OFFICE OF RAIL REGULATION

ORR Best Practice Study

Visit to USA/Canada

30 September to 13 October 2007

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Contents

Front Cover: Shows a Union Pacific empty coal train heading west near Gibbon on the Platte River 3-track mainline west of Grand Island, Nebraska

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1	Dec2007	Initial draft	Draft
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Glossary of Acronyms and American Terms

AAR	Association of American Railroads
Back track	Siding
Block	Engineering possession
Cluster-buster	An approach to replace the minimum number of defects in clusters to restore the track back to a condition to extend its life by a number of years
CN	Canadian National Railroad
Dispatcher	Signalman
FRA	Federal Railroad Administration
GRMS	Gauge Restraint Measuring System
Hi-Rail	Road-rail transport
Joint bar	Fishplate
Ground wire	Earth wire
MAXIMO	IBM comprehensive asset lifecycle and maintenance management system for all asset types on a single unified platform.
Messenger wire	OLE catenary wire
Mud spot	Wet spot
NJT	New Jersey Transit
Plate	Signaling and power isolation
Rock and roll	Twist and syclic track faults
S&C	Signals and communications
Siding	Loop
Snow melter	Points heater
Speed order	Temporary speed restriction
Stick rail	Jointed track
STB	Surface Transportation Board. Part of US Department of Transportation. The economic regulatory agency for railroads
Sun kink	Rail buckle
Surfacing	Tamping
Tie	Sleeper
Tower	Signal box or control centre
Trouble truck	Rapid response vehicle
Trolley wire	OLE contact wire
Undercutting	Ballast cleaning
UP	Union Pacific Railroad
Via Rail	Canadian national passenger rail operator
Warp	Twist fault

Executive Summary

The visit to USA and Canada between 30 September and 13 October was arranged around 6 full days of meetings and 4 days of site visits. Additional time was spent travelling on the different networks to inspect infrastructure.

Context of Findings

In both the USA and Canada, freight is by far the most important product carried on railroads. Passenger services, particularly interstate are limited but expanding.

The USA deregulated the freight railroad industry in 1980 and all freight railroads are in private ownership. This has had a profound effect on the industry. Regulation is now almost entirely concentrated on safety and some anti-competition issues. Economic regulation is achieved through the market place, partly within the railroad industry but mainly from road and shipping competitors.

The freight railroad network is extensive but largely concentrated within the 7No Class I Railroads. Despite rates dropping substantially since 1980 (but beginning to rise as capacity is fully utilised), profitability has risen, utilisation and productivity have increased substantially whilst safety has also improved massively.

The big problem facing the industry is how to expand capacity to meet a forecast doubling of freight tonnages by 2020 as well as carrying more traffic resulting from environmental and labour issues increasingly affecting the road haulage industry.

In contrast, passenger railroads remain in public ownership including Amtrak on the NE Corridor (federal ownership) and various local commuter systems such as New Jersey Transit, Long Island Railroad etc. serving towns and cities (usually state owned).

Principal Issues

Whilst currently successful from all points of view, the railroads have a number of challenges to overcome. Capacity is the key factor. Railroads are endeavouring to carry more, faster using existing infrastructure. The age and skill base of the workforce is becoming an issue. The application of best practice asset management skills to extend the economic life of the infrastructure will be one of the key solutions.

Asset Management

The larger railroads are in the process of developing asset management tools as an essential part of asset stewardship. Examples were seen of good use of MAXIMO, SAP and MIMS. Most railroads have recognised that development takes many years and that the best approach is an incremental one with each engineering discipline tackled in turn. The benefits are recognised as having good records of all assets, their maintenance and renewal histories, the cost of all activities and the development of whole life minimum cost approach. Structured numeric sampling of asset condition is common and this drives asset replacement.

All railroads demonstrated that their asset strategies ensured that premature renewal did not occur unless an exceptionally good business case could be made. Where ever possible, component change was preferred. This approach was particularly evident in tie and switch replacement.

A common approach is for renewals to consist of good quality heavily engineered assets that require relatively low maintenance.

Recycling and cascading of used track materials was almost universal.

Materials

American and Canadian railroads invest substantially in R&D and have a good understanding of the life to be expected out of items such as rail and ties. They have invested heavily in head hardened rail and have accepted the responsibility of needing to grind the rail head to optimise rail and wheel life and reduce the growth and propagation of all defects including RCF. This was also linked to the development of rail lubrication and friction modifiers.

The support for the TTCI research facility at Pueblo was widespread and partly funded by an AAR levy.

Procurement

There was an almost universal use of in-house resources for design, installation and maintenance. Only limited specialist skills or services were bought in and occasionally to meet peak loads where existing workforce would be overloaded. For bought in services it was emphasised that the client had to write a good tight specification and supervise the supplier closely.

Operations

Every railroad was concentrating its operations in fewer and fewer regional control centres and, where appropriate co-located with an Electrical Control Room. Communications with trains and those out on track was almost entirely by radio. Possessions were well managed and efficient both in take up and hand back. There were very few examples of complete closures. Revenue earning trains took priority over engineering works.

