

ORR Best Practice Study

A report on the programme of international visits carried out by ORR between July – October 2007

Summary Report



A summary of issues identified during eight international fact-finding visits

Canada



USA



Denmark



The Netherlands



Austria



Switzerland



Germany



Australia



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Version No	Date	Details	Status
1	Jan 2008	Initial draft	Draft
2	Feb 2008	Final draft for approval	Final Draft
3	March 2008	Approved for publication	Final

Glossary of Acronyms

AAR	Association of American Railroads
Amtrak	USA national passenger operator
ARTC	Australian Rail Track Corporation
BDK	Banedanmark (Railnet)
CN	Canadian National Railroad
DB	German National Railways
Dol Victoria	Department of Infrastructure
DSB	Danish State Railways
FRA	Federal Railroad Administration
NJT	New Jersey Transit
NS	Main Dutch passenger operator
OBB	Austrian Federal Railway
ProRail	Dutch railway infrastructure operator
QR	Queensland Rail
RailCorp	New South Wales passenger operator
SBB	Swiss Federal Railway
UP	Union Pacific Railroad
Ellipse	Formerly MIMS – asset management system
Maximo	IBM asset management system
SAP	System Application Process – asset management system

Acknowledgements

We wish to thank the many members of different railway administrations, federal government officials and private individuals who contributed to the success of the best practice study in all eight countries visited.

We were always welcomed warmly and enthusiastically, our questions were patiently and thoroughly answered and we were also granted access to observe practices on a number of site visits. On occasions this involved staff working at weekends, for long hours or being diverted from their normal work. To all of these railway industry colleagues we are extremely grateful. We trust that this report accurately and fairly reflects their contributions.

Executive Summary

This report provides an introduction to a programme of international fact-finding visits that was conducted by ORR during the summer and autumn of 2007 to a number of railway administrations in Europe, North America and Australia. This study tour forms part of our work on the 2008 Periodic Review, which will determine the regulated outputs and access charges for the five year control period (CP4) between 1 April 2009 and 31 March 2014.

To be able to determine these charges we need to understand the costs that Network Rail expects to incur to run its business, and we need to do this with the widest possible knowledge of how other railways are operated and managed. The specific aim of this visit programme was therefore to seek information that will help us in our assessment of Network Rail's expenditure plans and enable us to reach a robust determination of the expenditure required to maintain and renew its infrastructure assets in an efficient and economic manner that is in accordance with best asset management practices.

This report summarises the major themes and issues that emerged during our visits and it documents the main challenges that we identified for Network Rail. It therefore provides the introduction to the supporting suite of individual visit reports, each of which contain much more detailed information and commentary.

This report also provides the foundation for more international comparisons in the future. We believe that there are many opportunities for Network Rail to investigate, compare itself, challenge its existing practices and consider adopting ideas and initiatives from other railways and the wider supply industry. Network Rail faces many of the same challenges as the comparator railways we visited, and therefore if it is to become a truly world class business, it must be active in seeking to identify and implement best practice. Constructive interaction with other railway organisations is an essential element in that process, and it needs to last well beyond the confines of the 2008 periodic review. Indeed, it should be a continuous process.

In fairness, Network Rail claims that it already does much in this respect. However, we remain to be convinced that the present level of engagement with other railways is at the right level, of appropriate nature and sufficiently detailed. We will therefore be continuing to discuss the lessons set out in this report with Network Rail, and to seek further evidence of an open and learning approach within the pursuit of appropriate best practice for Britain's railways.

1. Introduction and Objectives

- 1.1 During 2007 ORR conducted a programme of international fact-finding visits to a number of railway administrations in Europe, North America and Australia. This study tour forms part of our work on the 2008 Periodic Review (PR08), which will determine the regulated outputs and access charges for the five years between 1 April 2009 and 31 March 2014 (known as control period 4, CP4).
- 1.2 To be able to determine these charges we need to understand the costs that Network Rail expects to incur to run its business, and we need to do this with the widest possible knowledge of how other railways are operated and managed. The specific aim of these visits was therefore to seek information that will help us in our assessment of Network Rail's expenditure plans and enable us to reach a robust determination of the expenditure required to maintain and renew its infrastructure assets in an efficient and economic manner that is in accordance with best asset management practices.
- 1.3 The importance of this is clear. We know from other elements of our PR08 work that when benchmarked against other railways, Network Rail's costs for managing its infrastructure assets are considerably higher than most, if not all, of its comparators. Our visits to a number of these have corroborated this view, and we are pleased to note that Network Rail is currently doing some further work to understand more about its relative costs. We are in no doubt that many of the observations made in this report highlight real opportunities for Network Rail to achieve a more efficient railway that provides better value for money.
- 1.4 Railways can be very dependent upon processes and procedures that stem from custom and practice, without much attempt to adapt and change through learning by comparison. We found much evidence of this still, but also found that it is beginning to change. Network Rail has stated its aspiration to be a world class organisation in the railway industry. To achieve this we expect it to demonstrate that it has a good understanding of best practice, that it actively seeks information about how others operate, maintain and renew comparable railway networks and that it learns readily and adopts practices appropriate to Britain where these have a sound case and clear benefits.
- 1.5 No single railway administration around the world is likely to 'best in class' in every aspect of what it does. Apart from historic practice, ownership and organisation structures, business objectives, traffic patterns, funding and regulatory arrangements, geographical and physical features are amongst the many factors that influence the way in which each railway operates and performs. These factors must obviously be taken into account when comparing other administrations with Network Rail.
- 1.6 This study tour was not a formal benchmarking exercise, but it was a valuable opportunity to identify areas of international practice where Network Rail could apply lessons, or at least do further investigation of opportunities to improve its own business processes. Most railways are facing very similar challenges, and it was clear from our visits that there are many useful comparisons and transferable observations and lessons to be made, for example in areas such as asset management, cost analysis, working methods, plant and equipment, possessions management, asset inspection and condition monitoring. We have

used these to examine how well Network Rail's policies and processes measure up to best appropriate practice, and to see what further opportunities may exist. It is our objective to encourage Network Rail to actively seek out and pursue such opportunities.

