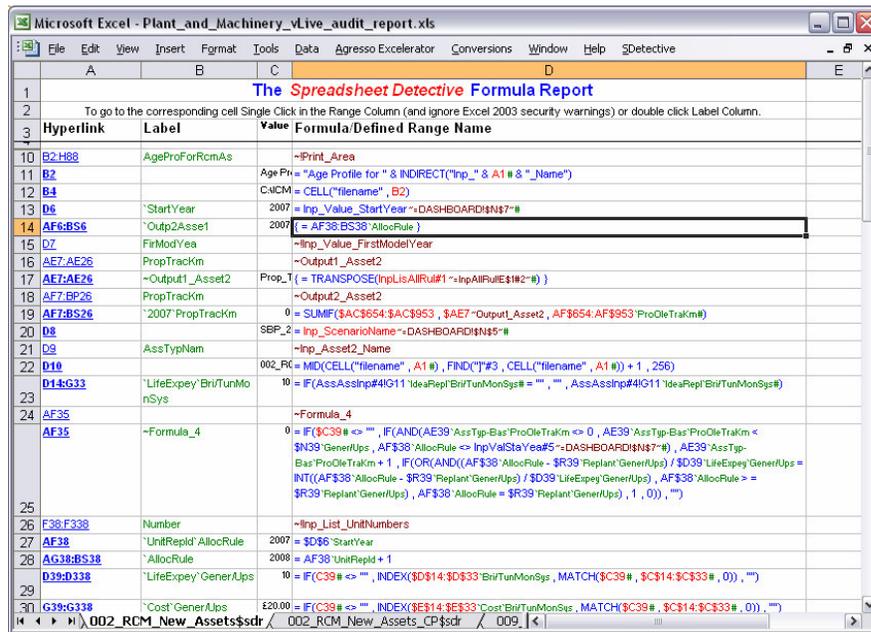


Figure 7.1.1 Spreadsheet Detective report

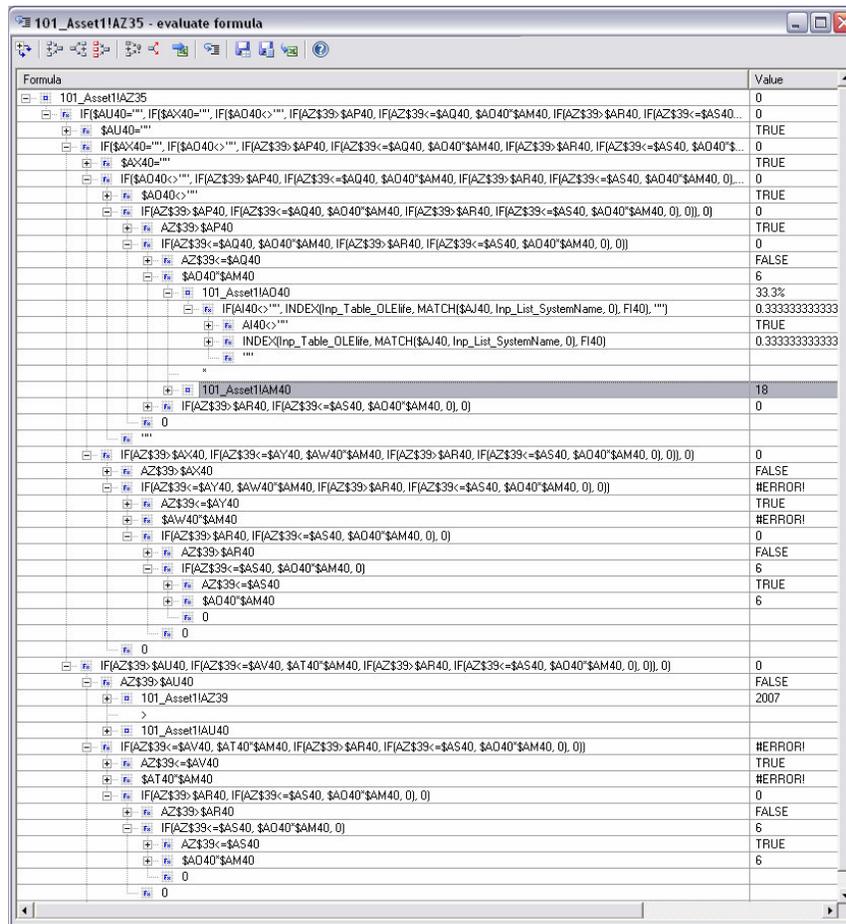
7.1.3 This report lists all the functionally distinct formulae in each worksheet as well as all the named ranges and any special Excel ranges such as queries to external databases, print areas etc. It also tries to make the formulae more comprehensible by annotating each cell or range referred to with a name that suggests its function.

7.1.4 We used the report in two ways: firstly, as a help in understanding the purpose and function of each formula, and secondly as the source of a checklist of items to audit.

7.1.5 In this second use, we used our specially-written Visual Basic scripts to load all the distinct formulae into our audit database, parsing them en route to identify what type of formulae they were: lookup, calculation, summary, string manipulation, template for copying etc.

7.2 Dependency Auditor

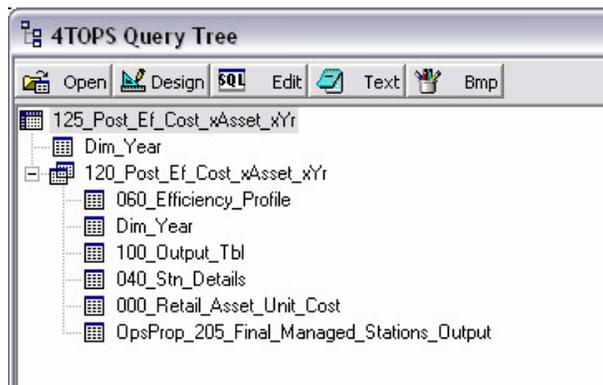
7.2.1 Dependency Auditor, from Spreadsheet Tools, www.spreadsheettools.com, is a spreadsheet auditing tool which focuses on individual formulae. It is extremely useful for working out how complex nested formulae work.



7.2.2 The screenshot above shows the way a very complex nested “IF()” formula from the Electrification module can be expanded in Dependency Auditor to see how its value is arrived at and to reveal the internal structure of the formula.

7.3 Query Tree

7.3.1 Query Tree from Four Tops, www.4tops.com, is an MS-Access database auditing tool which helps to explore the dependencies between queries. It is extremely useful for working back through a chain of nested queries to see where the data originally comes from and what processing has been done to it on its way to the final result set.



- 7.3.2 The screenshot above shows Query Tree indicating the sources that contribute to one query from the Telecoms module.

7.4 Bespoke VBA code

- 7.4.1 We wrote a number of Visual Basic for Applications routines to help analyse the spreadsheets and databases to gather data to support the audit. The data gathered was loaded to our MS-Access audit database to enable us to list, categorise, prioritise, analyse and report on the spreadsheet formulae and database queries of the model.
- 7.4.2 Routine “ProcessAuditWorkbooks” iterated through the formulae reports which we previously generated using the Spreadsheet Auditor tool, extracting all the formulae and named ranges and listing them out as a comma separated values text file that could then be loaded to the audit database. It also categorised the formulae into calculations, lookups, summaries etc by inspecting their contents.
- 7.4.3 Routine “ProcessQueries” iterated through the actual model spreadsheets, extracting the details of all the external data queries they contained. For each such query, the module extracted the results range, the source database and the source query name. The results were listed out as a comma separated values text file which could then be loaded to the audit database.
- 7.4.4 Routine “ProcessAuditDatabases” iterated through all the MS-Access databases in the model, listing out all the queries they contained. Each query’s type (Select, Append, Delete, Crosstab etc) was listed and its SQL statement was parsed to identify the target table(s) and additional data such as did the query have a filter (WHERE clause), a summarisation (GROUP BY clause) or a specific sequence (ORDER BY clause); or whether it involved any arithmetic calculation. All the information was listed out as a comma separated values text file which could then be loaded to the audit database.

