A Report for
Network Rail and ORR
from
Asset Management Consulting
Limited (AMCL)

Version v1.0
6th September 2012

**Review of Asset Failure
Management
Final Report**

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Network Rail and ORR
Review of Asset Failure Management
Final Report

Date: 6th September 2012
Version: v1.0
Compiled by: N. Mildmay-White

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AMENDMENT HISTORY		
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Draft A	All	Initial draft for client review
Draft B	All	Updated to reflect comments on factual accuracy
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Executive Summary

AMCL (Asset Management Consulting Limited) is the Independent Reporter (Part B - Asset Management) to Network Rail and the Office of Rail Regulation (ORR) in the United Kingdom.

A number of independent audits of Network Rail undertaken by AMCL in this tenure have highlighted concerns relating to the processes for and definition of reliability, availability and maintainability (RAM) targets, as well as the quality and analysis of the associated asset defect and failure information being recorded by Network Rail in relevant systems. In parallel, the ORR has raised concerns relating to the safety consequence of Network Rail's management of failures in relation to the recommendations from the Grayrigg inquiry.

A tri-partite meeting was held on 21st November 2011 to discuss Network Rail's plans for improving the capture and utilisation of failure information. It was agreed that it would be appropriate for the Independent Reporter to undertake a review of the processes and systems used for both the definition of asset failure/rectification targets and the capture and management of defect and failure information, with a particular emphasis on Network Rail's Fault Management System (FMS).

The review of Asset Failure Management supporting systems included the review of the appropriateness of the systems and the data currently collated within them for Network Rail's current and planned approaches to Asset Failure Management.

This report documents AMCL's findings and recommendations relating to the review of Asset Failure Management.

The key findings are as follows:

Fault Management

A significant amount of work has taken place between the central Infrastructure Reliability Group (IRG) and the Routes to improve Failure Management at Network Rail by analysing fault data to spot trends and highlight reliability issues. A hierarchy of meetings has been created from local Maintenance Delivery Units (DUs) to national level to share and monitor reliability issues and solutions.

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Infrastructure Reliability Group

A key issue with the IRG meetings is a lack of process for escalating failure issues and defined responsibilities for producing solutions. This has led, in some cases, to issues being identified but solutions not being developed due to the lack of ownership.

There is currently no central repository for reliability issues and solutions, therefore IRG team members have to rely on their own knowledge or discussions with colleagues to match an issue to a known solution.

A number of reports are produced by IRG to aid the company in the understanding of fault and reliability issues. These require subsequent analysis by the recipient to enable emerging trends to be identified. In the data quality reports many measures only look at the quality of delay producing fault as opposed to all faults.

Maintenance Strategy

Network Rail is seeking to extend the reliability centred maintenance approach for signalling assets to other assets groups and incorporate local factors such as failure rates to enable maintenance regimes to be tailored to suit local asset condition. Due to the Network Rail Maintenance Strategy being developed at the same time as an internal review of Network Rail Maintenance Standards taking place there is a risk that the two will not align.

Routes

Devolution is improving the communication of Failure Management and Reliability issues within the key functions in the Routes by creating closer working practices and regular meetings. The inclusion of Schedule 8 costs within the Route budgets is also focusing attention on improving performance and reducing incidents.

There has been a significant improvement in the completeness of the fault data captured in FMS; in 2007 only 9% of records were complete, then in August 2009 changes to the FMS system were made to improve data collection. As at Period 2 of 2012/13 98% of delay causing fault incidents were complete but this does vary by Route from between 100% complete to 92% complete.

However, the data identified for capture also reduced significantly in August 2009 as part of the changes mentioned above, meaning completeness statistics may have increased but there is also a significant risk to the quality of the data.

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AMCL found that there are significant variations in the level of resources being assigned to Failure Management by the Routes, both in improving the accuracy of the fault data being collected and the analysis of fault data to identify reliability issues.

An increasing number of teams in Network Rail, both centrally and in the Routes, are using fault and reliability information to create targeted performance improvement plans. But without significant changes to the FMS system it is AMCL's opinion it will prove increasingly difficult to identify and prioritise reliability issues due to poor root cause information in the current drop down menus.

Fault Management System

As detailed in previous reports the root cause choices in the FMS drop down menus are considered insufficient and these need to be reviewed using the outputs from FMEA (Failure Modes and Effects) analysis. Network Rail has planned to do this by January 2013 but there are no plans for how to turn the FMEA output into a usable number or wording of drop-down menu choices in FMS.

FMS is a legacy system built up over time from a number of separate systems. It is relatively expensive and increasingly difficult to maintain due to the age of the hardware and the number of servers it is hosted on. Changes to FMS local are particularly expensive due to external ownership of the intellectual property.

The current FMS system has multiple users across Network Rail involved in two main business requirements; fault fixing and reliability improvement. However, there is no owner of the system requirements.

There is no configuration management processes to update changes in the Ellipse asset register into the asset register sub-set held in FMS and no process for looking at the effects of any changes to the Failure Management processes. This is a key risk as increasing changes are made to the asset register in Ellipse by the on-going Master Data Management (MDM) project.

ORBIS

There are currently no plans within the ORBIS programme to develop FMS. Network Rail states that the current plan is to link handheld devices to the fault capture consoles which will link to FMS. However, this still needs to be reflected in ORBIS and supported by a Systems Architecture for these data flows.

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The key recommendations from this review are:

1) The IRG should document the process for the escalation of fault/reliability issues, setting out the conditions required for an issue to be investigated centrally or for it to be pushed back to the Route. [January 2013]

2) The IRG should develop a central data library for fault/reliability information and solutions that is accessible by the Routes. [End CP4]

3) The IRG team should widen the monitoring and reporting of FMS data quality to cover all faults not just delay producing incidents. [January 2013]

4) Further to the recommendations set out in the Network Rail Asset Management Roadmap Update (13/04/2012) sections 2.2 to 2.7 detailing the move to risk based maintenance, Network Rail should evidence how reliability information and analysis is being used to inform this process and the changes to key national strategic decisions; particularly in renewals and maintenance policies. [by end CP4]

5) Network Rail should clarify how it will ensure that the current review of the maintenance standards aligns and integrates with the emerging maintenance strategy. [January 2013]

6) Network Rail should produce guidance for the Route FMS support and analysis teams setting out the expected competencies within the team and the level to which fault management activities should be mandated in the devolved organisation. [January 2013]

7) Network Rail should formalise a stream of work to turn the root cause analysis from FMEA analysis into usable drops down menus in FMS. [January 2013]

8) The MDM team should develop a configuration management process for changes to the asset register in Ellipse looking at how changes may affect FMS data collection and provide sufficient time for changes to be made to the FMS asset register. [January 2013]

9) The ORBIS team should produce a System Architecture for the data flow to link handheld devices to the fault capture consoles which will link to FMS. [November 2012]

10) Network Rail should appoint from within the FMS users a single owner of the FMS system requirements. [November 2012]

11) Network Rail should look at the cost benefit case for replacing the FMS system as part of the ORBIS programme. [March 2013]

AMCL would like to take this opportunity to thank all those who contributed to this review.

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1   Introduction

1.1   Background

AMCL (Asset Management Consulting Limited) is the Independent Reporter (Part B - Asset Management) to Network Rail and the Office of Rail Regulation (ORR) in the United Kingdom.

A number of independent audits of Network Rail undertaken by AMCL in this tenure have highlighted concerns relating to the processes for and definition of reliability, availability and maintainability (RAM) targets, as well as the quality and analysis of the associated asset defect and failure information being recorded by Network Rail in relevant systems. Examples of recent and relevant reports include the '2011 AMEM Assessment' (Mandate Reference Number (MRN) BA/016), the 'Review of RoSE' (MRN BA/014) and the 'Review of Performance on the Sussex Route' (MRN BA/018).

These reports have expressed concerns over Network Rail's ability to determine the root cause of defects/failures and the lack of RAM targets disaggregated across the asset hierarchy. It is considered by AMCL that this may inhibit Network Rail's ability to develop optimised maintenance regimes and other appropriate service assurance measures.

In parallel, the ORR has raised concerns relating to the safety consequence of Network Rail's management of failures in relation to the recommendations from the Grayrigg inquiry.

A tri-partite meeting was held on 21st November 2011 to discuss Network Rail's plans for improving the capture and utilisation of failure information. A number of initiatives were described by Network Rail, including the use of FMEA-based fault trees for assisting failure finding and improvements proposed as part of the company's current Asset Information Strategy. It was agreed that it would be appropriate for the Independent Reporter to undertake a review of the processes and systems used for both the definition of asset failure/rectification targets and the capture and management of defect and failure information, with a particular emphasis on Network Rail's Fault Management System (FMS).

This report documents AMCL's findings from that review.

1.2   Objectives

The objective of the mandate was to carry out an independent audit of the processes and systems used for Asset Failure Management within Network Rail. This included the capture,

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management and analysis of defect and failure information, with a particular emphasis on Network Rail's Fault Management System (FMS). The mandate included:

- Assessing whether any improvements to these processes and systems are being addressed by Network Rail (e.g. by 'Offering Rail Better Information Services' (ORBIS) and other improvement initiatives) to a level necessary to support the on-going Asset Management Improvement Programme (AMIP) and development of risk-based maintenance regimes.