2. The Visit Programme

2.1 Starting with an initial list of more than 15 possible comparator countries, the final selection of countries that we approached to host our visit programme was determined using the following criteria:

- the railway administration had a particularly good reputation as the owner of a well run, high performing, efficient and well engineered network and/or there was a national reputation as a leading exponent of asset management
- the railway administration was facing, or had recently faced, challenges about declining asset condition and the effect of condition on the reliability and performance of the network
- we should try not to re-visit countries that have recently hosted other fact-finding visits that included ORR staff (e.g. Japan)
- the nature of the railway network, with preference being given to comparators with similar traffic patterns to Britain i.e. intensive mixed traffic services operating on high speed main lines, dense commuter routes and significant amounts of rural railway

2.2 The final selection is shown in Table 1 below:

Country	Administration	Dates
Austria	OBB	09 -12 July 2007
Australia	RailCorp, New South Wales Queensland Rail DoI Victoria ARTC	20 August – 05 September 2007
Canada	CN	10 – 12 October 2007
Denmark	BDK	17 – 21 September 2007
Germany	DB	08 – 10 October 2007
The Netherlands	ProRail	24 – 26 September 2007
Switzerland	SBB	09 – 14 September 2007
USA	Amtrak New Jersey Transit Union Pacific	30 September – 09 October 2007

Table 1. List of Countries Visited

3. Conducting the visits

- 3.1 ORR appointed a number of consultants to assist us with the visit programme. We were able to use their expertise, and in a number of cases their contacts, to plan our investigations and to support our preliminary desk research. This looked at the characteristics of each railway organisation we were due to visit, and the main issues that they were facing. In each case we prepared a questionnaire that was sent to our hosts sufficiently far in advance of the visit, allowing them to focus their preparations upon areas that we considered to be the most useful to study.
- 3.2 Our hosts had always prepared well and provided us with a massive amount of information. In each case the format of the visit was largely centred around presentations and subsequent discussions with key personnel. Inevitably, the structured nature of the meeting agendas – and very often the pace of the presentations, which covered a wide range of issues in quite limited time – meant that it could be difficult to drill down more deeply into specific issues and areas of interest. We always recognised that this was likely to happen however, and we have noted a number of issues where there is a case for further and more detailed examination.
- 3.3 In developing and carrying out the visits programme we consulted fully with Network Rail, and Network Rail staff joined with us on the visits to North America, the Netherlands and Germany. In all cases we have been sharing the report findings and conclusions with them.

4. Documentation

- 4.1 This report has been written to provide an overview of the visit programme. It explains the overall purpose of the study, it summarises the major themes and issues and it documents the main challenges that we identified for Network Rail (see Appendices A to G). It should therefore be used as the introduction to the supporting suite of individual visit reports, each of which contain much more detailed information.
- 4.2 Together with this summary report, these individual visit reports have been made available on our website and are being specifically copied to Network Rail. In all cases the reports have been cleared with our hosts to ensure that we have accurately and correctly reflected the content of our visits.

5. Key Themes

- 5.1 Immediately after completion of the whole visit programme, the team held a review workshop to consolidate our observations and findings. This enabled us to group them under a number of major topic headings. These are listed below, presented in five main groupings that reflect key elements of best practice asset management: policy and strategy, life cycle processes, delivery, technology and equipment and people issues. The following paragraphs then briefly introduce the key observations under each heading, in a way that explains the issues without discussion in depth. Cross-references to the individual visit reports are made so that readers can follow issues through in greater detail if they wish.
- 5.2 The main themes are shown in Table 2 below:

Main Theme	Sub-Sections
Strategy and Policy	Organisational Structure Asset Policies Asset Management
Asset Life Cycle Processes	Asset Inspections Capability, Maintainability, Reliability Condition Monitoring Materials Management
Delivery	Operations and Performance Monitoring Engineering Access to the network Project Management (Quality Control)
Technology and Equipment	Research and Development Engineering Innovation (materials and components) Engineering Plant and Equipment
People Issues	Skills and Staffing Safety

Table 2. Key Themes

5.3 Strategy and Policy

5.3.1 Organisational Structure

Although we noted the basic organisational characteristics of the railways we visited (including in some countries the federal and state regulatory, financial and safety governance authorities) in order to understand the context in which they operate, it was not the purpose of this study to examine the theory and practice of management structures. We noted great diversity in the way the various railway administrations we visited are organised, ranging from vertical

integration where all engineering work is carried out 'in house' (such as in the USA) to ones that outsource significant elements of their maintenance and renewal programmes. We observed that national structures have generally evolved over many years, adapting in different ways to national objectives, ownership, legislation and funding arrangements. We have found no evidence that there is any 'best practice' organisation model. Even though Network Rail has chosen to bring infrastructure maintenance 'in house', we found other examples where outsourced maintenance delivery continues to work well with proactive contractor management that focuses strongly on programme delivery and quality control. In such cases we also found good examples of contractors driving innovation and efficiency improvements. More information on this is discussed below.

There were some interesting case studies of operational organisation. For example, we noted railways that:

- had created regional signalling control centres co-located with electrical control rooms (Denmark, Germany, USA)
- developed a mature system of managing regional networks, with local management given a high degree of responsibility for aligning operation, expenditure and performance. The networks provide excellent opportunities for internal benchmarking and are driving very significant efficiency initiatives, focused mainly on developing low cost technologies in signalling and train control. (Germany)
- were learning important and widely applicable lessons about how best to manage the interface between maintenance and renewals delivery (Austria)

Continual dialogue between different railways should stimulate creative thinking about how each organisation structure can best be tailored to suit the business objectives and operational requirements.

5.3.2 *Asset Policies*

Well-documented asset policies that describe the approach to maintaining and renewing railway infrastructure are an essential building block towards best practice asset management. Policies for each asset category (track, signalling, engineering structures etc) explain the mechanisms for wear and deterioration and should set out the most economic solutions for managing the assets according to the underlying business objectives. This should define how maintenance and renewal interventions are balanced on different types of route in order to achieve the optimum whole life cost. Where this approach cannot yet be demonstrated (e.g. where condition, work history and cost data are not yet sufficiently accurate and/or understood) the documentation of asset policies tends to reflect more about current practices and engineering judgments.

This is not to suggest that all railways will adopt the same policies. We were already aware, and have seen significant further evidence during our visits, of radically different approaches to track renewals policies depending on the nature and operation of different networks. Broadly, these range from a North American practice of partial component renewal to a widely adopted European practice of undertaking large scale, whole track system renewals from sub-base upwards. In some cases (e.g. Germany) we noted that the arrangements for funding renewals appears to drive track renewals on a time basis, and we

saw some evidence of track renewal taking place earlier than we would expect to occur on the British network.

Neither philosophy can be regarded as universal best practice. What our observations serve to emphasise is the importance of Network Rail completing detailed life cycle cost analysis to define and justify the policies it applies, and in this we believe there is much for it to learn from the work that has already been done on other networks (see section 5.6.1).

Network Rail is working to develop its asset policies and the underlying economic justifications, although it remains constrained by incomplete knowledge of maintenance costs and performance impacts at a detailed asset level. In this it does not appear to be untypical of many railways. In our visits we found considerable evidence of clearly preferred approaches to engineering solutions but only limited evidence that these are supported by formal asset policies that demonstrate real life cycle cost analysis. That said, we did conclude that some administrations do appear to be making good progress in understanding the life cycle costing of track asset management in particular, and we recommend that Network Rail should give high priority to considering how it can best link with such work. We were particularly impressed by:

- the work done by Austrian Railways (OBB) and the Technical University of Graz to understand and model the life cycle costs of track and to manage the track system accordingly, resulting in:
- strong focus on the benefits of achieving high quality track installation, not least in respect of good formation and drainage management (OBB and RailCorp).
- a clear relationship between high quality track with better quality ride for passengers and a reduction in rolling stock maintenance costs (RailCorp).
- formal policies for track renewals (USA – Union Pacific)
- formal policies for partial renewals of switches & crossings, supported by clear understanding of the relative costs and advantages of partial renewals compared with full renewals (USA and Canada)
- the development of a tactical life cycle cost analysis tool that is used to support decision making on the optimum scope and timing of track renewals (The Netherlands). We understand that ProRail has found that the use of this tool has moved the balance of work to some extent towards more partial renewal/life extension work rather than full renewals, resulting in reduced costs.