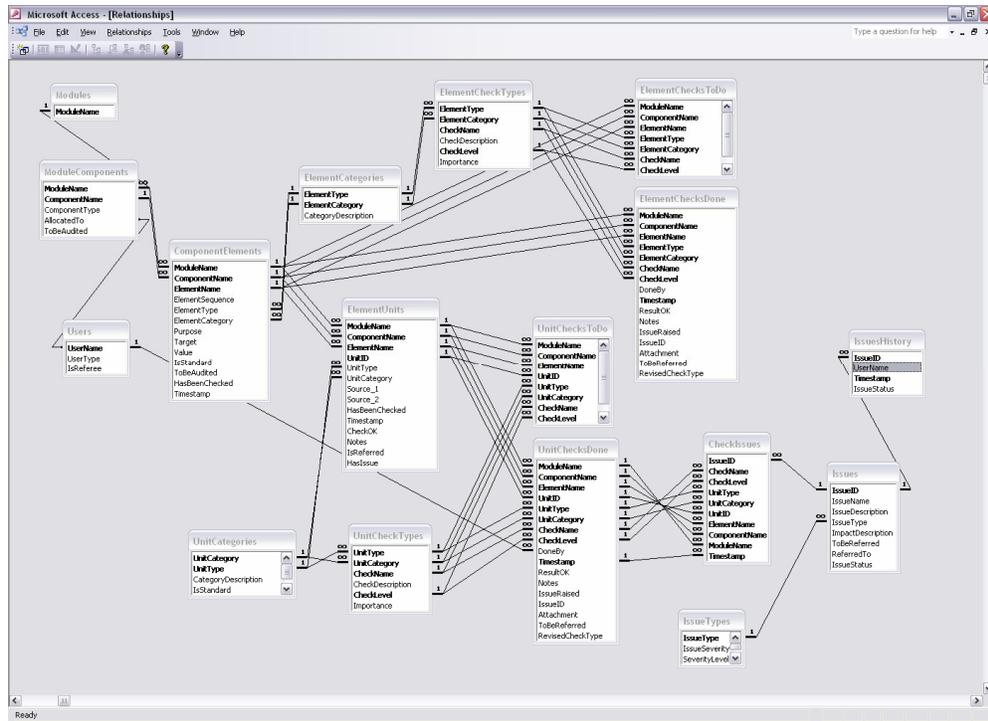
8 Appendix B: Guidance to Auditors

8.1 Audit database – screenshots

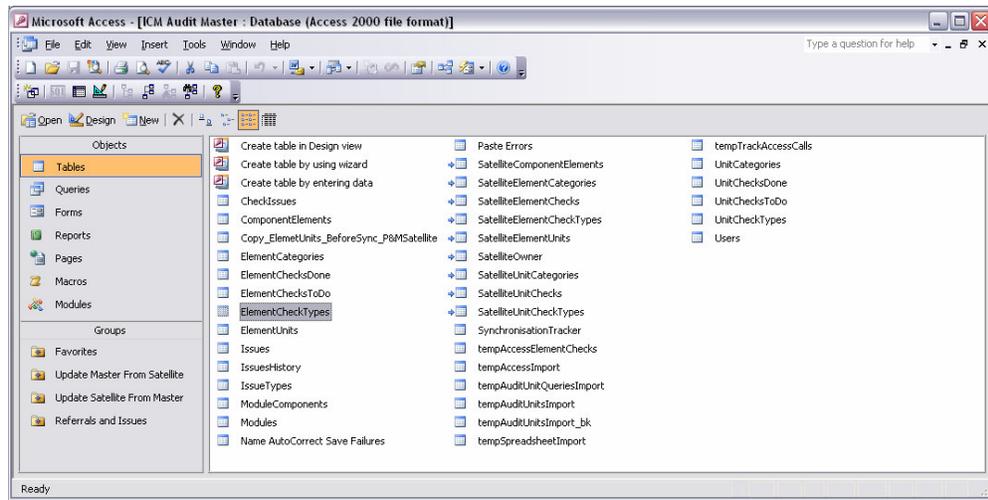
8.1.1 The screen used by auditors for capturing formula checks.

Module	Worksheet	Cell Range	Cell Type	Source	HasBeenChecked	Timestamp	CheckOK	Attachment	Refer
Electrificatio	Electrificatio	008_Inp_AllocationR	AA13_AA362	FormulaCalculation	Inp_AllocationSCADA		<input checked="" type="checkbox"/>		
AA13_AA36	UserCheck_3		User defined check	Possibility for Users to add c	tbd		<input type="checkbox"/>		
AA13_AA36	UserCheck_2		User defined check	Possibility for Users to add c	tbd		<input type="checkbox"/>		
AA13_AA36	UserCheck_1		User defined check	Possibility for Users to add c	tbd		<input type="checkbox"/>		
AA13_AA36	SizeOK		Size in rows and columns is appropriate to the pur		High		<input type="checkbox"/>		
AA13_AA36	ReferencesOK		Refers to correct data ranges of correct size		High	12/02/2008	<input checked="" type="checkbox"/>		
AA13_AA36	MatchesSpec		Matches the functional specification requirement		High	12/02/2008	<input checked="" type="checkbox"/>		

8.1.2 The internal data structure of the master audit database.



8.1.3 The complete list of audit database tables



① Getting Started

⇒ What you need

Along with this document, you should have received the following:

- Functional Specification Doc
e.g. ICMv2 functional specification DRAFT 191107.pdf
- Satellite Access Database (incl. Structure & Use)
e.g. ICM Audit Satellite CK.mdb (the last 2 letters being your personal initials)
- Module_audit Spreadsheet
e.g. Telecoms_vLive_audit.xls
- Module_audit_report Spreadsheet (i.e. Spreadsheet Detective Report)
e.g. Telecoms_vLive_audit_report.xls

Should anything be missing or not seem to match up, please contact us immediately.

If you can, working on a computer with 2 screens would make the task easier for yourself.

⇒ Set-up indications

- Open the 2 Spreadsheets and the Satellite Database on your computer. If you have 2 screens, the best is probably to have Access open on one, and the 2 Excel spreadsheets open on the other, with the window split in 2 so that you can see them both at once (to do this, go to Window / Arrange / Horizontal).
- Print off the part of the Spec that corresponds to the Module assigned to you, along with a highlighter or pen.
- Keep the instructions document at hand for reference, probably best printed off.
- Should you find it helpful, have a glance through the introduction to the overall Model in the Spec to get a flavour for it.

⇒ Keys to Understanding the Spreadsheet Detective Output

- What does the SD do?

The particular output from the Spreadsheet Detective that we are using here is the 'Report Sheet' function, which lists all the different formulae appearing in worksheet. So for each worksheet in our _audit spreadsheets we will have a corresponding worksheet in the corresponding _audit_report spreadsheet. For example, if a formula is copied across a range of cells, it will only appear as one entry in the SD report also specifying the range it is applied to.

- What do the different columns stand for?
 - Hyperlink – Shows the cell or range of cells the entry/formula applies to
 - Label – a system-generated name the SD gives this entry/formula
 - Value – the first value the formula takes in the actual spreadsheet
 - Formula/Defined Range – the actual Formula syntax or Named Range defined.

- What do the different colours mean?
 - Brown – Named Ranges defined in this worksheet
 - Blue – Formula/Function, Cell Range from this worksheet or reference to Named Ranges from other worksheets
 - Green – made-up labels /reference names
 - Red – Cell Ranges or Named Ranges from other worksheets

② Checking _audit Spreadsheets against Specifications

The Specifications document is set up in a clear and consistent way for all the Modules of the ICM model. So as a starting point we suggest going through the specifications of your assigned module step by step and checking the corresponding spreadsheet accordingly, i.e. are all the elements mentioned in the spec actually present in the spreadsheet and are the modelling approaches and allocation rules specified really applied.

Basic outline presented in the Spec for each Module (extract from Spec):

- Overview – provides a short summary of the main aspects of functionality contained within the module and highlights any issues specific to the type of expenditure being modelled, incl. functionality diagram specific to the Module.
- Key data dimensions – describes any “dimensions” specific to the module not already described under network segmentation or a previous chapter. Dimensions are lists of “entities” (such as Asset Types or Strategic Routes) used to structure model data and can be identified throughout the rest of this document as terms contained within angled brackets, e.g. <Strategic Routes>. Another way to explain data dimensions is that typically they will be used as row or column headings on an input template or model report.
- Model results – provides a description, including dimensionality, of the final output data items produced by the calculations in each module.
- Model calculations – provides a summary description of the steps in the computational process that the module uses to derive its results from the data and assumption, incl. modelling approaches & allocations rules applied.

Going through the spreadsheets, you will notice some 'purple formulae'. These are the main calculations made. These are named and get pasted across whole tables using named ranges. There is a macro that actually does this copying. This method is used mainly to keep the spreadsheets a manageable size.

- Model inputs – lists all of the different data inputs required by the model, states their input category and describes their dimensions.
- Model dashboard – contains a screenshot of the dashboard used to control each module and a brief description of which inputs can be changed and which results can be viewed.

Going through the specifications and the _audit spreadsheet together will also hopefully give you an overview and a feeling for what is going on, and thus help getting around the module spreadsheets etc. and the various checks identified at the different levels (i.e. workbook, worksheet, cell ranges/formulae...).

The easiest is probably to print off the part of the spec relevant to you and tick the different elements off as you go through them. Any issues or comments along the way should be captured. **How?** *Can we add something in the DB....? Or simply an Excel Spreadsheet that they make up or form given by us to fill out....?*

③ Audit Satellite Database

⇒ Purpose

Each User / Auditor will have their own 'Satellite' version of the centralised Audit Master Database, giving them access to only those elements they need for their own part of the audit.

These Satellites will help defining which checks specifically need to be done for what elements of their assigned Module, as well as allow the users to manage and collect their checks to do and record the outcomes with any comments.

The Master and Satellites will be synchronised at the end of each day, so that they all get updated appropriately both ways.