- Where appropriate, identifying recommendations for proposed improvements to these processes and systems and how these processes and systems could be further improved to support Network Rail's wider and longer-term Asset Management aspirations, taking into consideration the additional risks that devolution introduces.

1.3 Scope

Defect and failure information is used in several areas within the overall Asset Management System. While the core processes and systems relate to key activities in the 'Maintain' phase of an asset's lifecycle, the scope of Asset Failure Management is wider. It also covers the interfaces with other areas of Asset Management, in terms of how this data is specified, collected and used to influence Asset Management decisions across the organisation. This scope is illustrated in Figure 1 and discussed further in the Methodology section below.
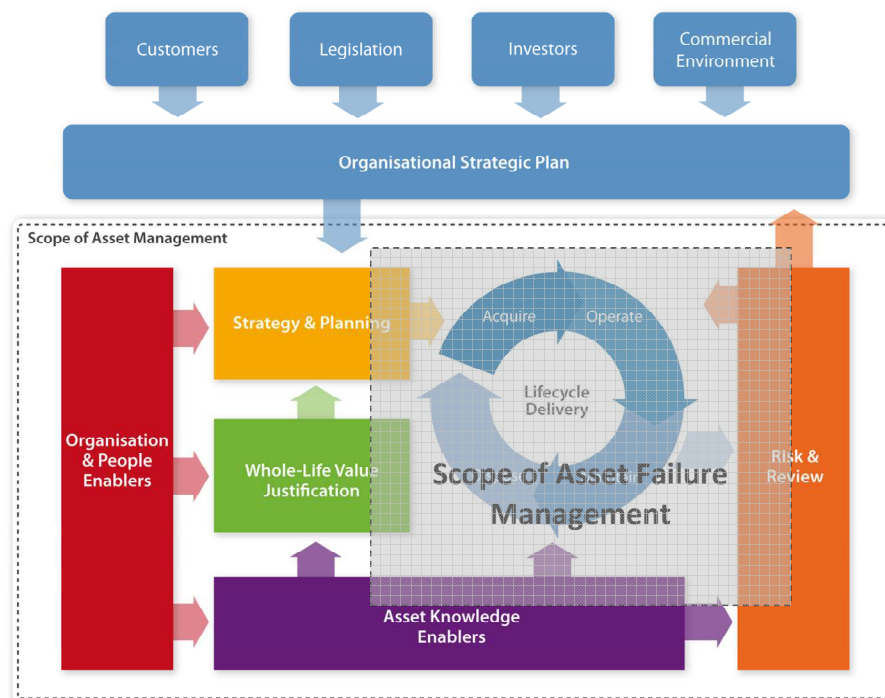

Figure 1 Asset Failure Management within the Asset Management Conceptual Model

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The review also considered the existing recommendations from relevant previous studies and reports, including:

- Grayrigg inquiry;

- 2011 Asset Management Excellence Model™ (AMEM) Assessment;

- Sussex Route Performance Review;

- Reliability of Signalling Equipment (RoSE) Audit;

- Network Rail's own planned improvements (for example, through the AMIP, ORBIS and 'business as usual' activities); and

- Wider industry good practice, including that seen in other utilities (over and above the existing recommendations from the AMEM Assessment).

1.4 Methodology

The work was undertaken via a desktop review of available documentation, interviews with key stakeholders and sample data analysis from relevant systems.

The desktop review and interviews covered the following elements of an overall Asset Failure Management approach:

- The framework for Asset Failure Management and its integration into Network Rail's overall Asset Management System, including integration with maintenance optimisation;
- Specific Asset Failure Management processes;
- Performance target setting including defect, failure and incident levels; and
- Definition, understanding and documentation of known potential failure modes and root causes.

The review of Asset Failure Management supporting systems included the review of the appropriateness of the systems and the data currently collated within them for Network Rail's current and planned approaches to Asset Failure Management.

To achieve this, this review took into account the interfaces and activities within the overall Asset Failure Management framework. An illustration of how the elements of the framework can be mapped to recognised good practice (the Institute of Asset Management (IAM) and the Global Forum on Maintenance and Asset Management (GFMAM)) Asset Management activity groups is shown in Figure 2. The activities highlighted in red formed the focus of this review. The other activities were considered in terms of interfaces with the core activities.
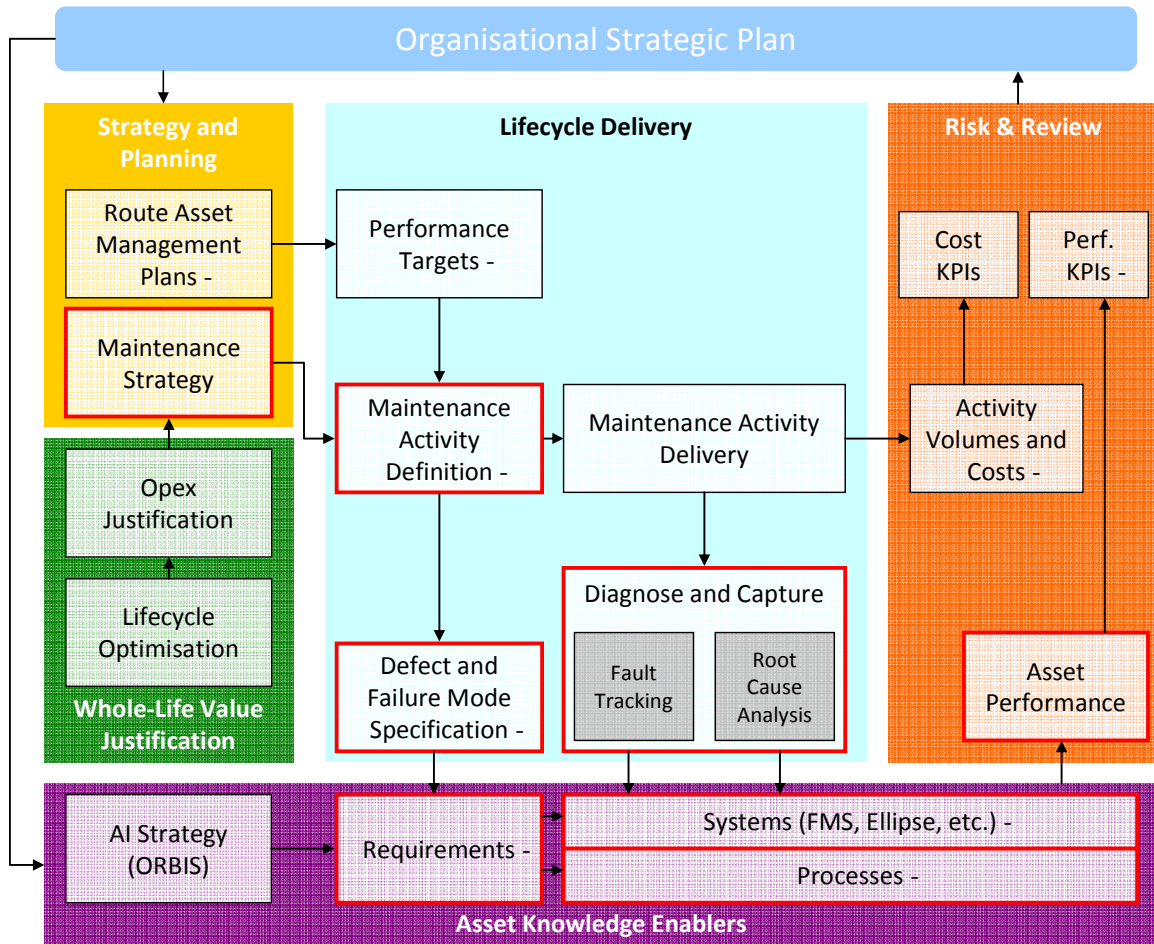
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Figure 2 Elements of Asset Failure Management in Scope

The key steps in the approach are outlined in Table 1.

ID	Task	Description
1	Project Kick Off & Logistics	Kick off meetings with ORR and Network Rail; Stakeholder and documentation identification; and Stakeholder Interface Plan.
2	Desktop Documentation Review of Framework, Processes and Systems	Good practice in other industries; Information from existing reviews; Overall Asset Failure Management approach; Specific process documentation; and Systems documentation.

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ID	Task	Description
3	Stakeholder Interviews	Network Rail (HQ): process / system owners, developers and maintainers;
		Network Rail (Routes): process / system users;
		Network Rail, Asset Information;
		Network Rail Infrastructure Maintenance Performance Manager;
		Other Network Rail stakeholders, covering the use of failure and defect information for the purposes of policy development and performance improvement; and
		ORR stakeholders (to cover current concerns and Grayrigg recommendations).
4	Analysis	Assessment of existing processes and systems;
		Analysis of sample failure from key systems, including FMS, Ellipse and RDMS;
		Assessment of root cause analysis studies;
		Assessment of proposed improvements against good practice in other industries; and
		Current and proposed future coverage of failure modes.

Table 1 Approach

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2 Network Rail Asset Failure Management Overview

There are a variety of teams and groups within Network Rail that have an involvement in the overall cycle of Asset Failure Management. AMCL developed the initial, good practice based, model for how Failure Management could be viewed (shown in Figure 2). This was subsequently used in desktop studies and interviews with Network Rail as a starting point and to build an understanding of where in the overall process the team/group's work fitted.