This is not only about Network Rail learning from organisations that are ahead of it. Network Rail has much input to make too, and in some asset categories (e.g. in maintenance strategies for structures – especially bridges) we believe it may be the case that its life cycle modelling is best current practice.

Given the importance of life cycle costing to all railways, we believe that there is great value in co-operative working between organisations and further sharing of analytical methods.

5.3.3 Asset Management

The main focus of our asset management assessment was upon the processes for collecting, using and maintaining asset information. This is arguably one of the greatest challenges currently faced by any railway network operator, and we spent some time looking at experiences elsewhere. Unsurprisingly we have concluded that there are significant opportunities for exchanging experience and learning points between system users.

We therefore recommend that Network Rail should consider what opportunities may exist for developing greater practical contact with other railway users of asset information systems, perhaps by means of a joint user group.

Our conclusions can be summarised in two areas:

- the user-facing presentation of information i.e. the system
- how information is applied and exploited to inform decision making

Network Rail has been progressing well with its asset information strategy during the last three years. We have never underestimated the enormous challenge that is posed by the complexity of the railway network and some of its deeply ingrained cultures, and we know that the development of mature information management is usually measured in a span of several years. In this we noted interesting comparisons with other systems. In Switzerland, for example, SBB spent 10 years between initial development and completion of its asset information system.

However, we also concluded that some railways appear to be further forward than Network Rail in (a) their implementation of user-friendly information systems and (b) their culture of acceptance at working level. We particularly noted the use of GIS based network models in Australia and Switzerland, and we consider that there are significant opportunities for Network Rail to learn from these in developing its own corporate network model. This is a concept that has been under development for some years, and we are concerned that Network Rail is now lagging behind other railways in its application.

During a number of visits (e.g. to Austria and Denmark) we also formed the view that extensive information on all aspects of infrastructure condition and performance is not only very accessible to end users but is also used routinely to ensure that the appropriate engineering specifications are established effectively. We know that Network Rail is seeking to do the same, but once again our observations indicate that some other railways demonstrate greater proficiency and discipline in doing this.

Asset management is relatively new as a formal discipline in Europe but has been developed further in Australia. In Europe, the term asset management may still be thought of as more of a financial discipline, with process management systems being used for financial or works management. We found a range of products in use, including Maximo (IBM), SAP and Ellipse (formerly MIMS). All systems demand good quality, comprehensive asset data and this takes time and significant resources to develop properly, and a long-term commitment to ensure that information systems are kept fully up to date.

One of the key themes to emerge from our study was that:

- where other railways have well established asset management systems they appear to be more fully exploited to their maximum functionality than Network Rail has yet achieved with its use of Ellipse
- widespread evidence for this was found in Australia, Austria, Germany, Switzerland and the USA.

Unfortunately, time generally prevented us from taking this assessment further and into more detail. We therefore consider that there is useful further work to be done to compare the operation of asset management systems and to understand the extent to which asset knowledge is creating business value.

At a detailed level, we observed processes and systems in use to display information about networks and individual asset information (e.g. asset condition). We particularly noted:

- how the investment in high quality track renewals in Austria is resulting in low inspection and maintenance costs, with strong emphasis on the need to maintain high quality condition data that enables a move from reactive maintenance to a 'predict and prevent' maintenance regime that maximises asset life
- the application of comprehensive fault recording and analysis systems in the USA and Canada
- an increasing move towards remote condition monitoring and automated inspection processes (see sections 5.4.1 and 5.4.3)

5.4 Asset Life Cycle Processes

5.4.1 Asset Inspections

Best practice asset management requires appropriate inspection regimes for different asset groups and includes the potential for introducing a risk based (rather than a rigid time based) approach. The opportunities offered by a move towards risk based maintenance regimes are discussed separately in this report, as are the opportunities to monitor the performance and degradation of infrastructure using innovative techniques.

The two key themes to highlight in this section relate to:

- inspection strategy (including frequency)
- inspection methods

In respect of inspection strategies we noted that, almost without exception, the railways we visited appear to undertake less frequent manual inspection of their infrastructure than is currently practised by Network Rail. Indeed, it was often the subject of comment by those we met in other organisations and there was widely shared surprise that Network Rail still relies upon relatively high frequency manual inspection.

It goes without saying that any potential changes in an inspection regime must be carefully handled, never compromise the knowledge that is acquired and therefore deliver at least the same level of safe asset management that is achieved by the existing processes. We simply observe that it is the experience of other railways that technology changes and new inspection methods do provide significant opportunities to adapt and even improve inspection regimes.

Network Rail is as aware of this as the other railways we visited, and of course has made substantial changes of its own in respect of data collection through introduction of (for example) the New Measurement Train, the Southern Measurement Train, new rail flaw detection systems and by application of unattended track geometry measurement.

From our visits, we have drawn Network Rail's further attention to:

- the opportunities for learning about new and/or different innovative inspection equipment and techniques to improve inspections. (eg. The Netherlands)
- experience being gained (again by ProRail in the Netherlands, for example) by changing the ergonomics of inspection from manual track patrolling to office based analysis of inspection videos
- the use of UIC developed methodology for measuring and scoring discrete sections of track based upon actual component condition (Switzerland)
- the potential benefits of carrying out (some) track inspections using road-rail vehicles (for example as practised in the USA)

5.4.2 Capability, Maintainability, Reliability

One of the key asset management strategies for Network Rail to consider is the development of a risk-based approach to infrastructure maintenance. Advice from the industry's independent asset management reporter indicates that such a strategy may realise savings in the order of 20 – 30% of existing maintenance costs.

We found evidence that other railways are beginning to apply risk based maintenance strategies. In the Netherlands, for example, Prorail is continuing to implement a programme that was initiated four years ago, using Failure Modes, Effects and Criticality Analysis to shape its maintenance strategy. We consider that Network Rail could benefit significantly by sharing in the development of such widely recognised best practice techniques, and we will be continuing to seek evidence that it is active in doing this.

While achieving a risk based approach to maintenance is a major strategic opportunity, we also found many examples of detailed maintenance practices from which lessons can be learned. Our challenges to Network Rail include:

- other railways (e.g. SBB) appear to achieve much higher reliability of points. Why does the level of points failures appear to be higher in Britain than on other networks?
- in Denmark, Banedanmark (BDK) has carried out extensive analysis of the performance of the point machines on its network. As with Network Rail, the newer designs often appear to be less reliable. We are already aware of steps that Network Rail is taking to improve the reliability of its points, but
 - to what extent is it benchmarking itself with other railways as it does this?and

- to what extent is it working with other railways to drive greater reliability from the more recent designs of point machine? Does Network Rail consider that a stronger combination of client organisations could drive an improved performance by the supply industry?