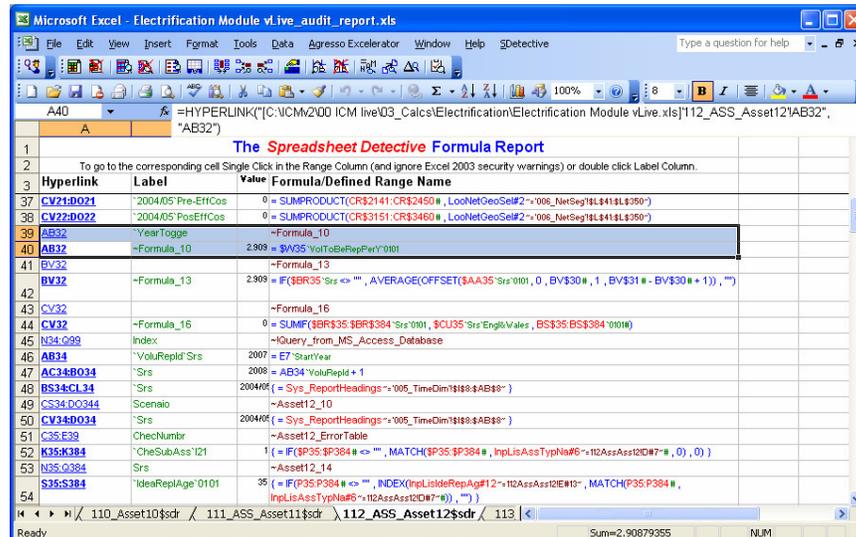
⇒ Structure

Checks are made at 2 levels - the Element Level, which for the Excel Spreadsheets are the Worksheets, and the Unit Level, which for the same are the Cell Ranges / Formulae.

The equivalents for the Access Databases are the Queries or Macros and their Columns or VB Statements for instance.

⇒ Process

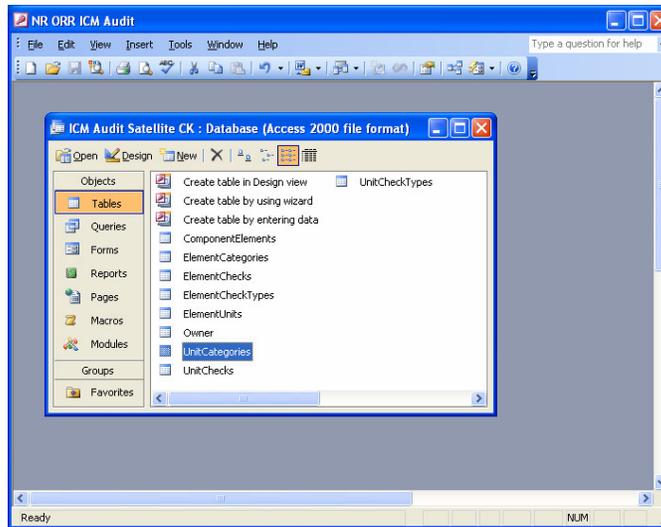
Steps:



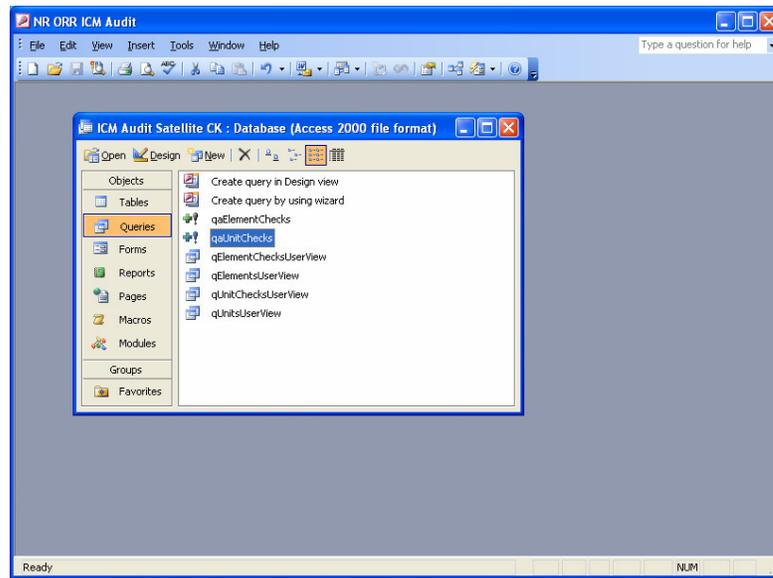
The screenshot shows an Excel spreadsheet with a table titled "Volume Replaced". The table has columns for years from 2007 to 2016 and a column for SRS codes. The data is as follows:

SRS	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0101	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
0102	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
0103	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0104	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
0105	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
0106	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
0107	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0108	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
0109	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
0110	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
0111	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
0112	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0113	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
0114	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0115	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0116	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0117	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0201	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
0202	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
0203	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
0204	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Additionally, a description of the unit categories can be found in the table should the category name not be sufficient.



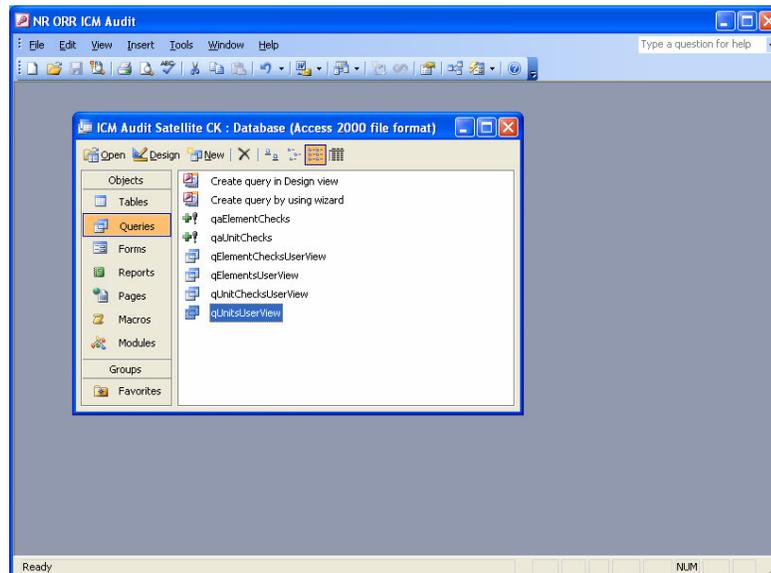
- 1 - Depending on whether you are starting work at the Element (worksheet) or Unit (formulae/cell ranges) level, run the corresponding qa Query, i.e. qaElementChecks or qaUnitChecks.



This will now populate a table with all the corresponding checks you will need to do for each of the elements/units to be audited.

Note – you will not need to go through all the tables in the database to find this particular table, see Step 2.

2 - Now run the qElementsUserView or qUnitsUserView Query, depending on what level you are currently working on.



You will now be able to extend each entry by clicking on the little + sign on their left, which will list all the checks to do for this particular entry. You may need to set the subdatasheet link up yourself should it not appear already.
 To do this...

Module	Workbook	Worksheet	Cell Range	Cell Type					
Electrification	Electrification Module vLive	111_ASS_Asset11	Z392.Z741	Please Select					
Electrification	Electrification Module vLive	111_ASS_Asset11	Z748	Please Select					
Electrification	Electrification Module vLive	111_ASS_Asset11	Z751.Z1100	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AA35.AA384	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AA392.AA741	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AA751.AA1100	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB32	PFAssetRepVolume					
Cell Range	Check	Check Description	CheckImportance	Done	Timestamp	OK	Notes/Issues	Attachment	Refer
AB32	PFAssRepVolTargetName	Target range for asset replacement volumes form TBD		<input type="checkbox"/>		<input type="checkbox"/>			<input type="checkbox"/>
AB32	PFAssRepVolName	Purple formula for asset replacement volumes has TBD		<input type="checkbox"/>		<input type="checkbox"/>			<input type="checkbox"/>
AB32	PFAssetRepVolume	Purple formula for asset replacement volumes mat TBD		<input type="checkbox"/>		<input type="checkbox"/>			<input type="checkbox"/>
*				<input type="checkbox"/>		<input type="checkbox"/>			<input type="checkbox"/>
Electrification	Electrification Module vLive	112_ASS_Asset12	AB34	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB35.B0384	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB389	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB391.B0391	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB392.B0741	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB748	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB750.B0750	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB751.B01100	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AC34.B034	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	B4	Please Select					

Alternatively you could run the query qElementChecksUserView or qUnitChecksUserView accordingly, which lists the checks in a separate table if you find it more convenient to work that way.

3 - All you need to do then is work your way through the checks as described, and fill in the empty fields accordingly.

Once a check is complete,

- o Tick it off in the 'Done' field
- o Add the date in the 'Timestamp' field (shortcut for this by pressing the 'Ctrl' & ';' keys simultaneously)
- o If everything was in order and you have not come across any issues along the way, tick the 'OK' field, otherwise leave it blank.
- o If the result was not OK, explain what the problem is or what is unclear in the 'Notes/Issues' field. You also have the option to attach a document in the 'Attachment' field to help describe what you have come across. If you are in doubt about the result or the issue seems to require further looking into, you can also tick the 'Refer' field.