Using this as a basis AMCL was able to build up a picture of the groups and teams involved in Failure Management at Network Rail, as shown in Figure 3.
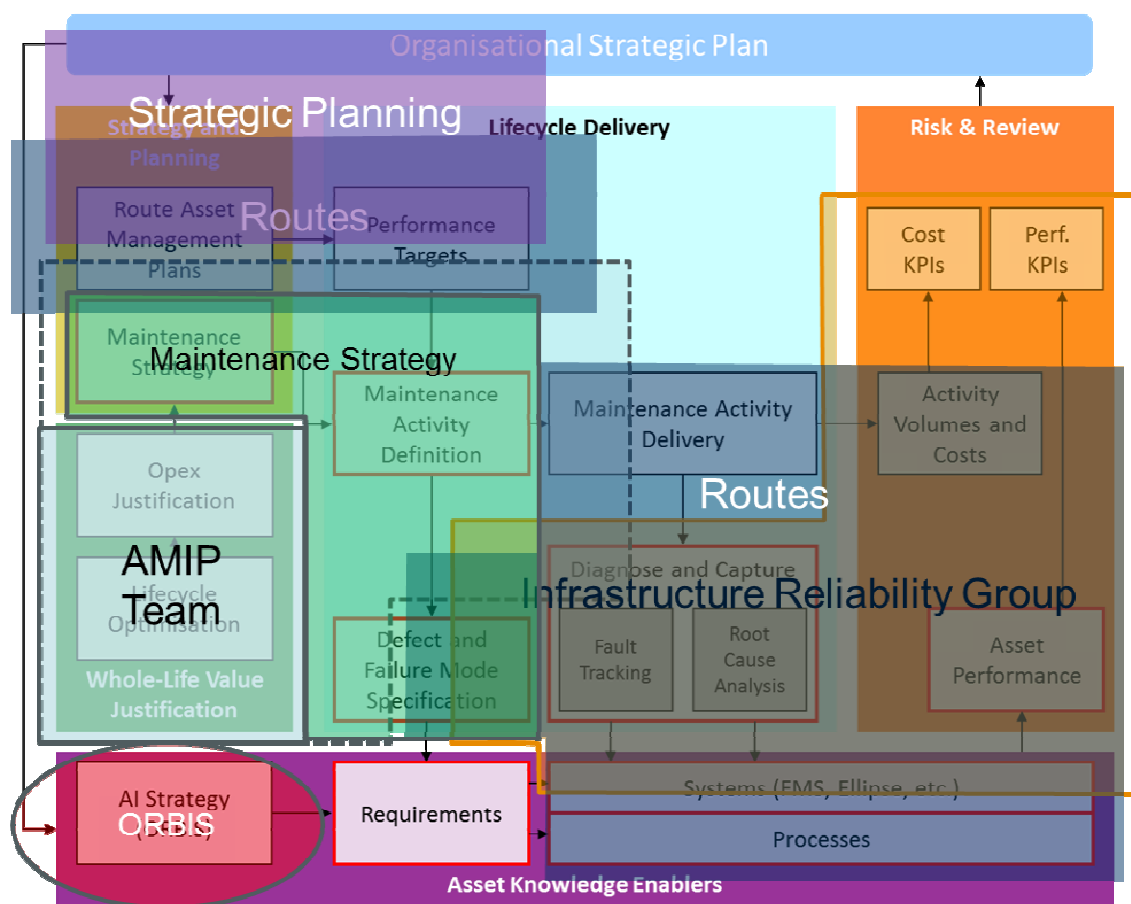

Figure 3 Failure Management teams in Network Rail

As can be seen, most aspects of Asset Failure Management are covered by a team or group within Network Rail but the key good practice 'gap' identified by the overview above relates to the definition/ownership of requirements for Fault Management systems within the organisation. In Asset Knowledge there is the ORBIS programme which is looking at the wider Asset Information Strategy but ORBIS is not planning on reviewing the FMS system, this is discussed further in section 5.2. Speaking to the technicians who maintain the FMS system there are

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multiple users of the fault information but there is no single owner of the system requirements and no one in the course of AMCL's review stated that they were the owner or that they know who the owner of the requirements was. This is discussed further in section 5.

There was also considered by AMCL to be a lack of clarity over the overall responsibility for integration and coordination of Asset Failure Management within the organisation and the roles undertaken by various parts of the organisation. In particular there is a disjoint between the strategic elements of Failure Management and the more practical side of the plan do review loop in Maintenance, it was unclear how the practical solutions for reliability improvements are being fed into the Maintenance Strategy and the Route Asset Management plans. These elements are discussed further in Sections 3 to 5.

It should also be noted that the various teams and roles within the overall Network Rail Asset Failure Management process had varying degrees of progress and maturity at the time of the review. In particular it was found that in the recently devolved Routes, which can be seen to play a major role in Asset Failure Management, there was significant variation in the level of Failure Management undertaken. Based on the Route reviews undertaken by AMCL as part of this work, it is considered that the role undertaken by the Routes varied between the best internal practice seen - shown in Figure 4. Here the Routes have dedicate resources to improving fault data quality, carry out significant levels of fault data analysis to spot fault issues and develop solutions, and involved Maintenance, Asset Management, and Operations in this process. Conversely, some Routes were identified where Asset Failure Management activities are minimal and restricted to implementing reliability campaigns and best practice from central Network Rail and there are still issues around fault data quality, as shown in Figure 5. This is discussed further in Section 4.

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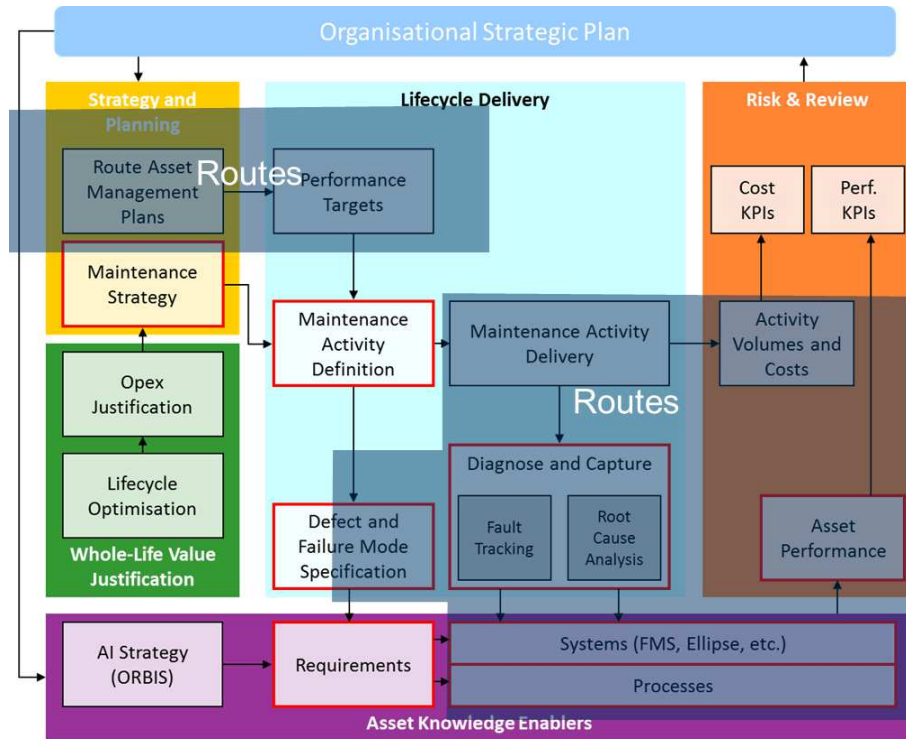Version: v1.0
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Figure 4 Best Internal Practice Route Failure Management Observed
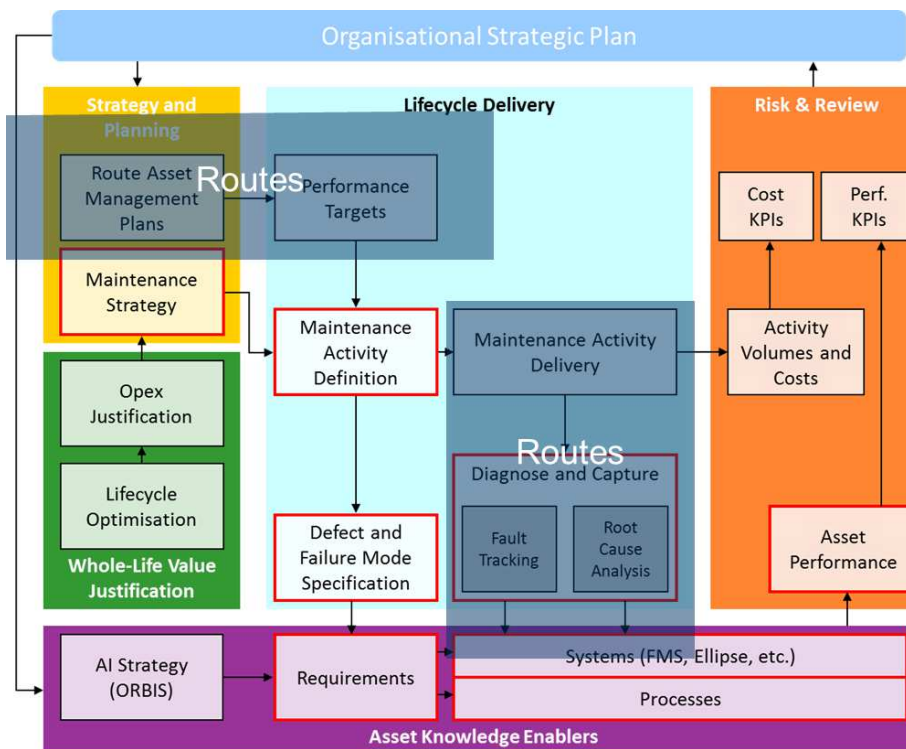
Figure 5 Minimal Internal Practice Route Failure Management Observed

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3 Failure Management

This section looks in more detail at the individual teams/groups involved in Failure Management and discusses their strengths and weaknesses.