5.4.3 *Condition Monitoring*

Network Rail shares many of the same challenges as the other railways we visited, not least in the need to find new ways of assessing and understanding the condition and performance of the infrastructure assets. We noted several examples of how the drive to improve worker safety while improving the reliability and performance of the assets has driven innovation into inspection and monitoring processes. For example:

- There is increasing use of remote monitoring of points (e.g. Switzerland)
- Other railways are successfully using video inspection and surveillance techniques, especially in areas of dense traffic where manual inspection is difficult (e.g. The Netherlands)

There are also several examples of automated track mounted vehicle-track monitoring systems that we believe may offer Network Rail greater sophistication and functionality than their present installations. While we understand that a trial site is proposed for one such system, Network Rail appears to be rather slow in exploring the benefits offered by new(er) technologies for condition monitoring.

5.4.4 *Materials Management*

It is common practice on many railways to maximise the economic use of materials by refurbishing and re-cycling (cascading) them from primary routes to secondary parts of a network. This used to happen quite extensively in Britain too, but we believe that in recent years under Railtrack and Network Rail this practice has largely been abandoned.

We found considerable evidence of well established re-cycling practices, for example:

- depots dedicated to receiving, refurbishing and re-issuing infrastructure components including track and signalling equipment (Germany, Switzerland and USA)
- rail cascading policies (Australia, USA)

We consider that Network Rail needs to be more active in the re-use of materials, or at least in investigating the business case for extending the economic life of many assets.

5.5 Delivery

5.5.1 *Operations and Performance Monitoring*

Although it was generally difficult to access detailed data about asset reliability on the railways we visited, we found considerable anecdotal evidence that many of them suffer less performance impact caused by infrastructure failure

than is the case with Network Rail. Although Network Rail carries out some internal benchmarking to drive performance improvement, we believe it could do more to compare itself with, and learn lessons from, other railways. For example:

- In Germany, we noted that a national control centre manages the operation of both long distance passenger services and high value freight operations across the entire network, with responsibility for other services devolved to regional operations centres
- We were also impressed by the application of predictive software in network control centres, providing signallers with decision support to improve the effectiveness of managing train services by looking ahead and modelling service patterns during unplanned perturbations (Germany, Denmark). Does Network Rail utilise similar decision support systems?
- We noted a culture of open learning and continuous individual performance improvement amongst signallers (Denmark). This is discussed further in section 5.7

5.5.2 Engineering Access to the Network

All railways face the same challenge in seeking to balance the need to access the infrastructure to inspect, maintain and renew it, with the requirement to maximise its availability for normal operation. For most of the railways visited there was a clear message that engineering is there to serve the operation of the railway and at best should be virtually invisible. In recent years, Network Rail's engineering access has caused extensive disruption, particularly to weekend travel. Currently there are many areas in which Network Rail's engineering productivity in track possessions compares very poorly with that of other railways. However, it is now beginning to address this issue and is seeking to reduce very significantly the disruptive impact of its engineering works. Its various productivity initiatives and the evaluation of its "7 Day Railway" proposals are key issues for PR08.

We found no 'best practice' solution to this issue during our study. Instead, we noted that different organisations have developed bespoke practices that best suit their needs. We also noted that many are also evaluating changes to their traditional practices. The approaches to carrying out engineering works can differ greatly:

- In Switzerland, much work is currently carried out in very short weeknight possessions. However, consideration is being given to the opportunities that slightly longer possessions may deliver in terms of unit cost efficiencies
- In Australia, many of the heavily used commuter routes (e.g. in the Sydney conurbation) are subject to cyclic full weekend blockades
- In The Netherlands there is a preferred approach to grouping both maintenance and renewal works into long blockades, closing routes for a

week or more at a time and either diverting services or using bus substitution.

- For routes that mainly carry freight, commercial considerations of the customer often limit closure of lines to 6 hours or less.

As we review Network Rail's proposals for future engineering access, we will want to be sure that different access strategies have been fully understood and evaluated.

During our visits we generally found that other railways succeed in managing the process for taking and giving up track possessions and isolations much more quickly than is currently achieved in Britain. Although we emphasise this point as an observation, we do recognise that Network Rail is seeking to develop improved processes of its own, and in this it has been in discussion with other railways.

There are also lessons to be learned about planning processes and the timescales for planning engineering works. In our report on the overrun of engineering works over the Christmas/New Year holiday in December 2007 – January 2008 we said that:

“Network Rail should work with the industry to review its own planning timescales and the timescales for relevant industry processes, such as possession booking and train planning, to see whether a different approach would offer a more efficient structure which provides both predictability and stability” (source: Report of ORR's Investigation into Engineering Overruns, February 2008)

In doing so, Network Rail should recognise that there are likely to be good learning opportunities by engaging with other railways that face very similar planning challenges. In Germany, for example, we understand that the planning of major engineering works that have the potential to be very disruptive to operating timetables can commence some three years before the actual works take place.

5.5.3 Project Management (Quality Control)

Our visit programme did not provide us with too many opportunities to compare detailed project management processes. However, we did note clear lessons to be learned in respect of the quality control exercised by client organisations in managing works both to routinely replace assets (e.g. track renewals) and in projects to upgrade and enhance a network. We particularly noted:

- Evidence of close management supervision of signalling renewal projects in Switzerland (SBB)
- Stringent quality checking of completed works, including routine track renewals (Austria, The Netherlands)

In our opinion, Network Rail has important lessons to learn about the benefits of adopting more stringent contactor supervision and/or more quality checking to ensure works are completed to the specified standards. Although the delivered quality of track renewal works appears to be improving, we believe it has to improve more if Network Rail is to demonstrate that its work is consistently achieving the standards required to deliver minimum whole life costs.

5.6 Technology and Equipment

5.6.1 *Research and Development*

We noted some strong links between a number of railway administrations and industry led and/or academic research organisations, most particularly:

- The key role played by the TTCI test facility in Colorado in spearheading technology development on behalf of the Association of American Railroads (USA)
- Strong practical support to a number of European railways by the Technical University of Graz (Austria, Switzerland)

In the latter case, we were impressed by the way in which the University of Graz has given extensive practical support to Austrian Railways (OBB) in the analysis and development of life cycle cost analysis for track asset management on a range of route section templates. We have provided Network Rail with the details of this life cycle modelling, and we believe that it should be actively and vigorously seeking to apply the lessons from such experience as it develops its own life cycle cost analysis and hence refines its asset policies.

We have challenged Network Rail to consider whether it is giving sufficient emphasis and direction to the role of research and development as it seeks to become more of a world-class business and deliver economic asset management.