Module	Workbook	Worksheet	Cell Range	Cell Type					
Electrification	Electrification Module vLive	111_ASS_Asset11	Z392.Z741	Please Select					
Electrification	Electrification Module vLive	111_ASS_Asset11	Z748	Please Select					
Electrification	Electrification Module vLive	111_ASS_Asset11	Z751.Z1100	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AA35.AA384	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AA392.AA741	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AA751.AA1100	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB32	PFAssetRepVolume					
Cell Range	Check	Check Description	CheckImportance	Done	Timestamp	OK	Notes/Issues	Attachment	Refer
AB32	PFAssRepVolTargetName	Target range for asset replacement volumes form TBD		<input checked="" type="checkbox"/>	24/01/2008	<input checked="" type="checkbox"/>			<input type="checkbox"/>
AB32	PFAssRepVolName	Purple formula for asset replacement volumes has TBD		<input checked="" type="checkbox"/>	24/01/2008	<input checked="" type="checkbox"/>			<input type="checkbox"/>
AB32	PFAssetRepVolume	Purple formula for asset replacement volumes mat TBD		<input checked="" type="checkbox"/>	24/01/2008	<input type="checkbox"/>	Is not picking		<input type="checkbox"/>
*				<input type="checkbox"/>		<input type="checkbox"/>			<input type="checkbox"/>
Electrification	Electrification Module vLive	112_ASS_Asset12	AB34	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB35.B0384	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB389	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB391.B0391	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB392.B0741	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB748	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB750.B0750	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AB751.B01100	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	AC34.B034	Please Select					
Electrification	Electrification Module vLive	112_ASS_Asset12	B4	Please Select					

- 4 - At the end of your day, send us your database back so that we can synchronise all of the Satellites and the Master.

Any checks not completed will still be there the following day, along with new/additional ones if applicable. Master and Satellites get updated, so that in the morning the process can start again for anything new or outstanding.

Please note that the proposed checklists are non-exhaustive and should you come across anything or have some further ideas on what checks would be useful/relevant, then you can also input/add your own. These would then be picked up by us during the update and may consequently be taken on as a basic check in our main check list. [Explain how to do this](#)

8.3 Complete list of Checks

- 8.3.1 The table below lists all the element and unit checks that were made, listed by type of "component" (spreadsheet or database), "level" (worksheet / formula, or query / column) and category of item.

Item Level	Item Type	Item Category	Check	Description
Element	AccessRunCode	Delete	MatchesSpecification	Query carries out intention of the specification
Element	AccessRunCode	Import	ColumnMapping	Columns are mapped from input to output correctly
Element	AccessRunCode	Import	MatchesSpecification	Query carries out intention of the specification
Element	AccessRunCode	Process	Aggregates	The correct aggregate functions are used
Element	AccessRunCode	Process	ColumnMapping	Columns are mapped from input to output correctly
Element	AccessRunCode	Process	GroupByClause	Grouping columns are correct
Element	AccessRunCode	Process	MatchesSpecification	Query carries out intention of the specification
Element	AccessRunCode	Process	NullsHandled	Nulls are handled correctly in calculations
Element	AccessRunCode	Process	Rounding	Rounding is carried out appropriately
Element	AccessRunCode	Process	WhereClause	Filter criteria are correct
Element	AppendQuery	Calculated	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	Calculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	AppendQuery	Calculated	MatchesSpecification	Query carries out intention of the specification
Element	AppendQuery	Calculated	NullsHandled	Nulls are handled correctly in calculations
Element	AppendQuery	Calculated	Rounding	Rounding is carried out appropriately
Element	AppendQuery	Filtered	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	Filtered	JoinsCorrect	Joins are present, use the correct columns and are of the expected type

Item Level	Item Type	Item Category	Check	Description
Element	AppendQuery	Filtered	MatchesSpecification	Query carries out intention of the specification
Element	AppendQuery	Filtered	WhereClause	Filter criteria are correct
Element	AppendQuery	FilteredCalculated	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	FilteredCalculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	AppendQuery	FilteredCalculated	MatchesSpecification	Query carries out intention of the specification
Element	AppendQuery	FilteredCalculated	NullsHandled	Nulls are handled correctly in calculations
Element	AppendQuery	FilteredCalculated	Rounding	Rounding is carried out appropriately
Element	AppendQuery	FilteredCalculated	WhereClause	Filter criteria are correct
Element	AppendQuery	Grouped	Aggregates	The correct aggregate functions are used
Element	AppendQuery	Grouped	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	Grouped	GroupByClause	Grouping columns are correct
Element	AppendQuery	Grouped	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	AppendQuery	Grouped	MatchesSpecification	Query carries out intention of the specification
Element	AppendQuery	GroupedCalculated	Aggregates	The correct aggregate functions are used
Element	AppendQuery	GroupedCalculated	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	GroupedCalculated	GroupByClause	Grouping columns are correct
Element	AppendQuery	GroupedCalculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	AppendQuery	GroupedCalculated	MatchesSpecification	Query carries out intention of the specification
Element	AppendQuery	GroupedCalculated	NullsHandled	Nulls are handled correctly in calculations
Element	AppendQuery	GroupedCalculated	Rounding	Rounding is carried out appropriately
Element	AppendQuery	GroupedFiltered	Aggregates	The correct aggregate functions are used
Element	AppendQuery	GroupedFiltered	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	GroupedFiltered	GroupByClause	Grouping columns are correct
Element	AppendQuery	GroupedFiltered	MatchesSpecification	Query carries out intention of the specification
Element	AppendQuery	GroupedFiltered	WhereClause	Filter criteria are correct
Element	AppendQuery	GroupedFilteredCalculated	Aggregates	The correct aggregate functions are used
Element	AppendQuery	GroupedFilteredCalculated	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	GroupedFilteredCalculated	GroupByClause	Grouping columns are correct
Element	AppendQuery	GroupedFilteredCalculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	AppendQuery	GroupedFilteredCalculated	MatchesSpecification	Query carries out intention of the specification

Item Level	Item Type	Item Category	Check	Description
Element	AppendQuery	GroupedFiltered Calculated	NullsHandled	Nulls are handled correctly in calculations
Element	AppendQuery	GroupedFiltered Calculated	Rounding	Rounding is carried out appropriately
Element	AppendQuery	GroupedFiltered Calculated	WhereClause	Filter criteria are correct
Element	AppendQuery	Simple	ColumnMapping	Columns are mapped from input to output correctly
Element	AppendQuery	Simple	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	AppendQuery	Simple	MatchesSpecification	Query carries out intention of the specification
Element	CrosstabQuery	Grouped	Aggregates	The correct aggregate functions are used
Element	CrosstabQuery	Grouped	ColumnMapping	Columns are mapped from input to output correctly
Element	CrosstabQuery	Grouped	GroupByClause	Grouping columns are correct
Element	CrosstabQuery	Grouped	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	CrosstabQuery	GroupedCalculated	Aggregates	The correct aggregate functions are used
Element	CrosstabQuery	GroupedCalculated	ColumnMapping	Columns are mapped from input to output correctly
Element	CrosstabQuery	GroupedCalculated	GroupByClause	Grouping columns are correct
Element	CrosstabQuery	GroupedCalculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	CrosstabQuery	GroupedFiltered	Aggregates	The correct aggregate functions are used
Element	CrosstabQuery	GroupedFiltered	ColumnMapping	Columns are mapped from input to output correctly
Element	CrosstabQuery	GroupedFiltered	GroupByClause	Grouping columns are correct
Element	CrosstabQuery	GroupedFiltered	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	CrosstabQuery	GroupedFiltered	WhereClause	Filter criteria are correct
Element	CrosstabQuery	GroupedFiltered Calculated	Aggregates	The correct aggregate functions are used
Element	CrosstabQuery	GroupedFiltered Calculated	ColumnMapping	Columns are mapped from input to output correctly
Element	CrosstabQuery	GroupedFiltered Calculated	GroupByClause	Grouping columns are correct
Element	CrosstabQuery	GroupedFiltered Calculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	CrosstabQuery	GroupedFiltered Calculated	MatchesSpecification	Query carries out intention of the specification
Element	CrosstabQuery	GroupedFiltered Calculated	NullsHandled	Nulls are handled correctly in calculations
Element	CrosstabQuery	GroupedFiltered Calculated	Rounding	Rounding is carried out appropriately
Element	CrosstabQuery	GroupedFiltered Calculated	WhereClause	Filter criteria are correct
Element	DeleteQuery	Filtered	MatchesSpecification	Query carries out intention of the specification
Element	DeleteQuery	Filtered	WhereClause	Filter criteria are correct
Element	DeleteQuery	FilteredCalculated	MatchesSpecification	Query carries out intention of the specification
Element	DeleteQuery	FilteredCalculated	WhereClause	Filter criteria are correct