3.1 Infrastructure Reliability Group

Following the introduction in CP4 of specific reliability targets the Infrastructure Reliability Group (IRG) was initiated by the then Director Asset Management. With the devolution of Network Rail this Group has now moved over to Network Operations and reports into the Director Maintenance Services.

The initial remit of the IRG was to be a central coordinating function to find and share reliability best practice around Network Rail in order to drive down incidents and therefore the CP4 reliability measures. Over time the IRG has found that the Network Rail Routes are often too busy with the day to day Operations and Maintenance of the railway to dedicate resources to investigate and solve issues. As a result the IRG has taken on a wider - but not documented - role of statistical analysis of fault data to enable the Routes to spot trends; and to investigate and solve national reliability issues. However, in AMCL's opinion it is struggling to fulfil all these roles due to a lack of resources to carry out the expanded scope.

The IRG is comprised of two key areas; firstly a data and engineering team and secondly a team of Reliability Improvement Specialists (RISs) who specialise in three areas: Track, Electrification & Plant, and Signalling.

Since the creation of the IRG, Network Rail's overall rate of incidents has reduced significantly, as shown in Table 2. This is considered by AMCL to be largely due to the work of the IRG and its targeted approach to reducing fault incidents. However, at the same time, the delays per incident have increased across the network, greatly limiting the impact of the reduced numbers of incidents in terms of overall minutes delay. This has also resulted in a further expansion of the IRG mandate to include consideration of this issue.

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Category	Category Description	2006/07		2007/08		2008/09		2009/10		2010/11		2011/12	
		Incidents	DPI	Incidents	DPI	Incidents	DPI	Incidents	DPI	Incidents	DPI	Incidents	DPI
101	Points failures	9,084	92.0	7,830	94.1	8,041	93.5	7,136	111.1	5,818	111.1	5,169	115.5
103	Level crossing failures	2,365	49.1	2,200	49.1	2,260	44.6	2,162	50.6	2,003	50.6	1,933	48.4
104A	TSRs Due to Condition of Track	2,197	159.4	1,858	151.9	1,428	142.6	1,151	111.1	866	111.1	672	108.8
104B	Track Faults including Broken Rails	7,682	120.7	6,735	125.9	6,164	118.6	5,395	132.3	4,954	132.3	4,804	151.1
104C	Gauge Corner Cracking	91	102.0	75	208.9	170	132.4	127	170.0	66	170.0	46	100.6
105	Civil Engineering structures, earthworks & buildings	572	220.5	512	251.8	398	201.0	438	161.5	385	161.5	279	214.3
106	Other infrastructure	5,251	39.7	6,741	44.7	5,496	45.7	3,557	56.3	3,391	56.3	3,714	62.7
106A	Track Patrols & related possessions	2,637	31.0	3,128	25.0	3,365	20.3	2,568	14.6	2,269	14.6	1,949	15.5
108	Mishap - infrastructure causes	1,411	113.7	1,633	98.3	1,848	103.4	1,453	97.7	1,592	97.7	1,916	84.3
112	Fires starting on Network Rail Infrastructure	285	117.9	230	117.8	197	86.9	221	136.8	250	136.8	257	85.8
201	OLE/Third Rail faults	1,712	195.0	1,363	165.0	1,461	162.7	1,241	194.9	1,286	194.9	1,267	175.9
301A	Signal Failures	7,372	47.3	6,551	44.6	6,561	47.7	6,003	42.4	4,901	42.4	4,813	48.3
301B	Track Circuit Failures	7,524	103.2	5,999	108.5	5,384	108.6	5,147	120.5	4,569	120.5	4,242	142.6
301C	Axle Counter Failures	442	107.0	569	123.6	1,096	111.3	913	103.2	648	103.2	683	106.1
302A	Signalling System & Power Supply Failures	3,992	109.0	3,948	100.0	3,752	117.8	4,017	117.0	4,422	117.0	4,202	114.9
302B	Other Signal Equipment Failures	1,982	47.1	1,592	43.5	1,495	42.6	1,580	40.0	1,703	40.0	1,682	39.4
303	Telecoms failures	1,444	35.4	1,467	44.9	1,406	50.1	1,352	42.6	1,253	42.6	1,170	47.4
304	Cable faults (signalling & comms)	628	254.8	667	261.4	573	248.5	531	271.1	552	271.1	570	302.1
401	Bridge strikes	1,689	151.8	1,687	131.3	1,365	126.1	1,131	132.2	1,235	132.2	1,110	128.8
Total		58,360	91.7	54,785	88.5	52,460	87.0	46,123	85.9	42,163	95.2	40,478	100.1

Table 2 Network Infrastructure Incidents Recorded for Delay Attribution

The IRG has set up a hierarchy of reliability meetings from local Maintenance Deliver Unit (DU) level, through Route Infrastructure Reliability Group (RIRG), up to a National Infrastructure Reliability Group (NIRG). The different levels of Infrastructure Reliability Group meetings are show in the informal diagram previously provided by Network Rail in Figure 6.
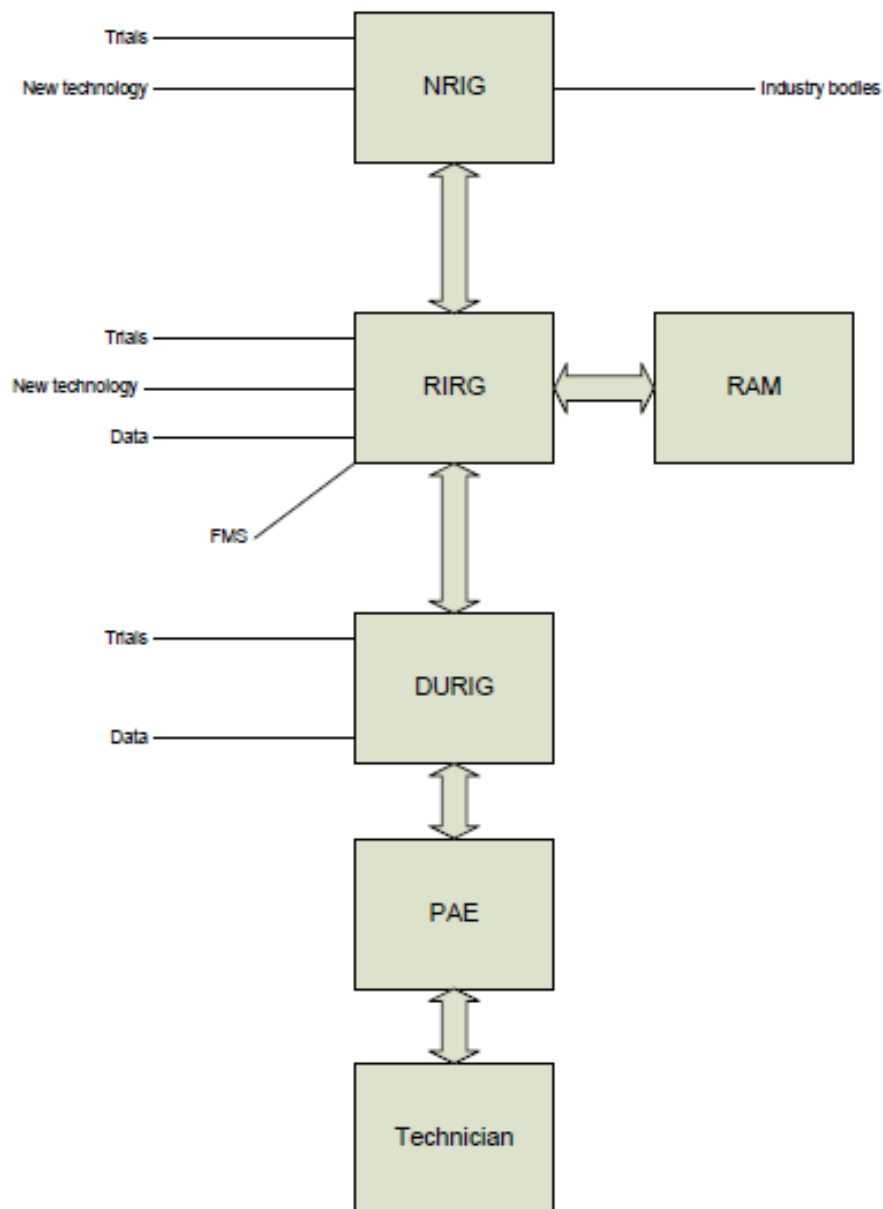
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Figure 6 Infrastructure Reliability Meetings Structure

In theory, reliability issues that are not immediately solvable are escalated up from a local level. The RISs can then check to see is this is national issue or if there is already a solution which can be fed back to the local level. If it is a national issue then a solution would be coordinated centrally. If the issue is a local one then it should be the responsibility of that area to develop a solution. This is not a documented process in Network Rail and there are no set criteria for agreeing who is responsible for investigating and solving issues.