However, innovation and development are not driven exclusively by client organisations or by academic research. We also observed a number of cases where external contractors have driven innovation and improvement (e.g. in implementing remote condition monitoring of points in the Netherlands). We believe that there is still considerable potential for Network Rail to harness the thinking and experience of its supply industry to improve its effectiveness and efficiency. Indeed, we note that some suppliers are able to bring direct experience of their activities elsewhere in Europe. During our visits we met with contractors as well as client organisations, and while some of the discussion was anecdotal, it clearly contained a significant theme that suppliers often find it much harder to exploit their expertise within the British market than they do on similar networks elsewhere.

Our challenge to Network Rail is to consider how it can improve the way in which it works in partnership with its suppliers and with academic/research

organisations to identify and adopt best practice. It should have a clear strategy for this and be seen to have clear processes for identifying and evaluating applicable best practice, and it needs to be driven with determination and commitment.

5.6.2 Engineering Innovation (materials and components)

The drive to increase the safety and performance of railway networks and to improve efficiency must exploit technology opportunities to the full. We know that Network Rail recognises this, and in some cases it is evaluating technologies for wider implementation. However, we remain concerned that it can be slow to embrace, or even to consider, all the opportunities that are available to it. Once again, we believe that an active and sufficiently detailed level of engagement with other railways must be highly beneficial. We noted a number of examples where, in our opinion, Network Rail's approach may be less than 'best practice':

- Austria and Switzerland have already done much work to demonstrate the benefits of under-sleeper pads to improve sleeper and ballast life. Although we understand that Network Rail is just beginning to undertake some limited trials, we question whether it is being sufficiently proactive and quick to learn from proven experience elsewhere.
- Similarly, a number of European railways are implementing absolute track geometry. How are Network Rail's applications and plans for any further implementation taking account of the lessons learned on other networks?
- Although Network Rail is using ground probing radar technology, we are concerned that it may still not be extracting the maximum benefit from a technology whose value has been well established for some years. This applies especially to ensuring that the information it produces is applied to achieve optimum track renewal specifications for the lowest life cycle cost
- Generally, we observed that European railways with the best understanding of the whole life cycle cost of track are paying the greatest attention to ensuring that the sub-base (formation) and drainage specifications are correctly detailed and installed. We are not convinced that Network Rail is yet at this stage
- We had hoped to discuss more detail about the economic case for installing slab track, with particular reference to the extensive experience in Germany. Unfortunately time did not allow us to pursue this investigation, but we have not yet seen sufficient evidence that Network Rail is actively assessing the business case for slab track in particular applications.
- Australia, in particular, has recognised that the railways need to adopt and adapt new technologies from other industries (particularly the defence industry). One administration is looking actively at digital radio systems in urban areas not only for improved voice communications but for real time data acquisition from infrastructure and rolling stock.

In respect of train control systems, we also noted that:

- Some other countries (e.g. Germany) appear to be well ahead of Network Rail in implementing GSM-R, using off-the-shelf commercial equipment rather than designing bespoke industry solutions
- There are good opportunities to learn from other networks in their development of low cost signalling (e.g. Germany)

5.6.3 Engineering Plant and Equipment

In respect of plant and equipment we have drawn conclusions that are very similar to the remarks in section 5.6.2. We believe there are significant opportunities for Network Rail to carefully review its approach to the engineering plant it employs on its network, and to learn from the practices of other railways. The observations we made during our visits included:

- Active use of innovative equipment such as rail vacuum machines to excavate ballast under switches and crossings, trenches etc (Denmark)
- Use of similar equipment to remove coal dust (Australia).

Both cases reveal widespread and flexible use of relatively new equipment. Although similar machines are known and available in Britain, and to some extent have had trials on Network Rail, we believe there may be some hesitation and reluctance to employ them more widely. Part of the problem may be that it is not clear who is responsible for championing the use of innovative engineering techniques that could deliver considerable benefits and efficiencies.

On visits to railways in Europe, we also observed:

- That there is heavy reliance upon contractor ownership and development of engineering plant. What benefits does Network Rail consider it achieves by adopting a greater role in specification and ownership of plant and equipment?
- That Network Rail continues to rely upon much older plant and equipment than is the case on other networks, with the consequence that the quality of work achieved may be compromised – again with long term cost implications
- Some evidence that the total volume of on-track maintenance machines (eg tampers) is considerably less than in Britain (Germany)
- Anecdotal evidence that suppliers and contractors feel that market entry in Britain is hampered by an onerous approvals system

By contrast, in North America we noted lessons that might be applied to Network Rail's management of parts of its own network (especially the non-core high speed lines, which have more in common with most European networks):

- Innovative and extensive use of old equipment (USA).
- Extensive use of low cost purpose built machines (USA).

Drawing these observations together, we consider that Network Rail should consider whether its procurement strategy is effective in identifying best practice opportunities, evaluating it and facilitating the introduction of new technologies and equipment.

5.7 People Issues

5.7.1 *Skills and Staffing*

To a large degree we found that most railways have a problem with the increasing age profile of their workforce, and therefore face common challenges to develop and train the people and skills required for the future. In this we found no evidence of any railway doing more than Network Rail in its approach to engineering training and apprenticeship schemes.

In Australia particularly, railway administrations are increasingly recruiting non-railway highly trained specialists (particularly from the defence industry). Given limited induction training on the railway environment, these technicians and engineers can provide the high-tech skills needed to maintain the increasingly complex and IT based systems of the modern railway. They are also considering training technicians to be multi-skilled where equipment requires two or more different skills to be inspected and maintained.

Australia is also planning to set up a “Rail Skills Council” to identify skills shortages for up to 10 years in the future.

We did make some interesting observations about how some railways hone their skills in the operation of networks. We were particularly impressed by examples of how signallers are actively encouraged to record errors and evaluate their own performance in an open learning culture (e.g. in Denmark). In the same case, we noted that signaller caused delay is monitored and then used to identify further training requirements.

We recommend that Network Rail should investigate how it might improve the operational performance of its own network by learning from this approach.

5.7.2 *Safety*

Our visit programme did not set out with the objective of comparing the safety cultures of different railways. However, we did make a number of observations that are included here for the record.

As would be expected, we found that a strong safety culture is deeply ingrained in the operation of all the railways we visited. That does not mean that all safety cultures look identical. Even within Europe, we found that there can be quite widely differing approaches to safe practices.

Of particular note, we were interested by a briefing given by DB Netz describing the role of the Board's Rail Safety Manager in undertaking proactive random inspections of the operational and maintenance functions exercised by the company. We understand that this programme ensures complete review of all delivery units across the whole German network every three years, giving the Board (for example) a comprehensive insight into the quality of track maintenance. Data provided in support of this particular presentation indicated that this active safety monitoring has driven a steady improvement in safety compliance.