Item Level	Item Type	Item Category	Check	Description
		d		
Element	DeleteQuery	Simple	MatchesSpecification	Query carries out intention of the specification
Element	MakeTableQuery	Calculated	ColumnLengths	Column lengths are as expected
Element	MakeTableQuery	Calculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	MakeTableQuery	Calculated	MatchesSpecification	Query carries out intention of the specification
Element	MakeTableQuery	Calculated	NullsHandled	Nulls are handled correctly in calculations
Element	MakeTableQuery	Calculated	Rounding	Rounding is carried out appropriately
Element	MakeTableQuery	Filtered	ColumnLengths	Column lengths are as expected
Element	MakeTableQuery	Filtered	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	MakeTableQuery	Filtered	MatchesSpecification	Query carries out intention of the specification
Element	MakeTableQuery	Filtered	WhereClause	Filter criteria are correct
Element	MakeTableQuery	Grouped	Aggregates	The correct aggregate functions are used
Element	MakeTableQuery	Grouped	ColumnLengths	Column lengths are as expected
Element	MakeTableQuery	Grouped	GroupByClause	Grouping columns are correct
Element	MakeTableQuery	Grouped	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	MakeTableQuery	Grouped	MatchesSpecification	Query carries out intention of the specification
Element	MakeTableQuery	GroupedCalculated	Aggregates	The correct aggregate functions are used
Element	MakeTableQuery	GroupedCalculated	ColumnLengths	Column lengths are as expected
Element	MakeTableQuery	GroupedCalculated	GroupByClause	Grouping columns are correct
Element	MakeTableQuery	GroupedCalculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	MakeTableQuery	GroupedCalculated	MatchesSpecification	Query carries out intention of the specification
Element	MakeTableQuery	GroupedCalculated	NullsHandled	Nulls are handled correctly in calculations
Element	MakeTableQuery	GroupedCalculated	Rounding	Rounding is carried out appropriately
Element	MakeTableQuery	GroupedFiltered	ColumnLengths	Column lengths are as expected
Element	MakeTableQuery	GroupedFiltered	GroupByClause	Grouping columns are correct
Element	MakeTableQuery	GroupedFiltered	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	MakeTableQuery	GroupedFiltered	MatchesSpecification	Query carries out intention of the specification
Element	MakeTableQuery	GroupedFiltered	WhereClause	Filter criteria are correct
Element	MakeTableQuery	Simple	ColumnLengths	Column lengths are as expected
Element	MakeTableQuery	Simple	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	MakeTableQuery	Simple	MatchesSpecification	Query carries out intention of the specification
Element	UpdateQuery	Calculated	ColumnMapping	Columns are mapped from input to output correctly

Item Level	Item Type	Item Category	Check	Description
Element	UpdateQuery	Calculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	UpdateQuery	Calculated	MatchesSpecification	Query carries out intention of the specification
Element	UpdateQuery	Calculated	NullsHandled	Nulls are handled correctly in calculations
Element	UpdateQuery	Calculated	Rounding	Rounding is carried out appropriately
Element	UpdateQuery	Filtered	ColumnMapping	Columns are mapped from input to output correctly
Element	UpdateQuery	Filtered	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	UpdateQuery	Filtered	MatchesSpecification	Query carries out intention of the specification
Element	UpdateQuery	Filtered	NullsHandled	Nulls are handled correctly in calculations
Element	UpdateQuery	Filtered	WhereClause	Filter criteria are correct
Element	UpdateQuery	FilteredCalculated	ColumnMapping	Columns are mapped from input to output correctly
Element	UpdateQuery	FilteredCalculated	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	UpdateQuery	FilteredCalculated	MatchesSpecification	Query carries out intention of the specification
Element	UpdateQuery	FilteredCalculated	NullsHandled	Nulls are handled correctly in calculations
Element	UpdateQuery	FilteredCalculated	Rounding	Rounding is carried out appropriately
Element	UpdateQuery	FilteredCalculated	WhereClause	Filter criteria are correct
Element	UpdateQuery	Simple	ColumnMapping	Columns are mapped from input to output correctly
Element	UpdateQuery	Simple	JoinsCorrect	Joins are present, use the correct columns and are of the expected type
Element	UpdateQuery	Simple	MatchesSpecification	Query carries out intention of the specification
Element	UpdateQuery	Simple	NullsHandled	Nulls are handled correctly in calculations
Element	VBAProcedure	ApplicationControl	NoDataImpact	VBA procedure does not impact data
Element	VBAProcedure	CalculationProcedure	AccessInterface	Interface with MS-Access conforms to standards and good practice
Element	VBAProcedure	CalculationProcedure	StructureOK	VBA procedure structure is clear and fits the intended purpose
Element	VBAProcedure	DataFromAccess	AccessControl	MS-Access commands conform to standards and good practice and are easy to follow
Element	VBAProcedure	DataFromAccess	ExcelTarget	Target areas in excel workbooks clearly flagged
Element	VBAProcedure	DataFromAccess	Purpose	Purpose of procedure in module data flow is clear
Element	VBAProcedure	DataToAccess	AccessControl	MS-Access commands conform to standards and good practice and are easy to follow

Item Level	Item Type	Item Category	Check	Description
Element	VBAProcedure	DataToAccess	ExcelSource	Source areas from MS-Excel are clearly identified using range names and formatting
Element	VBAProcedure	DataToAccess	Purpose	Purpose of procedure in module is clear
Element	Worksheet	AgeProfile	Allocation Type	Check that Allocation Type for each Asset Type is the one specified in the Spec. This is in the Data Entry Table to the top left of the worksheet, starting in/around Cell G37.
Element	Worksheet	AgeProfile	Asset Name Cell	Check A1 contains Asset Reference, i.e. Asset1, Asset2...
Element	Worksheet	AgeProfile	First Replacement Year	Check it is defined properly. This is in the table starting in/around Cell U37.
Element	Worksheet	AgeProfile	Output1_AssetN & Output2_AssetN	Check that these 2 Named Ranges are present, i.e. Output1_Asset1 & Output2_Asset1 etc. for the Annual Replacement Costs (around Cells AE4 & AF4) and that they are correctly defined. Output1 should cover the column containing the Allocation Rules, and Outp
Element	Worksheet	AgeProfile	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	AllocationInput	LiveLinks	Check links are correct and working
Element	Worksheet	AllocationInput	NamedRanges	Check named ranges are correctly defined
Element	Worksheet	AllocationInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	AllocationInput(2)	LiveLinks	Check links are correct and working
Element	Worksheet	AllocationInput(2)	NamedRanges	Check named ranges are correctly defined
Element	Worksheet	AllocationInput(2)	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_AgeProfile	AnnualReplacementCostSummary	Table should be present
Element	Worksheet	Asset_AgeProfile	AssetReference	Cell A1 contains the right Asset Reference (i.e. AssetN) or S or H
Element	Worksheet	Asset_AgeProfile	Name	Worksheet name in line with content and vice versa
Element	Worksheet	Asset_AgeProfile	Output1_AssetN	Named Range based on AnnualReplacementCostSummary should be present
Element	Worksheet	Asset_AgeProfile	Output2_AssetN	Named Range based on AnnualReplacementCostSummary should be present
Element	Worksheet	Asset_AgeProfile	PF_ReplacementCost	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeProfile	PF_ReplacementVolume	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeProfile	PF_ReplacementYear	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeProfile	Set-up	Set-up corresponds to general pattern / diagram

Item Level	Item Type	Item Category	Check	Description
Element	Worksheet	Asset_AgeProfile	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_AgeSteadyStateProfile	DetailedAssetData	Input is from the correct Access Database Query
Element	Worksheet	Asset_AgeSteadyStateProfile	MaintenanceAveragesSummary	Table should be present, with averages from CP6 onwards
Element	Worksheet	Asset_AgeSteadyStateProfile	Name	Worksheet name in line with content and vice versa
Element	Worksheet	Asset_AgeSteadyStateProfile	OptOutYear_PostEfficientCosts	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AnnualReplacementCosts_PostEfficient	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AnnualReplacementCosts_PreEfficient	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AnnualReplacementVolumes	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AverageAnnualPostEfficientCost	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AverageAnnualPostEfficientCost_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AverageAnnualPreEfficientCost	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AverageAnnualPreEfficientCost_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AverageAnnualReplacementVolumes	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	PF_AverageAnnualReplacementVolumes_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_AgeSteadyStateProfile	RenewalsAveragesSummary	Table should be present, with averages from CP6 onwards
Element	Worksheet	Asset_AgeSteadyStateProfile	Set-up	Set-up corresponds to general pattern / diagram
Element	Worksheet	Asset_AgeSteadyStateProfile	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_CostProfileLinkedToAP	AnnualPlannedSpend	Should come from Output2_AssetN from corresponding Asset_AgeProfile sheet
Element	Worksheet	Asset_CostProfileLinkedToAP	Asset Reference	Cell A1 contains the right Asset Reference (i.e. Asset_N, or S or H)
Element	Worksheet	Asset_CostProfileLinkedToAP	Name	Worksheet name in line with content and vice versa
Element	Worksheet	Asset_CostProfileLinkedToAP	OptOutYear_PostEfficientCosts	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileLinkedToAP	PF_AnnualPostEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileLinkedToAP	PF_AnnualPostEfficientSpend_ReportFormat	Should be present along with corresponding range of operation