In its investigation AMCL found that the IRG stated that it has to push back on what it sees as local issues which should be solved by the Routes but at the same time the Routes stated that

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they pushed issues upwards without seeing any solutions coming back. This demonstrates the issues around the lack of clear processes, roles and responsibilities as each party expects that the other will pick up the action and so risks an optimised solution not being found.

RISs keep other IRG team members up to date on developments in the Routes by passing reports on the RIRG meetings round to the rest of the group, local issues can then be raised and checked to see if they are national. Currently issues and known solutions can only be matched by RISs connecting them during RIRG meetings and team members responding to the meeting notes. The IRG discussed with AMCL developing a national library for reliability which would enable all those involved in Failure Management to share knowledge and find solutions quicker and faster than the current system. However, there are currently no formalised plans in place to make this happen.

The IRG has three levels of sharing best practice and solutions to specific issues with routes. Firstly, RISs sit on each of the RIRG meetings where they present the team's monthly reliability pack. Secondly, reliability alerts are produced and briefed through the technical briefing chain. These generally contain more detailed information than the monthly slides. Thirdly; campaigns can be mandated by the Managing Director, Network Operations. These involve training for the relevant parties and the work is loaded into Ellipse as tasks and progress is monitored.

The IRG provides guidance on how to structure the meetings through example agendas and it also provides the analysis packs for the Routes but it is up to the Routes to decide how to run the meetings and what to focus on.

The monthly RIRG meetings are not mandatory and during this review it was noted that the LNE Route had opted out; although AMCL has recently been informed that LNE has recommenced RIRG meetings and are involving the central IRG. The implication of Routes removing themselves from the RIRG meetings is that reliability best practice is not shared across Network Rail and that multiple Routes may spend time solving the same issue.

As mentioned above, it is left to the Routes to decide how to run the meetings and who they invite. In some Routes the Train Operating Companies (TOC) have representatives attending the meetings. This will often depend on the relationship between the Route and the TOCs.

The RIRG meetings have already resulted in significant sharing of best practice around Network Rail which has resulted in measureable reductions in incident numbers. For instance electrification and plant have come up with a 10-step plan for Overhead Line Equipment (OLE) improvement which has now been implemented through the RIRGs. For many of the Routes the

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reliability group meetings have resulted in a significant shift in behaviour from traditionally only looking at performance to also including incidents, enabling them to become proactive in Failure Management rather than just attributing delay.

3.1.1   Contractors

Network Rail stated that there are clauses on fault recording in some supplier service contracts but that these are often not followed up. The IRG is aware of this issue and stated that it is trying to change this and get root cause information from service contractors but AMCL did not see any evidence of this currently taking place. It was noted by Network Rail interviewees that service contracts usually form part of a secondary commercial arrangement and are not usually part of the original purchase contract. It was also noted that there are not usually any supplier quality management clauses or reliability targets included in the original purchase contracts or in the subsequent support contracts. However it is noted that since the review was undertaken Network Rail has stated that its contractors are engaging with linking failure information with their repair data.

The IRG are looking at introducing quality clauses and are working on a project in conjunction with Network Rail's National Delivery Service. The clauses will have five-levels of quality assurance activities based on a measure of the asset's risk and quantity. These clauses will put the onus onto the supplier to provide solutions and at the highest level fix, at their own costs, reliability issues.

AMCL was provided as evidence an example of where an issue had been solved in conjunction with the manufacturers. Reliability issues had caused a rise in the number of incidents involving linear variable differential transformer (LVDT) units in High Performance Switch System. Network Rail worked with the manufacture to carry out Failure Modes and Effects Analysis (FMEA) and discovered that the root cause was the soldering in a subcontractor's component. Network Rail worked with the subcontractor and found that the vibrational loading that the component was subject to was causing the soldering to fracture. New techniques were introduced and the issue solved. A rolling programme of inspections and replacements was introduced and tracked through the Infrastructure Reliability Group meetings and a complementary failure mode added to the FMS system.

3.1.2   Reporting

There are a number of reports produced by the IRG to aid different parts of the company in understanding fault and reliability issues:

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Daily Reliability Reports are produced for the RISs detailing the key delay causing incidents. The delay information comes from TRUST and the report provides a hyperlink to the corresponding FMS entry which provides information on the fault and its rectification. The IRG is currently looking to integrate the FMS and TRUST data sets as a reporting process, rather than just providing a hyperlink in the soft copy of the report. The National Performance team is developing this using the Business Objects reporting software and early examples of the reports were evidenced. The report helps the RISs to understand what is happening on a daily basis and over time it can be used to identify emerging trends. It is also useful for end of period reporting to Route Managing Directors and Train Operating Companies as it provides an easy link to the fault information on individual instances of large delay causing faults, which are often at the forefront of discussions.

The IRG produce a monthly pack for each of the Routes, which estimates progress towards reliability targets, taking into account the predicted effect of planned reliability programmes. These reports contain a significant amount of information and require analysis by the Route prior to their monthly reliability meeting to identify the areas requiring attention and discussion. In AMCL's opinion there is a wide variety across the Routes as to how much time they spend reviewing these reports. In the course of the review AMCL also found that the some of the Routes, especially at the DU level, did not fully understand the way in which the future incident trends were calculated and therefore did not trust the information.

There is also a national periodic report produced for the National Infrastructure Reliability Group (NIRG). This report looks at 13 Period service affecting failures (not including freight and terminal delays as per the regulated KPIs) and the resulting delay minutes are broken down for infrastructure by FMS asset types. It shows the six regulated reliability targets with a further five breakdowns by asset type. The NIRG reports are reviewed by the IRG team before the meeting so that the relevant trends and issues are picked out for discussion.

A graphical tool called NAT Trends (National Trends) populated each period by Network Rail's Performance Team allows the user to produce graphs of; incidents, minutes and delay per incident from TRUST data. This tool is made available on Network Rail's internal intranet knowledge hub.

The IRG team are developing a Business Objects solution linking TRUST and FMS data

The IRG produce a periodic FMS data error report to the Routes splitting the data two ways; by Delivery Unity and Control Centre. The report looks at the following errors within FMS:

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- Symptoms Unknown - Delay causing faults with unknown/other recorded in the symptom field;

- Unverified Failures - Delays causing faults that have not been raised against an Ellipse asset;

- Missing Codes - Failures without a specific root cause identified;

- Incorrect Priorities - The number of delay causing faults without a TRUST number and the number of non-delay causing faults with a TRUST number; and

- Ellipse/FMS Load Errors - Outlines Ellipse assets that have failed to load into FMS due to changes in Ellipse not being updated in FMS.

Many of the above measures only look at the quality of delay causing faults but AMCL consider that the quality of all fault reporting should be considered.

The report also ranks the Delivery Units and Control centres, as well as showing if they have improved or deteriorated since the last period. It is then up to the Route to decide if and how it will reduce data errors.

The above shows some of the wealth of information that is currently being produced on faults and reliability. Because of the sheer volume of information produced it requires, especially at Route level, significant levels of analysis to be carried out to enable emerging trends to be identified and to be of significant use in active Failure Management. In AMCL's opinion not all of the Routes are carrying out this analysis and the potential impact is a varied rate of incident reduction across Network Rail.

3.2 Maintenance Strategy

Network Rail is looking to extend the reliability centred maintenance approach (RCM2), which was developed for signalling assets, to other assets. It is also looking to incorporate local factors such degradation rates based partially on failure rates to enable maintenance regimes to be tailored to suit local asset condition.

Network Rail is currently developing a Maintenance Strategy concentrating on Criticality, Degradation, Intervention Options, Policy and the move towards Risk Based Maintenance. This Document is at too early a stage to judge its possible effect but Network Rail stated that one of the key purposes of the document is to give the Routes the ability to be flexible in the application of maintenance regimes but to still be working within National standards.

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The current Maintenance Standards are under review with the first step being to assign a criticality status to Standards, with Red meaning the Standards are mandatory, Green being advisory and application is at the Route's discretion. In the second step the Standard themselves, in terms of content and quality, are to be reviewed and work is currently being undertaken to prioritise the Standards in order to structure the review order. The prioritisation is based on using expert opinion to score each Standard based on three categories: Safety, Performance and OPEX Spend. These are then weighted with a ratio of 1:1.5:2 respectively to split the Standards into 3 categories of High, Medium and Low priorities. Network Rail aims to have reviewed the High category Standards by the end of 2012.

Network Rail stated that the aim of the reviewed Standards is to show Route Maintenance what needs to be achieved and the how it is done is then decided locally. The objective being to refine local maintenance regimes using a suite of core regimes but to use local risk assessment for the definition of their final application in the local context.