6. Applying our Findings

- 6.1 As the individual visit reports have been completed we have provided copies to Network Rail and we have also carried out a high level briefing on the key themes that have emerged from our study.
- 6.2 We are continuing to use the issues that we have identified in our assessment of Network Rail's plans and in the analytical process we are following with the company. Where issues are particularly relevant we are also factoring them into our bottom-up assessment of future efficiency opportunities for Network Rail. Together with other strands of the efficiency analysis, this will contribute to the determination of a CP4 efficiency target for Network Rail.
- 6.3 We will continue to liaise with Network Rail and to review the progress it is making in pursuing the opportunities to learn from the issues that this study has identified.

7. Conclusions and Next Steps

- 7.1 This programme of visits has provided us with an extremely valuable insight into many aspects of the operation and engineering of other railway administrations, and it has given us a considerable amount of information that we are using in our assessment of Network Rail's plans for CP4.
- 7.2 Not all of the lessons we drew from our visits are 'one way' observations about ways in which Network Rail can develop its business; in some cases we consider that British practices are as much best practice as anything we saw in other countries. Nevertheless, we believe that there are very many opportunities for Network Rail to investigate, compare itself, challenge its existing practices and consider adopting ideas and initiatives from other railways. In our view there is real potential for further efficiency improvement
- 7.3 We will therefore be continuing to discuss the lessons learned with Network Rail, and to see how the work we have done links with their own initiatives to engage with other world railways. Whilst we know that there is already such dialogue and that Network Rail is represented on various European railway bodies, we will be seeking further evidence that its engagement is sufficiently active in the pursuit of appropriate best practice for Britain's railways.
- 7.4 Although this comparative work is clearly an important part of our PR08 assessment, it will not end as we draw towards our final conclusions for the next control period. The need for continuing dialogue and comparison with other railways will continue far beyond the PR08 process. We plan to build upon this initial visit programme in the future and to maintain the momentum that these visits have achieved. We expect to do this through carrying out more focused investigation of issues that we have already identified as being of potential value, as well as hopefully extending our visits to other railway administrations that did not feature in this first programme. Through it all, we will continue to pursue our goal of ensuring that we regulate Network Rail as a well-informed regulator conversant with worldwide best practice.

APPENDICES

KEY THEMES AND CHALLENGES FOR NETWORK RAIL

Appendix A Austria

Themes and Challenges for Network Rail

Asset Policies

1. Does Network Rail specify criteria to decide whether old track formations need to be renewed or not? When renewing formations, does Network Rail specify a modulus of elasticity for completed work?
2. ORR observed excellent ballast and cess profiles with very good drainage properties evident along all of the routes travelled within Austria. This indicated a clear focus on drainage management. Do Network Rail's plans for drainage work in its strategic business plan for CP4 include cess lowering and cess cleaning to ensure resilient and economic track performance?

Asset Management

1. High track renewal quality is paramount to achieving low life cycle costs. How is Network Rail planning to ensure that high quality track renewals are delivered by its contractors in CP4? Can it demonstrate that its unit costs reflect the delivery of suitably high quality?
2. The activity with the greatest effect on reducing life cycle cost is providing a good formation and ensuring drainage system is effective. How will Network Rail ensure it delivers the right volume of drainage, at the right locations and specification in CP4?
3. For efficient track asset management and to facilitate the move from reactive maintenance to predict and prevent, asset information knowledge needs to be accurate, sufficiently broad and appropriately available to frontline staff. Is Network Rail's web portal sufficiently developed for this?

Capability, Maintainability, Reliability

1. Reducing axle counter re-set times and using sweep trains is causing lost productivity. Will these be reduced for CP4 to increase productivity?

Engineering Access

1. Is NR's approach and mitigation against possession over-run risk adverse? Is it justified in terms of lost production every shift – is there guidance to differentiate mitigation measures for work on different parts of the network?

Engineering Innovation (materials and components)

1. Does NR's specification for ballast ensure that softer material (such as most limestones), with significantly shorter service lives, are not used?
2. The case for under-sleeper-pads seems very convincing. Is NR assessing the use of these – particularly for modular S&C?

Research and Development

1. Is NR's investment in research and development adequately targeted and funded to deliver economic and world-class strategies?

Wheel/Rail Interface

1. Is NR planning to measure rail inclination and equivalent conicity to ensure optimisation of its maintenance and renewal interventions?

Modern Infrastructure – Engineering Plant

1. Is NR procurement strategy effective in identifying best practice and introducing new technology quickly? Why is NR policy to purchase machines when most European administrations leave ownership to the contractors?
2. NR's assumed design life of high output kit seems very low (c.15 years) compared to contractor estimates – why is this so and what are the unit cost implications of this?
3. Why is the NR owned Harsco TRT and Plasser MOBC, not yet redeployed?
4. NR uses a mixed fleet of mostly old and some new tampers and regulators. The old ones have lower leases than the new machines but suffer from lower productivity, lower reliability and lower quality output. How can NR show that this approach is the most economic in the long term?
5. Ballast distribution machines appear attractive to UK due to high volume of ballast on UK track, but located in wrong places and thus not providing its correct function. Has NR assessed the business case?
6. Will Network Rail ensure that new engineering equipment and plant has longer maintenance frequencies to help reduce costs?

Miscellaneous

1. NR track renewal contracts have not historically appeared to incentivise contractors to improve productivity and innovate. Following conclusion of the 6 to 4 exercise in September 2007, how will contractors be incentivised to innovate?
2. Network Rail is developing a modular signalling system with simplified interlocking rules. Network Rail to advise on its anticipated effect on costs.

Appendix B Australia

Themes and Challenges for Network Rail

Asset Management

1. Network Rail should make full use of the features within its chosen asset knowledge and works management system Ellipse as demonstrated by RailCorp
2. Network Rail should consider adopting a rational and documented approach to asset disposal in line with world best practice
3. Network Rail should consider adopting a formal process for material disposal with emphasis on reusing, selling on to other users or recycling with scrap as a last resort

Capability, Maintainability, Reliability

1. Network Rail should consider adopting a long term view on asset replacement that ensures a robust track base that provides a high quality ride, less maintenance and longer life
2. Network Rail should consider using specialist plant more frequently to remove coal dust or other contamination before operations are effected
3. Network Rail should look to more radical solutions to improve operational flexibility and to remove assets with high maintenance and low reliability

Engineering Access

1. Where appropriate, Network Rail should consider the benefits that a regular corridor blockade might bring in the execution of maintenance and renewal works on key routes. This might be more appropriate in the more dense suburban services into London and other principal cities.

Remote Condition Monitoring

1. Network Rail should be reviewing worldwide best practice in remote condition monitoring as this will support its aim to “predict and prevent” There are many good examples installed that provide better information than the current systems in use in the UK

Wheel/Rail Interface

1. Network Rail needs to develop its asset information to demonstrate the relationship between good wheel/rail profiles and the longer asset lives/better ride/reduced vehicle maintenance that result

Skills and Technology

1. Has Network Rail considered the use of a data communications system based on a public network?
2. Is Network Rail considering recruiting skilled technicians and engineers from other industries to meet the predicted future skills shortage??
3. Is Network Rail considering the adoption of multi-skilled training to reduce the number of different staff currently needed to maintain some plant and equipment?