Performance

Engineering performance was closely monitored on a daily basis and all staff were involved. A common theme was the “8 o’clock conference call” every day when all supervisors up to Chief Engineer discussed performance and issues of the previous 24 hours and actions to be taken. League tables were used to demonstrate best practice in different divisions and asset failures closely monitored. Extensive remote condition monitoring of various asset types was adopted by at least one railroad visited. This methodology was seen as the best way to try and anticipate failures and remedy them before they delay trains.

Mechanisation

Mechanisation of quite basic operations was widespread even on quite mundane tasks such as spot tie replacement. Development of state of

the art equipment such as automatic placement of the correct volume of ballast at the correct locations was observed using GPS.

Summary

The USA and Canadian railroad systems concentrate almost entirely on freight haulage and are generally efficient and profitable. Being privately owned they adopt a short planning horizon, typically 12-18 months. Their engineering maintenance and renewals are driven entirely by what they can afford year by year as they receive no government subsidies. Engineering is viewed clearly as a support activity to enable operations to run the revenue earning trains.

The passenger services are subsidised by Federal or state support and are not profitable. Typically, Amtrak and NJT receive 50% government subsidy. Nevertheless they appear to adopt a similar asset management approach exercising tight control on spending budgets and safety/reliability performance.

Despite the differences compared to the UK, there were many examples of good practice that should be adopted.

Acknowledgements

We wish to thank the many members of different railway administrations, federal government officials and private individuals who contributed to the success of this visit, a full list of whom may be found in the contacts section of this report.

Our questions were patiently and thoroughly answered and we were also granted access to observe best practice. This involved staff working at weekends or taken from their normal work in order to accompany us. To all of these we are extremely grateful.

Interior view of Philadelphia Penn Station

1. Purpose

To review railway engineering in the USA and Canada where it is believed that maintenance and renewal of assets is carried out more efficiently and more economically than in the UK.

In the USA and Canada the dominant players are the private railroads and to a lesser extent public corporations that operate passenger services. All, to a lesser or greater extent, are vertically integrated and all operate with substantial directly employed workforces for all functions with only very limited input from consultants and contractors who provide specialist services or help to meet peak demands. Regulation at Federal level is common to all railroads but the influences from an economic view are relatively small.

To understand this better, the visits have included 2 separate private Class I railroads (UP and CN), chosen because they are considered best in class, plus two passenger operators (Amtrak and NJT) that operate or own mixed traffic railroads more akin to the UK network. The USA federal authority (FRA) and the Association of American Railroads (AAR) were also visited to better understand the overall scene in North America.

The information gained will help inform ORR's assessment of the October 2007 Strategic Business Plan that was submitted by Network Rail at the end of October 2007.

Amtrak 30 Year Old Track Relaying Train at work near Bryn Mawr, west of Philadelphia (Note this was a weekday operation with all adjoining lines open to traffic and OLE live)

2. Introduction

The USA has many private freight railroads, classified by annual turnover. It has a single national long distance passenger carrier Amtrak who also owns some infrastructure and has operating rights over much of the main freight railroads. There are also publicly owned non-profit making administrations that own and operate urban passenger networks.

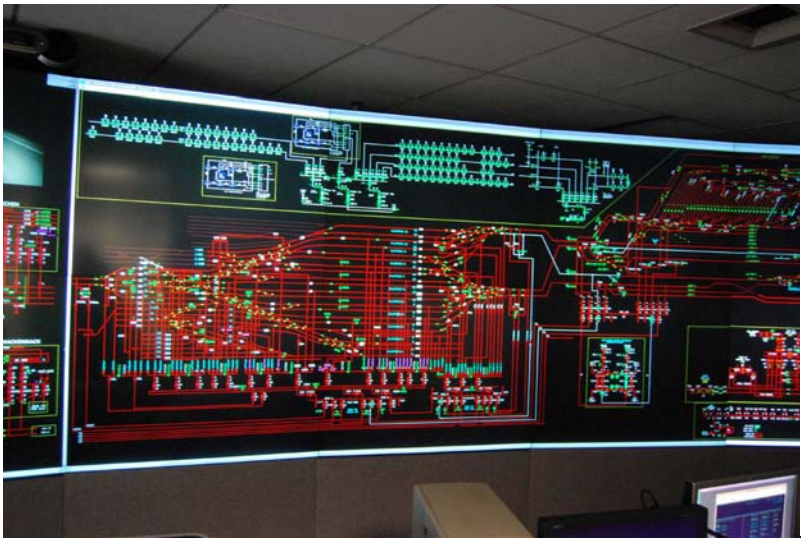
Canada is simpler and has only two large railroads that operate most of the freight. One of these, CN is also a substantial owner of railroads in the USA as far south as New Orleans. There is one national passenger carrier, Via Rail, that operates over the freight railroads and again, there are publicly owned administrations that own and operate urban passenger networks.