Item Level	Item Type	Item Category	Check	Description
Element	Worksheet	Asset_CostProfileLinkedToAP	PF_AnnualPreEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileLinkedToAP	PF_AnnualPreEfficientSpend_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileLinkedToAP	Set-up	Set-up corresponds to general pattern / diagram
Element	Worksheet	Asset_CostProfileLinkedToAP	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_CostProfileLinkedToAP	TotalAnnualCostSummary	Table should be present, with averages from CP6 onwards - this will be output going into Pre-Dashboard
Element	Worksheet	Asset_CostProfileOnly (1)	AnnualPlannedSpend	Should be simple input not linked to another worksheet
Element	Worksheet	Asset_CostProfileOnly (1)	Asset Reference	Cell A1 contains the right Asset Reference (i.e. Asset_N, or S or H)
Element	Worksheet	Asset_CostProfileOnly (1)	Name	Worksheet name in line with content and vice versa
Element	Worksheet	Asset_CostProfileOnly (1)	OptOutYear_PostEfficientCosts	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (1)	PF_AnnualPostEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (1)	PF_AnnualPostEfficientSpend_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (1)	PF_AnnualPreEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (1)	PF_AnnualPreEfficientSpend_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (1)	Set-up	Set-up corresponds to general pattern / diagram
Element	Worksheet	Asset_CostProfileOnly (1)	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_CostProfileOnly (1)	TotalAnnualCostSummary	Table should be present, with averages from CP6 onwards - this will be output going into Pre-Dashboard
Element	Worksheet	Asset_CostProfileOnly (2)	Asset Reference	Cell A1 contains the right Asset Reference (i.e. Asset_N, or S or H)
Element	Worksheet	Asset_CostProfileOnly (2)	Maintenance_AnnualPlannedSpend	Should be simple input not linked to another worksheet
Element	Worksheet	Asset_CostProfileOnly (2)	Maintenance_OptOutYear_PostEfficientCosts	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	Maintenance_TotalAnnualCostSummary	Table should be present, with averages from CP6 onwards
Element	Worksheet	Asset_CostProfileOnly (2)	Name	Worksheet name in line with content and vice versa
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Maintenance_PostEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Maintenance_PostEfficientSpend_ReportFormat	Should be present along with corresponding range of operation

Item Level	Item Type	Item Category	Check	Description
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Maintenance_PreEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Maintenance_PreEfficientSpend_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Renewals_PostEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Renewals_PostEfficientSpend_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Renewals_PreEfficientSpend	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	PF_Renewals_PreEfficientSpend_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	Renewals_AnnualPlannedSpend	Should be simple input not linked to another worksheet
Element	Worksheet	Asset_CostProfileOnly (2)	Renewals_OptOutYear_PostEfficientCosts	Should be present along with corresponding range of operation
Element	Worksheet	Asset_CostProfileOnly (2)	Renewals_TotalAnnualCostSummary	Table should be present, with averages from CP6 onwards
Element	Worksheet	Asset_CostProfileOnly (2)	Set-up	Set-up corresponds to general pattern / diagram
Element	Worksheet	Asset_CostProfileOnly (2)	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_LifeCycleProfile	DetailedAssetData	Input is from the correct Access Database Query
Element	Worksheet	Asset_LifeCycleProfile	Name	Worksheet name in line with content and vice versa
Element	Worksheet	Asset_LifeCycleProfile	PF_AnnualReplacementCosts_PostEfficient	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AnnualReplacementCosts_PreEfficient	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AnnualReplacementVolumes	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AverageAnnualPostEfficientCost	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AverageAnnualPostEfficientCost_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AverageAnnualPreEfficientCost	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AverageAnnualPreEfficientCost_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AverageAnnualReplacementVolumes	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_AverageAnnualReplacementVolumes_ReportFormat	Should be present along with corresponding range of operation
Element	Worksheet	Asset_LifeCycleProfile	PF_PostEfficient_SuperDashboard	Should be present along with corresponding range of operation

Item Level	Item Type	Item Category	Check	Description
Element	Worksheet	Asset_LifeCycle Profile	RenewalsAveragesSummary	Table should be present, with averages from CP6 onwards
Element	Worksheet	Asset_LifeCycle Profile	Set-up	Set-up corresponds to general pattern / diagram
Element	Worksheet	Asset_LifeCycle Profile	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_ServiceLifeProfile	Check	Check
Element	Worksheet	Asset_ServiceLifeProfile	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Asset_Workbank Profile	Check	Check
Element	Worksheet	Asset_Workbank Profile	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	AssetInput	Asset Name Cell	Check A1 contains Asset Reference S.
Element	Worksheet	AssetInput	No Check, just needs to be present ?	N/A
Element	Worksheet	AssetInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	AssetInput_AP	Allocation Type	Check that Allocation Type for each Asset Type is the one specified in the Spec. This is in the Data Entry Table to the top left of the worksheet, starting in/around Cell G37. (old)
Element	Worksheet	AssetInput_AP	Asset Name Cell	Check A1 contains Asset Reference, i.e. Asset1, Asset2... (old)
Element	Worksheet	AssetInput_AP	First Replacement Year	Check it is defined properly. This is in the table starting in/around Cell U37. (old)
Element	Worksheet	AssetInput_AP	Output1_AssetN & Output2_AssetN	Check that these 2 Named Ranges are present, i.e. Output1_Asset1 & Output2_Asset1 etc. for the Annual Replacement Costs (around Cells AE4 & AF4) and that they are correctly defined. Output1 should cover the column containing the Allocation Rules, and Outp
Element	Worksheet	AssetInput_AP	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	AssetInput_CP	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	AssumptionInput	NamedRanges	Check named ranges are correctly defined
Element	Worksheet	AssumptionInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	CalendarInput	LiveLinks	Check links are correct and working
Element	Worksheet	CalendarInput	NamedRanges	Check named ranges are correctly defined
Element	Worksheet	CalendarInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Configuration	Don't need auditing	N/A
Element	Worksheet	Configuration	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly

Item Level	Item Type	Item Category	Check	Description
Element	Worksheet	CostProfileOnly	Asset Name Cell	Check A1 contains Asset Reference S.
Element	Worksheet	CostProfileOnly	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	CostProfileSeparateAP	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	Dashboard	Dropdowns	Check
Element	Worksheet	Dashboard	MaintenanceCosts	Check source
Element	Worksheet	Dashboard	MaintenanceCostsGraph	Check
Element	Worksheet	Dashboard	RenewalsCosts	Check source
Element	Worksheet	Dashboard	RenewalsCosts_Calculations	Check calculations
Element	Worksheet	Dashboard	RenewalsCostsGraph	Check
Element	Worksheet	Dashboard	RenewalsVolumes	Check source
Element	Worksheet	Dashboard	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	EfficiencyInput	LiveLinks	Check links are correct and working
Element	Worksheet	EfficiencyInput	NamedRanges	Check named ranges are correctly defined
Element	Worksheet	EfficiencyInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	NetworkInput	LiveLinks	Check links are correct and working
Element	Worksheet	NetworkInput	NamedRanges	Check named ranges are correctly defined
Element	Worksheet	NetworkInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	OtherCalculations	Calculations	Check calculations are correct, if any present
Element	Worksheet	OtherCalculations	LiveLinks	Check links are correct and working, if any present
Element	Worksheet	OtherCalculations	NamedRanges	Check named ranges are correctly defined, if any present
Element	Worksheet	OtherCalculations	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	OtherInputs	Calculations	Check calculations are correct, if any present
Element	Worksheet	OtherInputs	LiveLinks	Check links are correct and working, if any present
Element	Worksheet	OtherInputs	NamedRanges	Check named ranges are correctly defined, if any present
Element	Worksheet	OtherInputs	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	OtherOutputs	Calculations	Check calculations are correct, if any present
Element	Worksheet	OtherOutputs	LiveLinks	Check links are correct and working, if any present
Element	Worksheet	OtherOutputs	NamedRanges	Check named ranges are correctly defined, if any present
Element	Worksheet	OtherOutputs	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly

Item Level	Item Type	Item Category	Check	Description
Element	Worksheet	PreDashboard	MaintenanceCostsSummaryTable	Check source. Also, they need to be the post-efficient costs
Element	Worksheet	PreDashboard	MaintenanceCostsSummaryTable_Calculations	Check calculations
Element	Worksheet	PreDashboard	RenewalsCostsSummaryTable	Check source. Also, they need to be the post-efficient costs
Element	Worksheet	PreDashboard	RenewalsCostsSummaryTable_Calculations	Check calculations
Element	Worksheet	PreDashboard	RenewalsVolumesTable	Check source. Also, they need to be the post-efficient costs
Element	Worksheet	PreDashboard	RenewalsVolumesTable_Calculations	Check calculations
Element	Worksheet	PreDashboard	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	PreDashboard	VarianceReportMapping	Check calculations
Element	Worksheet	Pre-Dashboard	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	ReportInput	Check	Check
Element	Worksheet	ReportInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	ReportOutput	Check	Check
Element	Worksheet	ReportOutput	PurpleFormula	Check
Element	Worksheet	ReportOutput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	SupDas_Input	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	SupDas_Output	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	SuperDashInput	Calculations	Check calculations are correct, if any present
Element	Worksheet	SuperDashInput	NamedRanges	Check named ranges are correctly defined, if any present
Element	Worksheet	SuperDashInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	SuperDashOutput	CheckOutput	Check it is doing the right thing
Element	Worksheet	SuperDashOutput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	TBD	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Element	Worksheet	TBD	tbd	tbd
Element	Worksheet	TrafficInput	SimilarChecked	Sheet is very similar to another sheet that has already been checked thoroughly
Unit	CellRange	Annual Post-Efficient Spend	PFFPostEffSpend	Purple formula for post-efficient spend matches pattern (old)
Unit	CellRange	Annual Post-Efficient Spend	PFFPostEffSpendName	Purple formula for post-efficient spend has correctly-named range FORMULA_n (old)