4. Has Network Rail considered setting up an industry wide *Rail Skills Council* to identify the skills needed up to 10 years ahead?
5. Is Network Rail considering the use of digital radio systems to improve voice communications and real time data acquisition from infrastructure and rolling stock?

Appendix C Denmark

Themes and Challenges for Network Rail

Organisational structure

1. Banedanmark (BDK) has found centralised and combined operations centres to be very effective. What consideration is Network Rail giving to centralising various network control operations?

Asset Management

1. BDK uses an Excel based prioritisation tool that takes into account the effect of not doing the work on train performance, cost of doing the work, number of passengers effected (excluding delay). Also, a very clear hierarchy of routes has been agreed with stakeholders, to ensure consistent prioritisation of works. How does NR prioritise maintenance and renewal jobs across different assets for specific routes?

2. BDK monitors usage and effectiveness of asset management tools. Does Network Rail monitor use of web portals by frontline staff to make sure it is being fully utilised to improve performance?

3. BDK uses a failure consequence model to predict direct and secondary delays. How does Network Rail model delays and assign criticality levels to different assets at different locations?

Asset Inspections

1. BDK inspects track by foot patrol once a year and by trolley every 8 weeks. Network Rail's equivalent frequencies appear high by comparison. How is Network Rail using such comparisons in its inspection strategy?

Capability, Maintainability, Reliability

1. Entreprise is very clear on its most reliable point machines. Is Network Rail following best European practice in selecting and maintaining its machines?

2. As a result of previous neglect, Entreprise now routinely replaces drainage when track is renewed. How is Network Rail addressing a similar history of drainage in Britain ?

Engineering Access

1. In Denmark, the average possession takeup or hand back time is 20minutes, often including electrical isolations. What best practice lessons can Network Rail learn from European practice in this regard? Has Network Rail reviewed Danish processes for achieving or improving on those times?

2. Entreprise uses radio communication from advance lookouts to improve workforce safety in red zones. Has Network Rail considered the use of radio based communication for advanced lookouts? If not, why not?

Engineering Innovation

1. BDK is planning to roll out ERTMS in a way that minimises costs, particularly of interfaces, for their system. How have ERTMS plans elsewhere informed the development of Network Rail's own implementation plans?
2. BDK has found no benefit from using axle counters. What justification can Network Rail demonstrate for continuing to replace track circuits with axle counters, particularly given Network Rail's need for 4 hours 'wheels free' time at the end of some possessions?

Research & Development

1. BDK finds attendance at the European Infrastructure Managers' (EIM) Group to be very useful to identify and spread best practice. BDK commented that Network Rail is one of the few European infrastructure managers that apparently do not attend the EIM. What is Network Rail's response to this challenge?

Wheel/Rail Interface

1. In Denmark out-of round wheel alerts are integrated with operators and defective trains are directed straight to the depot. Significant rail life extension has resulted at critical locations. What consideration has Network Rail given to alternative systems to its own Wheelchex? (Gotcha/Quo Vadis for example).

Modern Engineering Plant

1. Entreprise makes innovative use of leased rail vacuum machines to excavate trenches and simple foundations as well as S&C re-ballasting. What applications does Network Rail consider are appropriate for this type of equipment in Britain?
2. Entreprise uses simple and reliable leaf fall removal equipment and considers the British approach to be unnecessarily complex. How does Network Rail respond to this?

Skills and Technology

1. Entreprise can accelerate the training of signallers and OLE staff to 18 months if they are recruited from other electrically based trades. Is Network Rail considering accelerated training of staff recruited from other electrically based trades?

Staffing

1. BDK has a 'Synergi' system / database to encourage its operations and signalling staff to record errors and create a open learning culture which improves performance. Does Network Rail have a similar system in operation?
2. BDK has a system to identify signaller caused delay and benchmarks different signal control centres and operators. This is used to identify signallers for further training and improve train performance by benchmarking. Does NR have an equivalent system? If not, should it consider adopting one?

Appendix D Germany

Themes and Challenges for Network Rail

Organisational Structure

1. DB is developing a regional network to be managed separately from the core routes. Reducing costs is the aim with initiatives such as multi-skilling, risk-based approach. Is Network Rail looking at this approach and what aspects will it consider adopting?
2. DB has a national control centre linked to 7 regional centres. This is part of a 20 year control strategy. What plans does Network Rail have for developing a national control strategy and over what period?

Asset Policies

1. DB has less frequent inspection and maintenance frequencies than Network Rail. Is this because DB installs higher quality infrastructure that requires less maintenance? How is Network Rail investigating this comparison, and what lessons can it learn?

Asset Management

1. DB has dedicated processing facilities to recycle used materials. How can this inform Network Rail's policies?
2. DB is developing longer planning horizons for renewals works. Has Network Rail examined other planning processes?
3. DB uses the SAP asset management system to monitor and plan maintenance and renewals. Network Rail should compare the functionality of SAP with Ellipse to see if any improvements are needed.
4. The development of separate regional networks will enable DB to benchmark costs and performance, enabling it to maintain the infrastructure at lower cost. What steps is Network Rail taking to review this approach? What lessons are there for Britain?

Asset Inspections

1. DB is moving progressively towards integrating its different condition measuring systems. Is Network Rail following a similar approach and has it considered the potential advantages?

Engineering Innovation

1. DB is developing low cost signalling systems for rural lines. Network Rail should review this approach for possible application in the UK.

Miscellaneous

1. DB is developing predictive software in the control centres to model perturbations and resulting solutions for one or two hours ahead. Network Rail should review this approach to help improve performance and to reduce overall delays when problems arrive.

Appendix E The Netherlands

Themes and Challenges for Network Rail

Asset Policies

1. What processes does Network Rail adopt to determine maintenance and renewals requirements for track circuit relays? Should it consider adopting the ProRail approach?

Asset Management

1. ProRail has adopted a risk based approach to asset maintenance. To what extent has Network Rail developed this approach? How can it learn lessons from ProRail?

Asset Inspections

1. What initiatives is Network Rail considering for remote inspection of switches to support inspection and maintenance? Has it considered permanent cameras or video trains? Alternatively, has it considered other innovative inspection methods such as open floored wagon for track/switch inspection? This could enable inspections to be done during the day without disrupting traffic movements.

2. To what extent does NR use ground penetrating radar to investigate the condition of the ballast and formation layers?

3. How does Network Rail respond to the comment that they appear to use equipment such as the Southern Measurement Train too frequently?

Capability, Maintainability, Reliability

1. To what extent do Network Rail's project plans include requirements for maintainability?

2. To what extent are Network Rail's maintenance activities broken down activity by activity so that maintenance teams have a clear understanding of what they need to do?

Performance Monitoring

1. What testing does Network Rail do to check the quality of the finished work? How independent are the checks that are done?