Due to time constraints the Maintenance Strategy development and the Standards Review are taking place at the same time. This does mean that the reviewers of the standards may not have seen the final Maintenance Strategy before the review starts and so may not take into account the degradation rates, failure modes and characteristics when looking at possible intervention options but base them on the more traditional planned interventions.

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4 Routes

Previously in Network Rail the first time that the Asset Management, Maintenance and Operations functions came together organisationally was at board level. With devolution the front line of each area comes under the Route Managing Director, with a central function for each providing an advisory role.

4.1 Devolution

In interviews with Network Rail the opinion was consistently expressed that the new structure has fostered closer working practices between the functions and created a greater understanding of the issues they each face. In Failure Management this has been through regular meetings being held with various function heads to look at reliability issues. Another key factor in bringing reliability to the forefront in the Routes has been the introduction of Schedule 8 costs coming under the Route Budget, thus increasing the focus on reliability and also the key metric of incidents vs performance.

A number of Routes have weekly meetings with the TOCs to take them through the key delay causing incidents that have happened and to explain what the issues were and what is being done to prevent them happening again. Where this is happening AMCL found that it was creating a greater understanding and it was enabling preventative actions to be agreed which would produce a small delay in order to prevent possible larger delays. A greater focus on reliability has enabled decisions on the rationalisation of assets to reduce the number of incidents such as removal of little used crossovers.

AMCL would consider having the TOC join the reliability meetings as best practice but understands that the relationship needs to be of a sufficient level of maturity to enable constructive discussions on issues and solution. Currently many Routes are only at the level of discussions with TOCs on delay attribution, i.e. the impact of failures, but by utilising the reliability information provided by the IRG and the Route's analysis they can move to discussing the cause of failure and therefore develop joint plans to reduce them; such as TOCs accepting small amounts of delay to allow measures to be implemented to prevent larger incidents happening.

With the increased focus following the introduction of reliability targets there has been a concerted effort within Network Rail, led by the IRG, to reduce the number of incidents through a number of initiatives which has produced results as shown in Table 2. However many Routes have found that although the number of incidents has fallen there has been an increase in the

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amount of delay minutes per incident, leading to a reduced rates of performance improvements and is some cases an increase in delay minutes.

This fact has also been picked up by the IRG, as discussed in Section 3.1, and AMCL saw evidence of analysis starting to take place to separate out primary and secondary delay and understand the factors outside of the scope of Failure Management which are causing the fall in performance. The closer working between functions resulting from devolution means the appropriate parts of the business are meeting regularly to discuss this and this could enable initiatives to reduce the secondary delay. In this review AMCL did not review any plans for performance improvement outside of reliability.

Route teams are required to keep reliability action plans. These are compiled by the IRG to keep track of the progress of reliability initiatives and are used to produce the monthly reports predicting future incident numbers.

There are, however, some key risks that although not prominent now could arise due to devolution:

- Routes could remove themselves from national discussions on faults and therefore slow the sharing of best practices and result in the duplication of work.
- As the centre may be required to cut costs to balance the increase in personnel in the Routes; central Asset Management and reliability expertise could be lost and no central best practice guidance produced which would reduce the communication of solutions to reliability issues.
- There is no standard single structure for FMS support and analysis teams and so it is up to Routes how much time and effort they expend on fault rectification and reliability analysis and how they organise and build teams.

4.2 Kent

A review of the FMS data from Kent shows a marked improvement in the quality of the fault data. Kent has placed technical support engineers in the ICCs to review the FMS data being entered. This information is then used to drive towards predict and prevent maintenance plans, such as specific plans being developed for critical assets. They have identified their critical assets by looking at a number of factors, including performance and total number of incidents as well as location (proximity to maintenance). This has allowed them to focus maintenance attention and initiate targeted initiatives.

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The Kent Maintenance Improvement Team analyses significant amounts of fault data and works with the Delivery Units (DU) to enable issues to be dealt with at the delivery level and so the Route Infrastructure Reliability Group can review progress and deal with key issues.

The Kent Route Asset Managers are currently reviewing the factors behind primary and reactionary delays but AMCL has not seen any specific programs of work resulting from this.

Kent Asset Management discussed issues around flexibility of routing vs reliability of assets. It was felt that there is currently too great a bias towards flexibility, resulting in performance issues arising from too many little used assets. They are working with the relevant TOCs to agree the removal of redundant assets as part of the regular renewals process.

4.3 LNE

The LNE Route has also placed technical support engineers in with the FMS data inputters and has found that this has significantly improved the quality of the data. Although the Route still has concerns that the focus for the data technicians is on delay attribution and not on recording useful information on root causes.

LNE have a dedicated reliability team which was formed in September 2011, this team carries out its own analysis on fault data but they do review the information that is coming down from the IRG. During the interview section of this investigation LNE had withdrawn from the IRG monthly meeting and had been using the Joint Performance Improvement Plan (JPIP) peer reviews with different Routes to help improve and share best practice. But towards the end of this review AMCL learnt that LNE had restarted its official monthly meeting with the IRG.

As a possible solution to the poor root cause menus within FMS, LNE is looking to use failure codes which would be entered into the free text cell in FMS to improve fault searches, the codes would be looked up from tables by the front line staff. There are no official plans for the introduction at this stage but notably the LNE reliability team has gone on KT training, a Root Cause Analysis technique, so that they can carry out root cause workshops.

The LNE reliability team is splitting out primary and reactionary delays as part of their reliability analysis and focusing resources to look at the knock-on performance aspect of incidents.

All interviewees in LNE stated that there is increased communication of reliability issues across the Route teams and that reliability analysis is being used to target local spend. Weekly meetings are also held with TOCs at which reliability issues and solutions are discussed.

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The LNE Reliability team send out weekly reports to all those involved in Failure Management to show current targets achievement and performance. Specific reliability initiatives are assigned to individuals in maintenance to build up ownership at DU level.

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5 Fault Management System

5.1 Overview of FMS

The development of the FMS system started with the private maintenance contractors, which were contracted by Railtrack, and originally used a number of Fault Management systems. The decision was taken by Railtrack to harmonise to a single Fault Management system, from RTS Solutions, but each maintainer would hold a separate version contained on separate servers, called FMS local. A central Fault Data Processor was then developed by Logica using an Oracle based solution to extract data daily from each of the local servers, called FMS Central.

The Intellectual Property for FMS Central was subsequently bought by Network Rail, following the collapse of Railtrack, but RTS Solutions still own the IP to FMS Local. This means that there are considerable costs involved in making any changes to FMS local as they must be done through RTS Solutions. This piecemeal development of the FMS system over time has resulted, in AMCL's opinion, in an overly complicated and inflexible system which is increasingly expensive to maintain. The possible effect this has on the current improvement plans is discussed later in the ORBIS section.

In the course of AMCL's review it was found that there are a number of users of FMS data across Network Rail involved in two main business requirements; fault fixing and fault/reliability analysis. However, there is no single owner of the system requirements.

FMS Central imports information from the Ellipse asset register system on a weekly basis, against a pre-programmed asset list held in FMS Central. This means that any changes to the Network Rail asset base in Ellipse, such as new asset types, also have to be manually updated in the FMS asset list 'request'. If an asset rationalisation results in a new asset type replacing an old one then, unless the new asset type is set up on FMS, when the specific asset record transfers from the old asset type to the new one, the FMS asset record may become unavailable because the asset record is now associated with an asset type in Ellipse that is not available in FMS. AMCL did not see any formal configuration management plans around the effects of Ellipse data changes on FMS. The relationship between these systems is shown in Figure 7.
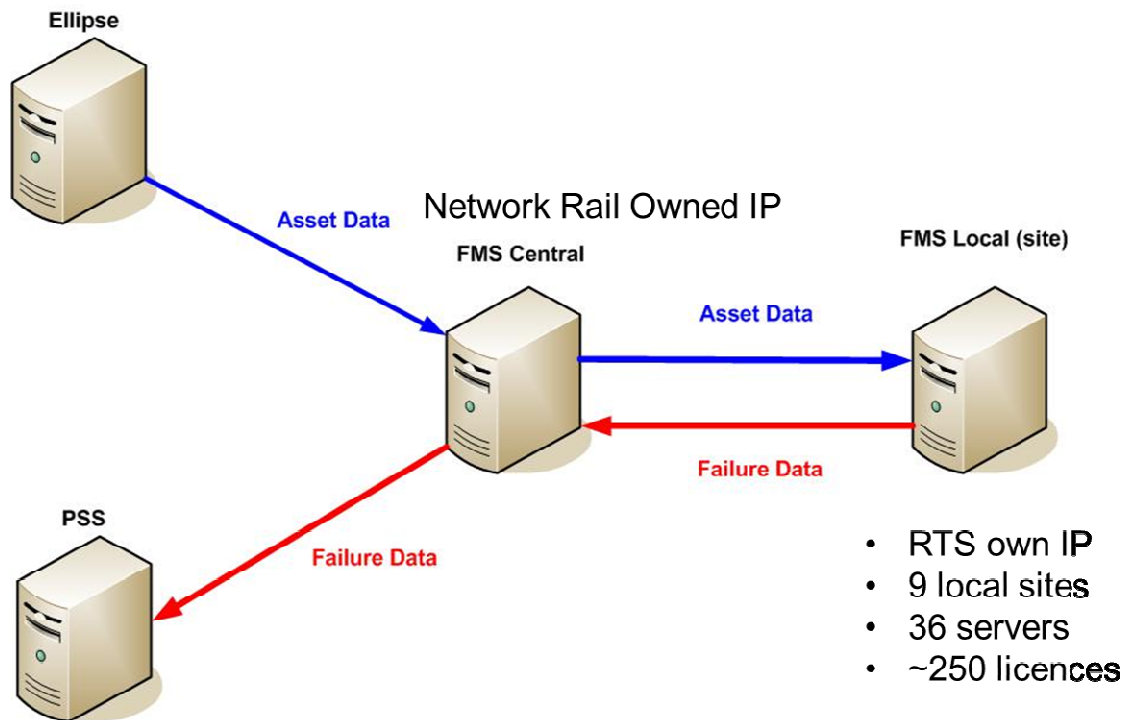
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Figure 7 FMS

Following previous recommendations Network Rail has created a link between the incident data in FMS and the performance data in TRUST by the manual inputting of the unique identifiers from one system into the other and vice versa. This has allowed a significant increase in the ability to analyse reliability issues. But there are no safe guards in place to stop the entry of key errors such as non-service affecting faults being given a TRUST number with delay minutes attributed against them. This is a risk but is not currently an issue; in Period 2 of 2012/13 only 0.75% of the previous 13 periods of delay causing faults had not been assigned a TRUST number in FMS.