Item Level	Item Type	Item Category	Check	Description
Unit	CellRange	Annual Post-Efficient Spend	PFFPostEffSpendTargetName	Target range for post-efficient spend formula has correct range name RANGE_n (old)
Unit	CellRange	Annual Post-Efficient Spend Report Format	PFFPostEffSpendRepFormatName	Purple formula for post-efficient spend report format has correctly-named range FORMULA_n (old)
Unit	CellRange	Annual Post-Efficient Spend Report Format	PFFPostEffSpendRepFormatTargetName	Target range for post-efficient spend report format formula has correct range name RANGE_n (old)
Unit	CellRange	Annual Post-Efficient Spend Report Format	PFFPostEffSpendRepFormat	Purple formula for post-efficient spend report format matches pattern (old)
Unit	CellRange	Annual Pre-Efficient Spend	PFFPreEffSpend	Purple formula for pre-efficient spend matches pattern (old)
Unit	CellRange	Annual Pre-Efficient Spend	PFFPreEffSpendName	Purple formula for pre-efficient spend has correctly-named range FORMULA_n (old)
Unit	CellRange	Annual Pre-Efficient Spend	PFFPreEffSpendTargetName	Target range for pre-efficient spend formula has correct range name RANGE_n (old)
Unit	CellRange	Annual Pre-Efficient Spend Report Format	PFFPreEffSpendRepFormat	Purple formula for pre-efficient spend report format matches pattern (old)
Unit	CellRange	Annual Pre-Efficient Spend Report Format	PFFPreEffSpendRepFormatName	Purple formula for pre-efficient spend report format has correctly-named range FORMULA_n (old)
Unit	CellRange	Annual Pre-Efficient Spend Report Format	PFFPreEffSpendRepFormatTargetName	Target range for pre-efficient spend report format formula has correct range name RANGE_n (old)
Unit	CellRange	FormulaCalculation	MatchesSpec	Matches the functional specification requirement
Unit	CellRange	FormulaCalculation	ReferencesOK	Refers to correct data ranges of correct size
Unit	CellRange	FormulaCalculation	SizeOK	Size in rows and columns is appropriate to the purpose
Unit	CellRange	FormulaCheck	ResultsOK	All values correctly balance e.g. to 0. Cell is coloured green.
Unit	CellRange	FormulaLookup	DataReferenceOK	Reference values conform to specification
Unit	CellRange	FormulaLookup	ReferenceOK	Refers to the correct data range of the correct size
Unit	CellRange	FormulaLookup	SizeOK	Size in rows and columns is appropriate to the purpose
Unit	CellRange	FormulaPurple	MatchesSpec	Matches the functional specification requirement
Unit	CellRange	FormulaPurple	RangeNamedOK	Is in correctly-named range FORMULA_n
Unit	CellRange	FormulaPurple	ReferencesOK	Refers to correct data ranges of correct size
Unit	CellRange	FormulaPurple	TargetRangeOK	Has target range
Unit	CellRange	FormulaPurple	TemplateMatchOK	Conforms to template for formula type
Unit	CellRange	FormulaSimple	ReferenceOK	Refers to the correct data range of the correct size
Unit	CellRange	FormulaSimple	SizeOK	Size in rows and columns is appropriate to the purpose

Item Level	Item Type	Item Category	Check	Description
Unit	CellRange	FormulaSummary	MatchesSpec	Matches the functional specification requirement
Unit	CellRange	FormulaSummary	ReferencesOK	Refers to correct data ranges of correct size
Unit	CellRange	FormulaSummary	SizeOK	Size in rows and columns is appropriate to the purpose
Unit	CellRange	FormulaText	NoObviousErrors	Formula appears to be correct
Unit	CellRange	NamedRange	NamedRange	Named range is correctly defined (old)
Unit	CellRange	PFAssetRepCost	PFAssetRepCost	Purple formula for asset replacement cost matches pattern (old)
Unit	CellRange	PFAssetRepCost	PFAssRepCostName	Purple formula for asset replacement cost has correctly-named range FORMULA_n (old)
Unit	CellRange	PFAssetRepCost	PFAssRepCostTargetName	Target range for asset replacement cost formula has correct range name RANGE_n (old)
Unit	CellRange	PFAssetRepDates	PFAssetRepDates	Purple formula for asset replacement dates matches pattern (old)
Unit	CellRange	PFAssetRepDates	PFAssRepDatesName	Purple formula for asset replacement dates has correctly-named range FORMULA_n (old)
Unit	CellRange	PFAssetRepDates	PFAssRepDatesTargetName	Target range for asset replacement dates formula has correct range name RANGE_n (old)
Unit	CellRange	PFAssetRepVolume	PFAssetRepVolume	Purple formula for asset replacement volumes matches pattern (old)
Unit	CellRange	PFAssetRepVolume	PFAssRepVolName	Purple formula for asset replacement volumes has correctly-named range FORMULA_n (old)
Unit	CellRange	PFAssetRepVolume	PFAssRepVolTargetName	Target range for asset replacement volumes formula has correct range name RANGE_n (old)
Unit	CellRange	Range	ReferenceOK	Refers to the correct data range of the correct size
Unit	CellRange	Range	SizeOK	Size in rows and columns is appropriate to the purpose
Unit	CellRange	RangeMSQuery	ColourOK	Range is coloured purple per the Styles convention
Unit	CellRange	RangeMSQuery	OptionsOK	Query options are appropriate to type of query and target area
Unit	CellRange	RangeMSQuery	QueryOK	Refers to a standard query in the appropriate MS-Access database
Unit	CellRange	RangeMSQuery	ReferenceOK	Refers to the correct data range of the correct size
Unit	CellRange	RangeMSQuery	SizeOK	Size in rows and columns is appropriate to the purpose
Unit	CellRange	RangeOutput	ReferenceOK	Refers to the correct data range of the correct size
Unit	CellRange	RangeOutput	SizeOK	Size in rows and columns is appropriate to the purpose

Item Level	Item Type	Item Category	Check	Description
Unit	CellRange	RangePurpleFormulaTarget	DataCovered	Covers the correct cells containing data
Unit	CellRange	RangePurpleFormulaTarget	RangeNamedOK	Is in correctly-named range RANGE_n
Unit	CellRange	RangePurpleFormulaTarget	ReferenceOK	Refers to the correct data range of the correct size
Unit	CellRange	RangePurpleFormulaTarget	SizeOK	Size in rows and columns is appropriate to the purpose
Unit	VBAStatement	VBASQLQuery	Aggregates	Correct aggregate functions are used
Unit	VBAStatement	VBASQLQuery	ColumnMapping	Columns are mapped from input to output correctly, including external VB variables
Unit	VBAStatement	VBASQLQuery	MatchesSpecification	Query carries out intention of the specification
Unit	VBAStatement	VBASQLQuery	NullsHandled	Nulls are handled correctly in calculations
Unit	VBAStatement	VBASQLQuery	WhereClause	Filter criteria are correct, including external VB parameters

9 Appendix C: Issues

9.1 Complete list of issues

9.1.1 The list below is of all the issues raised during the audit. For each issue we show how many times in how many distinct components of the ICM it appears.

9.1.2 The list has been passed to Network Rail for comment.

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
1	Severe Fault	16	Incorrect Aggregate	Count rather than Sum used in aggregate of query. Results in 1 activity per year instead of 26 or 52.	Volume of activity is undercalculated by a factor of 26 or 52. Significant financial impact.	5	2
1	Severe Fault	17	Incorrect Truncation	Non-integer values are truncated to integers at too detailed a level. Leads to significant underestimate of defect and activity volume	Volume of activity is undercalculated by roughly 30%. Considerable financial impact. Recommend recoding so truncation is deferred to a higher level of aggregation and replaced by rounding.	1	1
1	Severe Fault	18	Incorrect Volume Units	Maintenance volumes are calculated in incorrect units.	Significant errors in maintenance activity volumes for the affected activities.	3	1
1	Severe Fault	19	Missing Join	Missing join condition in access query. This leads to multiples of the correct number of rows being returned by the query.	Significant errors in maintenance activity volumes for the affected activity.	1	1
2	Significant Fault	10	Null Handling	Inconsistent handling of database nulls leads to incorrect query results	Filter criteria fail to work as intended, resulting in the wrong number of rows selected. Arithmetic totals can also be impacted.	26	4
2	Significant Fault	11	Flag Update	The wrong flag column is appended to or updated	The wrong value gets set. Depending on the unit costs associated with the flagged activity, this can have a significant impact on costs.	2	1
2	Significant Fault	21	Incorrect Lookup	Formula is referring to the incorrect source	Incorrect data is returned by the formula because of lookup reference error.	12	5