Condition Monitoring

1. Does NR have an equivalent to the 'Yardstick' that aims to ensure a consistent assessment of asset condition?
2. What initiatives is Network Rail considering for remote monitoring (such as POSS) on its assets?
3. Video based and remote asset condition monitoring are becoming increasingly important as the time available for maintenance work decreases. What remote techniques has Network Rail investigated and for what assets?
4. Is Network Rail planning to introduce remote asset monitoring systems for preventive maintenance similar to the Dutch systems and what systems is it planning to install?

Project Management/Quality Control

1. What quality control checks does Network Rail apply to work carried out by its contractors during a possession or blockade?
2. Does Network Rail undertake independent assessment of track quality in order to gain a view of the effectiveness of the contractors' work?

Engineering Access

1. ProRail believes that grouping together of different activities into single blockades is the most cost efficient way of carrying out renewals. How is Network Rail reviewing the experience and practices of other railways in developing its own future possessions strategy?

Engineering Innovation

1. What use does Network Rail make of geogrids to separate track formation layers?
2. How much investigation has Network Rail made in the use of ballast gluing to reduce dynamic forces in track components?
3. Has Network Rail considered the use of chorus dampers to reduce noise and vibration?

Staffing

1. In order to maintain continuity of work, does Network Rail take advantage of foreign labour during periods where UK labour is not available, i.e. during peak holiday seasons? If yes, to what extent?

Miscellaneous

1. How does the Infrastructure Cost Model approach that Network Rail is currently using compare with the ProRail systems?
2. How will the switch to Eurocodes affect Network Rail and the work it procures from design consultants? Will it affect the quality and cost of work?
3. Is Network Rail aware of the difficulties that its approval system poses to entry into the UK rail market? What action is it taking to encourage innovative companies into the market?

Appendix F Switzerland

Themes and Challenges for Network Rail

Organisational Structure

1. Within SBB, the train operating divisions clearly own the key output objectives, and the role of infrastructure asset management is to enable the success of the operators. What lessons could Network Rail learn for its own role in relation to its train operating customers?

Asset Management

1. The Swiss costs for maintaining infrastructure appear to be the best (lowest) in Europe. What aspects of best practice can Network Rail learn from the Swiss?
2. SBB has an extensive asset information system (DfA) that is kept up to date and used extensively. Has Network rail benchmarked its own systems to see if improvements could be made?

Asset Inspections

1. SBB uses a UIC derived scoring system for assessing the condition of track components. What investigations has Network Rail carried out? And with what results?

Capability, Maintainability, Reliability

1. SBB is convinced that absolute track geometry (ATG) brings benefits to track quality plus future efficiencies through automated design. Has Network Rail evaluated costs and benefits and does it intend to implement it on further routes as well as WCML?
2. As part of any evaluation of ATG carried out to date, has Network Rail established the true cost of installation – mainly survey work?

Condition Monitoring

1. SBB is very proud of its condition monitoring of S&C. Is Network Rail doing similar monitoring and how is this being done and to what extent?

Project Management

1. SBB claims to keep very close control of all projects. In the UK, the Portsmouth Re-signalling Project (and now Rugby) could be seen as examples of what can go wrong without close control. What measures is Network Rail adopting to avoid repeating past problems?

Engineering Access

1. SBB has an analysis system that allows it to simply assess the effect on costs of varying the possession strategy. Does Network Rail have a similar system and if not has it looked to adopt the Swiss or a similar system?

Engineering Innovation

1. SBB claims to double the life of the formation by investing in a sealing layer of bitumen as well as ensuring good drainage. Has Network Rail investigated this approach? and with what results?
2. Typically, safety costs are about 10% for a major project but SBB found, by adopting innovative electronic systems, that this reduces to 3%. What electronic or other systems is Network Rail planning to use to gain similar benefits?

Research & Development

1. Expert support from Graz University has helped SBB extend rail life by better rail grinding. Also:
2. In conjunction with this Graz has developed a “predictive rail wear” model for use in both Switzerland and Austria. While Network Rail has also done much work vehicle-track models and rail grinding, has it sought to share best practice with other developments in this field?

Appendix G USA and Canada

Themes and Challenges for Network Rail

Organisational Structure

1. What lessons might Network Rail learn about the benefits and dis-benefits by reviewing American practice of managing all engineering works in-house?
2. Network Rail should review its signalling and control philosophy by evaluating American best practice in concentrating control train and electrical control in fewer regional centres.

Asset Policies

1. Network Rail should review the UP structured approach for track renewals as a possible application in UK.
2. Network Rail should review its policies for the partial versus full replacement of S&C assets to ensure least cost whole life.

Asset Management

1. What work has Network Rail done to compare its fault recording and analysis systems with other systems being used elsewhere?
2. Can Network Rail demonstrate that it adopts best practice in recycling of used materials?
3. For secondary and freight lines, Network Rail should review past experiments in Britain (e.g. Amey work on West Country branch lines), worldwide experience (USA) and consider how lessons may be adapted for British conditions
4. Network Rail should demonstrate that it adopts a best practice formal approach to scheduling of engineering materials trains to ensure high utilisation.
5. Network Rail should make full use of the features within its chosen asset knowledge and works management systems.
6. Network Rail should compare its approach to the creation of the rail renewals programme to ensure it matches or improves on the CN approach.

Performance Monitoring

1. Network Rail should consider reviewing the performance of its whole engineering operations and maintenance functions, using its chosen asset management systems to provide comprehensive, current information with a hands-on involved management to closely monitor and support supervisors to drive up performance and reduce delay due to infrastructure faults. "Continuous Improvement" must be the motto

Asset Inspections

1. Network Rail to advise on the practicalities of carrying out all track patrols in the UK from road-rail vehicles.
2. Network Rail to advise how it routinely measures track gauge and whether the equipment used in North America should be adopted.
3. Network Rail to advise how it identifies innovative best practices world-wide and what formal evaluation processes are followed.

Capability, Maintainability, Reliability

1. At which critical locations does Network Rail adopt standby teams and are these multifunctional?
2. On which routes does Network Rail already have haul roads to access infrastructure and are there plans to extend these for busy, remote locations?

Engineering Access

1. Which of the approaches (minimise take up time, partial signal commissioning and a Service Plan Approach) will Network Rail adopt as part of its 7-Day Railway development?

Engineering Innovation (Materials and Components)

1. Network Rail to advise how it identifies innovative best practices world- wide and what formal evaluation processes are followed.

Remote Condition Monitoring

1. Network Rail to explain its strategy for more widespread adoption of RCM both in extent and in variety of measurements taken.

Wheel/Rail Interface

1. Network Rail to explain its current understanding of the wheel/rail interface and what measures it is proposing or adopting in light of best practice world-wide.

Modern Infrastructure – Plant

1. Network Rail to advise how it identifies innovative best solutions world- wide and what formal evaluation processes are followed to change materials, adopt new ideas etc.

Skills, Technology and Staff Issues

1. Network Rail to explain its management/staff philosophy including staff motivation and how it intends to manage emerging personnel issues.