Following previous recommendations on fault data quality there has been a significant improvement identified by this review. Previous reports showed that in 2007 only 9% of FMS records were complete; in August 2009 changes to the FMS system were made to improve data collection and reduced the amount of information required. As a result of this in Period 2 2012/13 98% of delay causing fault records were complete. However, the resulting reduced information requirements are also considered by AMCL to continue to limit the value of the FMS data to root cause analysis.

Data completeness does vary by Route. For example, taking the number of faults over one year where the operator has entered 'ZZ NO CODING AVAILABLE' for the asset - meaning they have been unable to locate the type of asset in the FMS drop down menus - Routes such as

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LNE are never using this coding so always assign a fault to an asset type, whereas Wales Route is unable to assign 10% of its faults to any asset type.
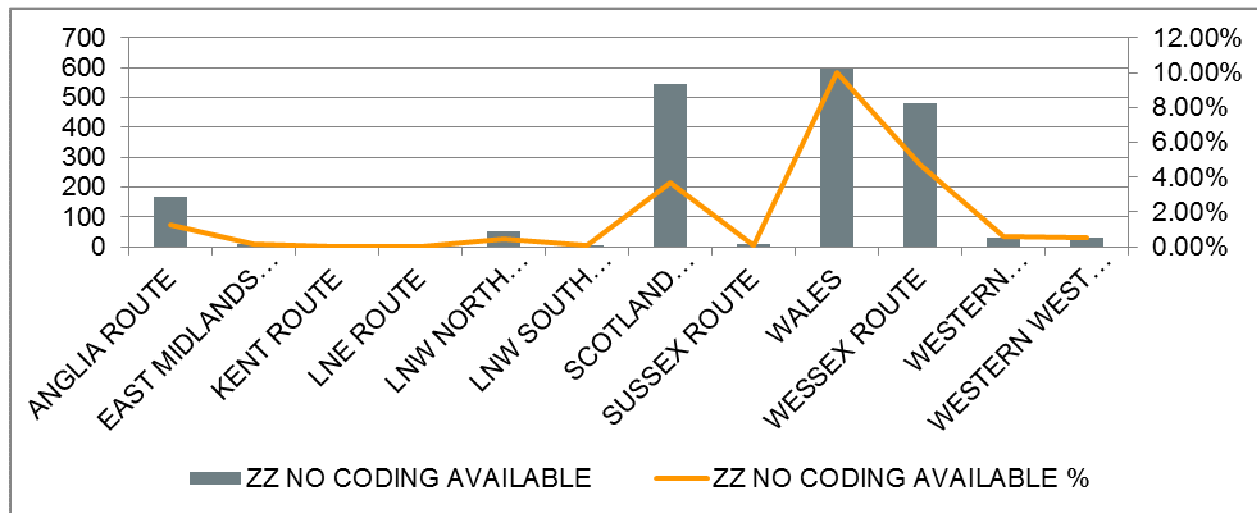

Figure 8 ZZ NO CODING AVAILABLE by Route

The IRG has discussed developing quality data manuals which will provide guidance to the data inputters but AMCL has not seen any plans for their development and implementation.

The current root cause menus in FMS are based on engineering knowledge but Network Rail has signed up to an action to replace these with fault menus based on the root causes analysis from FMEA work by January 2013 as part of the Asset Management Improvement Programme. However, a potential risk of this approach, identified by Network Rail, was that too many possible root causes are put into the drop down menu leading to poor data quality due to FMS data technicians being unable or unwilling to find the correct cause.

As an example Points have approximately 90 possible failure modes from FMEA analysis. AMCL would consider this to be too many allow the FMS operators to pick the correct mode consistently. A rationalisation of the key failure modes is required to produce a usable amount of selections which cover the most likely failures with a description the FMS operators can understand. AMCL would consider 10 to 15 root cause choices as best practice. AMCL did not see any plans for how the output from such analysis will be rationalised into a workable format. A logical palce for these plans would be within the developing Network Rail Maintenance Strategy, although a completed Maintenance Strategy was not available at the time of the review.

Currently the use by FMS operators of the free text entry to note most of the detail of the fault makes detailed analysis of this data extremely difficult and time consuming.

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A significant change to the root cause data fields will create difficulties in the comparison of new data to historic data and make trends harder to spot in the short term but AMCL believes the data in its current format will start in inhibit the spotting of reliability issues once the statistically obvious issues have been dealt with.

As the level of physical Asset data is dictated by Ellipse there is not always the required breakdown to allow full faults analysis, i.e. if the configuration of an asset is not recorded and out of five asset configurations there is a significant issue with just one, this may not be picked up as a reliability issue. If an issue is picked up then all five configurations would need to be investigated to find the one causing the issue.

5.2 Future Trust and FMS Analysis

Set out in Figure 9 is Network Rail's future aspirations for the interrogation of fault and performance information.
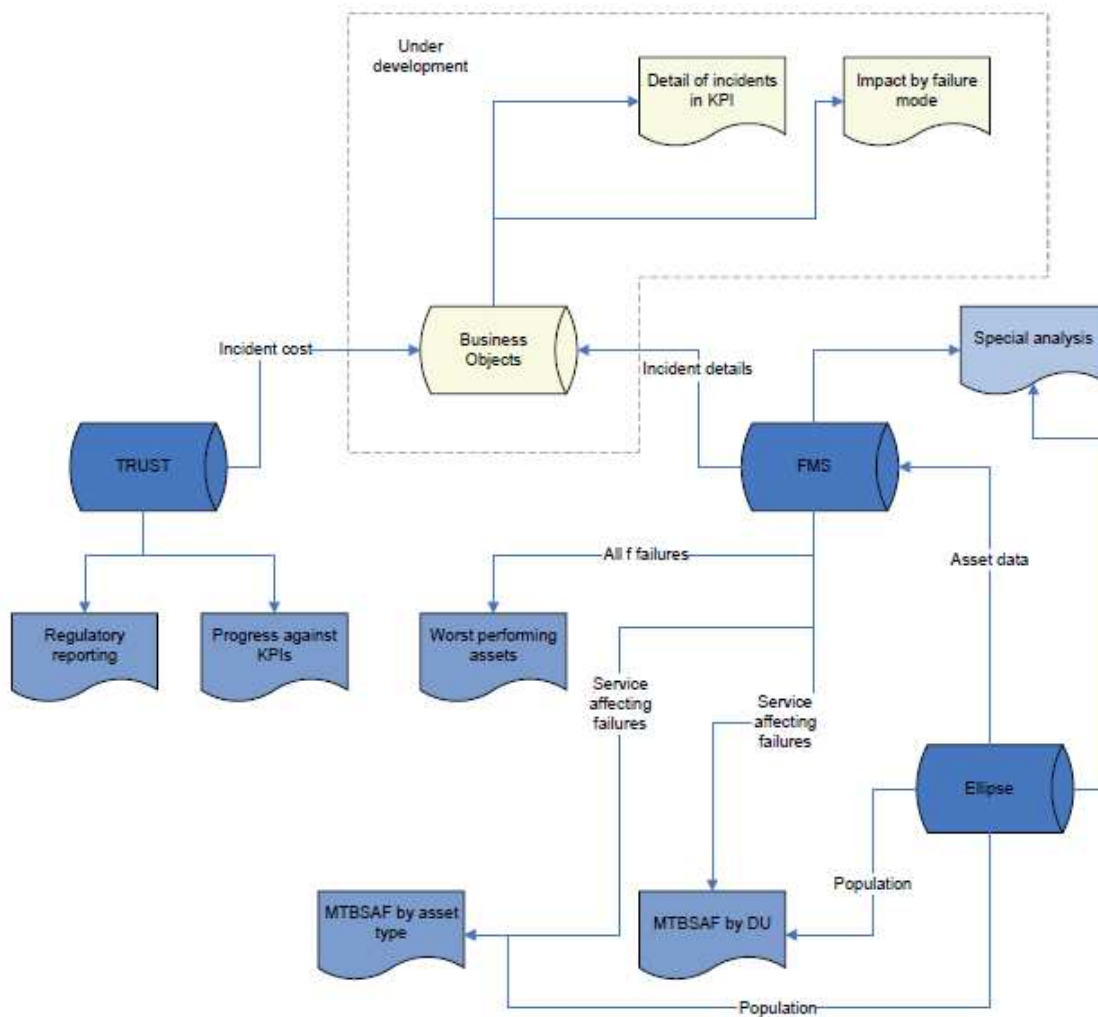
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Figure 9 TRUST and FMS analysis

Although not linked directly, the interrogation of the systems has been improved by the introduction of the relevant TRUST number into the fault record in FMS and vice visa. This has facilitated the recent development of further analysis using an Oracle based Business Objects analytical tool.