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
2	Significant Fault	50	Incorrect Range	Transfer range to MS-Access does not cover all the intended data	Data missing from MS-Access calculations	1	1
3	Minor Fault	01	FormatIn consistency	Spreadsheet cell formats not applied consistently	Makes it harder to identify purpose and location of spreadsheet ranges. Presents a risk to future amendment of the model to meet future requirements.	47	7
3	Minor Fault	02	UnusedR anges	Spreadsheet ranges contain data that is not used anywhere. A result of the iterative nature of model development.	Makes it harder to identify the genuine inputs to the model and their impacts on the results. Complicates the task of any future enhancers of the model.	24	2
3	Minor Fault	03	HardCod edFormul ae	Formula or query contains hard-coded values that define its behaviour. These are data or spec items that should be visible to developers and auditors.	Buries data elements of the functional spec inside formulae. Makes it harder to verify correct working of the model. Will make future changes to the model significantly more difficult to make and verify.	16	5
3	Minor Fault	04	HiddenF ormulae	Formulae and text are coloured the same as their background.	Hides the working of the model from auditors and future developers. If ranges and values need to be hidden from users, they should be separated on to a separate workbook that can be hidden and protected.	9	3
3	Minor Fault	24	TotalFor mulaInco rrect	Formula does not correctly add up the total number of inspections for the first row	Number of inspections is under-reported	5	2
3	Minor Fault	45	Formula Error	Formula appears to be incorrect	Incorrect calculation results may result	3	1
3	Minor Fault	54	AssetIDI ncorrect	Asset ID is incorrectly shown	May result in incorrect data being picked up	2	1
4	Warning	06	QueryRa ngeExten sion	Query ranges may fail to work correctly if the amount of data returned from the external data source increases	An increase in the size of input dimensions such as strategic route sections may cause model to fail. Suggest use of dynamic range names and query	28	8

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
					range properties to prevent this.		
4	Warning	07	AssetOrder	Formula depends on assets being listed in the same order in different parts of the workbook	A future change to asset types may not be correctly reflected in all places where it occurs, meaning that lookup formulae fail to pick up the correct value. The use of the index(match()) construct prevents this happening.	1	1
4	Warning	20	DeadLookupData	Reference to table of lookup data that should be live but instead is just cut - and - pasted	Any change to source data will not be represented in the copy. Suggest replace with live query to the source MS-Access database	2	2
4	Warning	30	HardCodedQuery	MS-Access query contains hard-coded table names. May be result of Access bug associated with long path or table names. Suggest recoding to avoid this problem.	Query will break if model is moved to a different directory location.	2	1
4	Warning	37	RangeConsistency	Several named ranges refer to the data area or similar adjacent, but contain different numbers of rows.	Future change to number of entries in the ranges will lead to error as one range picks up all the data items but the other doesn't. Suggest use of dynamic range names to ensure consistency and completeness.	55	4
4	Warning	41	HardCodedKey	Query refers to rows in linked table by numeric ID rather than "real world" key.	May create a fault if IDs in remote system change at any future time	1	1
4	Warning	42	Unclear layout	Worksheet layout is unclear	Will make debugging and extension harder	2	2
4	Warning	43	MissingAssetTypeRef	Worksheet is lacking an Asset Type in cell A1. The value in this cell is used to set up cell range names	Will cause workbook to fail to work if range names are refreshed by running the macro.	9	1

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
4	Warning	49	HardWiredTablePath	Tables have hard-wired paths.	This means they will not be refreshed if the model is moved to a different directory location. This will result in broken table joins and therefore incorrect query results.	2	1
5	Comment	09	AccessJoinGetsDeleted	A bug in MS-Access causes some joins between tables to be lost when the query is opened.	Missing joins in queries can cause wildly-inaccurate results. This bug can therefore potentially cause severe errors in the model. Suggest re-coding queries so that they do not provoke the Access bug.	1	1
5	Comment	12	ElementLife	IBJ replacement is based on % of sleeper life consumed, not % of rail life	Unknown impact. NR to comment on which is the more appropriate life to use.	1	1
5	Comment	14	ServiceLifeCap	Maintenance activities at percent of service life capped at 100%. If asset is kept in service beyond 100%, activity will not be carried out.	It is not clear whether this is intended behaviour or not. As long as the capacity constraint does not result in significant extension of service life beyond 100%, it should not matter. However, the behaviour should be documented.	4	1
5	Comment	22	UnspecifiedCalculation	Calculation does not appear in the Functional Spec	Functional Spec does not match the module's calculation. NR should reconcile the two.	5	4
5	Comment	23	CPAverageCalc	Calculation of Control Period averages for later CPs is suspect	CP6 to CP10 averages are all taken to be the 2018/19 figures. Since CP5 contains year-to-year variation, this single-year figure may not be the best estimate of the whole CP average.	16	2
5	Comment	25	RangeTooSmall	Named cell range used elsewhere in module does not cover all the data	Data or lookup options may be missed.	2	1

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
5	Comment	27	TooComplicated	Formula or query is too complicated to understand.	It is unclear whether formula or query is carrying out its intended function. Suggest recoding in smaller steps or simpler way to make the purpose clear and to aid future enhancement or modification	5	3
5	Comment	31	UndocumentedFormula	Function of formula, column or calculation not documented and unclear	Impossible to verify if formula is carrying out the requirements of the specification.	25	5
5	Comment	32	Specification	Not clear how intent of specification is implemented	Uncertain impact since it is not clear how or whether spec is being implemented.	11	3
5	Comment	34	DefectRateFormula	Defect Rate formula from T-SPA appears counter-intuitive, since defect rates go down for increasing traffic.	Model will miscalculate impact of increasing traffic on numbers of defects and volume of remedial maintenance	1	1
5	Comment	35	UnclearProcedure	Procedural logic is unclear and confusing. Would benefit from restructuring VBA code into smaller units and using standard techniques.	Maintenance and extension of model will be difficult, particularly if done by someone other than the original developer.	6	1
5	Comment	39	TableWithNoSource	Table of lookup data does not appear to be populated from anywhere.	May make debugging and extension of module harder.	4	2
5	Comment	40	EfficiencyDatum	Some doubt about the correct start year for efficiency profiles	May result in incorrect calculation of efficient costs because a different factor will be applied.	1	1
5	Comment	44	IncorrectInputData	Data input appears to be invalid	Incorrect calculation results will result	4	2
5	Comment	46	RangeNameInconsistency	Range name does not correspond with standard convention	May cause trouble when range formulae are refreshed	17	1
5	Comment	47	AssetType = 0	Filter criterion for Asset Type = 0 seems inappropriate	May not work as intended, leaving rows included that should be excluded	1	1
5	Comment	48	DeadTable	Data table has no known source	Will not be refreshed in any future data refresh, except by off-model process not documented	1	1

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
5	Comment	52	SSIS Purpose	Use of the SSIS year is undocumented and the purpose of queries involving it is unclear	Unable to check conformance with specification	12	1
6	Suggestion	05	RowFormulaeInconsistent	Formulae vary across the row.	Increases the chances of future errors in the formulae if changes need to be made to spreadsheets. Suggest changing the technique so that consistent formulae can be used along the row	9	4
6	Suggestion	08	ServiceLifeAssumption	The track model assumes that percent of service life consumed = (1 / service life based on this year's traffic). This contains an implicit assumption that each year's service life consumed is independent of where in its service life the asset is.	If incorrect, the assumption will result in wrong estimates of actual service lives for expected traffic profiles. Auditors' testing of the assumption and experience with other service life formulae suggest the assumption is valid.	1	1
6	Suggestion	15	Matching Case	Activity codes are matched using codes like "A36" in the input data and "a36" in the access queries.	This relies on MS-Access's case-insensitive text matching to work correctly. Suggest recoding with exact case matching to remove this dependency.	3	1
6	Suggestion	26	Capacity Cap	Dashboard does not explicitly show where postponement of renewal is occurring because of annual resourcing cap.	User of module has no direct idea that postponement is occurring. Suggest incorporation of new KPI of "% of required renewals not carried out" and / or "Proportion of assets in service beyond 100% of service life" to make this explicit.	1	1
6	Suggestion	28	OutputAccessRange	Ranges that contain data passed to the MS-Access components of the model are not clearly identified. Suggest add to standard styles and update formatting of output ranges.	It is very hard to follow the data flow from the Excel to the Access parts of the model. This is particularly true where many Excel tables exist on a worksheet together, but only some are used by the Access processing.	28	2

Severity Level	Severity	Issue ID	Issue Short Name	Issue Description	Impact of Issue	Number of Occurrences	Number of affected Components
6	Suggestion	29	OffSheet Reference	Sheets refer to ranges on other sheets. Good practice suggests such references should be grouped together at the top of the worksheet and identified by a specific display format	It is hard to follow the data flow of the model when references of this type are used.	5	2
6	Suggestion	36	HardCodedReferences	Formulae contain hard-coded values and cell references that are specific to each row. A	This means that each row's formula is different and so very hard to debug or modify. Change in structure of referenced data will also cause error. Suggest recoding refs to lookups and the values into data columns, per best practice used in other modules	10	5
6	Suggestion	38	HardCodedQueries	Hard-coded Access SQL queries are used in the VB code, rather than calling Access stored queries.	Makes debugging and maintenance of composite Access / Excel models harder. Suggest recoding with Openquery or RunMacro commands.	1	1