This is at an early stage in its development by the IRG and the outputs are not currently being used across Network Rail. Network Rail commented that it will improve and automate a lot of the analysis currently being done manually.

5.3 ORBIS

The 'Offering Rail Better Information Services' (ORBIS) programme is being developed with the following key objective:

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> "To serve Network Rail and the GB rail industry as the trusted source of asset-related
>
> information and insight, from which informed decisions can be made to balance risk,
>
> performance and funding to best deliver Network Rail's Promise".

The ORBIS programme is subject to a separate Independent Review and so this report will look solely at the Failure Management systems being dealt with within the ORBIS programme.

The ORBIS programme currently lists FMS as a 'tolerated' system within the ORBIS classifications. This means that there are currently no plans within ORBIS to review the current system and any changes are reliant on a business led strategy. AMCL in the course of its review could not find any current plans for a strategic review of the FMS or of its requirements by the business.

The programme plan for ORBIS contains a project to implement handheld devices for use by front line teams, which is currently underway. Theoretically this should provide an opportunity to give the front line maintenance teams the ability to access FMS data (either directly or through a Mobile Enterprise Application Platform interface) for improvements to fault finding and recording, including inputting root cause data into FMS where possible. However, the extent to which this integration of handheld devices and FMS is planned is unclear and detailed evidence on proposed data flows and architecture was not provided during this review. Network Rail states that the current plan is to link handheld devices to the fault capture consoles which will link to FMS. However, this still needs to be reflected in ORBIS and supported by a Systems Architecture for these data flows.

It is the advice of the FMS technical support team within Network Rail that a handheld link-up would be potentially difficult and expensive to achieve as the FMS servers may not be compatible with a link-up to mobile software due to their age and configuration. The technician's opinion was that it would be more effective and economical to develop a new system. The ORBIS programme has not at this time investigated the compatibility of all systems with handheld devices.

5.3.1   Master Data Management

The ORBIS Master Data Management Project states that its intent is to:

▪ Create a common business data vocabulary for our assets so when we are talking about assets we all mean the same thing;

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- Deliver a set of business data definitions which provide the descriptions and specifications of data relating to track and non-track assets, and a mapping showing which system holds what data;

- Deliver a 'Master Data Hub' that contains Track Asset master data which is cleansed, standardised and harmonised across six key applications in the Network Rail landscape;

- Deliver the synchronisation of track asset data between the Master Data Hub and three key track systems. (Ellipse, GEOGIS and TRS);

- Provide the capability for users in the Centre and the Routes to access a common set of business data definitions for assets and to view the track asset master record; and

- Define the data governance polices, data management (master and meta data) process and the responsibilities within job roles, to be implemented within AIO, to enable effective asset data management.

Tranche 1 of the MDM programme is starting with Track assets and is solely looking at Static Data such as the asset register in Ellipse and is not reviewing systems that handle Transactional (Dynamic) Data such as Fault data. The aspiration is that it will look at these systems in the future.

The MDM programme has therefore not reviewed the FMS system at this stage of the programme.

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6 Conclusions

The key conclusions that can be drawn from the Review of Asset Failure Management at Network Rail are:

Fault Management

A significant amount of work has taken place between the central Infrastructure Reliability Group (IRG) and the Routes to improve Failure Management at Network Rail by analysing fault data to spot trends and highlight reliability issues. A hierarchy of meetings has been created from local Maintenance Delivery Units (DUs) to national level to share and monitor reliability issues and solutions.

Infrastructure Reliability Group

A key issue with the IRG meetings is a lack of process for escalating failure issues and defined responsibilities for producing solutions. This has led, in some cases, to issues being identified but solutions not being developed due to the lack of ownership.

There is currently no central repository for reliability issues and solutions, therefore IRG team members have to rely on their own knowledge or discussions with colleagues to match an issue to a known solution.

A number of reports are produced by IRG to aid the company in the understanding of fault and reliability issues. These require subsequent analysis by the recipient to enable emerging trends to be identified. In the data quality reports many measures only look at the quality of delay producing fault as opposed to all faults.

Maintenance Strategy

Network Rail is seeking to extend the reliability centred maintenance approach for signalling assets to other assets groups and incorporate local factors such as failure rates to enable maintenance regimes to be tailored to suit local asset condition. Due to the Network Rail Maintenance Strategy being developed at the same time as an internal review of Network Rail Maintenance Standards taking place there is a risk that the two will not align.

Routes

Devolution is improving the communication of Failure Management and Reliability issues within the key functions in the Routes by creating closer working practices and regular meetings. The

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inclusion of Schedule 8 costs within the Route budgets is also focusing attention on improving performance and reducing incidents.

There has been a significant improvement in the completeness of the fault data captured in FMS; in 2007 only 9% of records were complete, then in August 2009 changes to the FMS system were made to improve data collection. As at Period 2 of 2012/13 98% of delay causing fault incidents were complete but this does vary by Route from between 100% complete to 92% complete.

However, the data identified for capture also reduced significantly in August 2009 as part of the changes mentioned above, meaning completeness statistics may have increased but there is also a significant risk to the quality of the data.

AMCL found that there are significant variations in the level of resources being assigned to Failure Management by the Routes, both in improving the accuracy of the fault data being collected and the analysis of fault data to identify reliability issues.

An increasing number of teams in Network Rail, both centrally and in the Routes, are using fault and reliability information to create targeted performance improvement plans. But without significant changes to the FMS system it is AMCL's opinion it will prove increasingly difficult to identify and prioritise reliability issues due to poor root cause information in the current drop down menus.

Fault Management System

As detailed in previous reports the root cause choices in the FMS drop down menus are considered insufficient and these need to be reviewed using the outputs from FMEA (Failure Modes and Effects) analysis. Network Rail has planned to do this by January 2013 but there are no plans for how to turn the FMEA output into a usable number or wording of drop-down menu choices in FMS.

FMS is a legacy system built up over time from a number of separate systems. It is relatively expensive and increasingly difficult to maintain due to the age of the hardware and the number of servers it is hosted on. Changes to FMS local are particularly expensive due to external ownership of the intellectual property.

The current FMS system has multiple users across Network Rail involved in two main business requirements; fault fixing and reliability improvement. However, there is no owner of the system requirements.

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There is no configuration management processes to update changes in the Ellipse asset register into the asset register sub-set held in FMS and no process for looking at the effects of any changes to the Failure Management processes. This is a key risk as increasing changes are made to the asset register in Ellipse by the on-going Master Data Management (MDM) project.

ORBIS

There are currently no plans within the ORBIS programme to develop FMS. Network Rail states that the current plan is to link handheld devices to the fault capture consoles which will link to FMS. However, this still needs to be reflected in ORBIS and supported by a systems architecture for these data flows.

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7 Recommendations

The following recommendations are made in relation to Asset Failure Management in Network Rail:

1) The IRG should document the process for the escalation of fault/reliability issues, setting out the conditions required for an issue to be investigated centrally or for it to be pushed back to the Route. [January 2013]

2) The IRG should develop a central data library for fault/reliability information and solutions that is accessible by the Routes. [End CP4]

3) The IRG team should widen the monitoring and reporting of FMS data quality to cover all faults not just delay producing incidents. [January 2013]

4) Further to the recommendations set out in the Network Rail Asset Management Roadmap Update (13/04/2012) sections 2.2 to 2.7 detailing the move to risk based maintenance, Network Rail should evidence how reliability information and analysis is being used to inform this process and the changes to key national strategic decisions; particularly in renewals and maintenance policies. [by end CP4]

5) Network Rail should clarify how it will ensure that the current review of the maintenance standards aligns and integrates with the emerging maintenance strategy. [January 2013]

6) Network Rail should produce guidance for the Route FMS support and analysis teams setting out the expected competencies within the team and the level to which fault management activities should be mandated in the devolved organisation. [January 2013]

7) Network Rail should formalise a stream of work to turn the root cause analysis from FMEA analysis into usable drops down menus in FMS. [January 2013]

8) The MDM team should develop a configuration management process for changes to the asset register in Ellipse looking at how changes may affect FMS data collection and provide sufficient time for changes to be made to the FMS asset register. [January 2013]

9) The ORBIS team should produce a System Architecture for the data flow to link handheld devices to the fault capture consoles which will link to FMS. [November 2012]

10) Network Rail should appoint from within the FMS users a single owner of the FMS system requirements. [November 2012]

11) Network Rail should look at the cost benefit case for replacing the FMS system as part of the ORBIS programme. [March 2013]