The visits were limited to two of the largest Class 1 railroads, Union Pacific (UP) and Canadian National (CN) plus two passenger operators Amtrak and New Jersey Transit (NJT). Amtrak is infrastructure owner in the North-East Corridor from Washington to Boston but has extensive running rights, as national passenger carrier, over many freight railroads across the USA. NJT operates mainly urban passenger services in New Jersey State and into New York but also operates on other railroads. It carries freight and passenger services from other railroads

The railroads visited were chosen on the basis that they were mixed traffic railroads with multiple users, similar to the UK, or were large railroads with good reputations for operating efficiently using best practice to maintain and renew their infrastructure.

The meetings and visits all took place between 01 October and 12 October 2007.

The ORR team consisted of Mervyn Carter (Civil Engineering Adviser), David Brace (Asset Engineering Adviser) and Bob Clarke (Consultant – First Class Partnerships). Tom Griffiths from Network Rail attended as observer from 02 October to 11 October.



Display Panel in Amtrak Electrical Control Room near Penn Station, New York

3. Background

The USA freight railroad system comprises 140,810 track miles. The Surface Transportation Board (STB) groups the network into three classes by annual revenue (Class I >$319m, Class II $25m -$319 and Class III <$25m). The Association of American Railroads (AAR) classifies the non-Class I railroads slightly differently as shown in Table 1 below. Regional railroads operate line-haul routes with at least 350 route miles and with annual revenue between $40m and $319m. Local railroads operate line-haul routes with less than 350 route miles plus switching and terminal railroads.

Classification	Number	Miles	No of Employees	Annual Revenue ($m)
Class 1	7	95664	162438	44457
Regional	30	15388	7322	1482
Local	523	29197	12047	1940
Canadian	2	561	?	?
Total		140810	>181807	>47878

Table 1 Classification of USA Railroads

(All figures derived from AAR "*Railroad Facts 2006").*

The Canadian figures represent short lines in USA but owned by CN or CP from Canada. As a result of purchasing the Illinois Central RR, CN became effectively a further Class I railroad.

Passenger operators, such as Amtrak, generally operate over the freight railroads but Amtrak owns and maintains about 745 miles of its own infrastructure along the NE Corridor. Suburban railroads such as New Jersey Transit (NJT) and Long Island Railroad also own and maintain their own network. As public administrations, the passenger carriers are forbidden to make profits.

The 1980 Staggers Rail and Motor Carriers Act was a defining point in the fortunes of the USA railroad system. The previously government regulated industry with its common carrier responsibilities and restricted investment was replaced with a largely deregulated system using competition as the primary regulator. Some residual powers were retained, mainly relating to anti-competition rules and safety. The Surface Transportation Board (STB) deals with disputes on rates, service disputes, planned mergers and plans for abandoning lines. It is increasingly taking an interest in capacity constraints although, unlike the UK, these seem to be short term (0-2 years).

Safety is regulated by the Federal Railroad Administration (FRA) part of the Department of Transportation, Its role is to promote and enforce rail safety

Since deregulation, there was immediate and sustained growth in productivity volumes and revenue, despite rates going down and staying down. Equally, safety has improved dramatically and investment has also increased equally dramatically. New technology has been introduced to improve performance. Before 1980, lines were closing. Now new operators are reopening lines as they are not burdened with common carrier responsibilities and are not required to keep uneconomic lines open. Productivity improvements are slowing but must increase, mainly through the application of new technology. The number of staff has also started to increase following substantial slimming down from 1980.

Congestion on the railroads in the US is beginning to effect performance and the markets may have to bear increased costs to address this. Rail's competitors - mainly road hauliers - are also suffering congestion and increasing environmental legislation.

In contrast, in Canada there are only five principal railroads, of which three are USA based and these haul the majority of all freight and give running rights to Via Rail, the national passenger carrier, Amtrak and urban passenger transport operators. There are in total 57 railroads operating in Canada.

View from Rear Cab of the New Jersey Transit Geometry Test Car

4. Regulatory and Advisory Bodies

4.1 Association of American Railroads (AAR)

The ARR was the major facilitator of the ORR visit to the USA and Canada. It advised on the best railroads to visit in order to meet our requirements, it provided the main contacts and met with the team on the first morning in the USA to brief us on the background to the American railroad scene.

The meeting was held in the AAR offices in Washington DC and was led by Bob Vanderclute, Senior Vice President Safety and Operations.

Presentations were made by Bob as well as Craig Rockey (Vice President Policy and Economics), James Britton (Senior Director Special Projects Safety and Operations) and Louis Cerney (Track and Bridge specialist consultant to AAR).

A printed copy of the main presentation is held as AAR01.

The mission statement for the ARR is “The Association of American Railroads promotes the common business interests of the North American railroad industry in the fields of policy and economics, legislative issues, exchanges between railroads, shippers and car owners, as well as research, technology, safety and security”.

AAR represents all the main railroads in the USA, CN and CP from Canada as well as the railroad operators in Mexico. There are a number of grades of membership so that Amtrak, the national passenger carrier and urban passenger administrations in Chicago and New York are also represented. Associate members include many suppliers to the railroad industry. The AAR is funded by means of a membership fee.

It provides services to its members in the following areas:-

a. Safety, security and operations

b. Policy and economics

c. Communications

d. Government affairs

e. Administration and finance

f. Law

It supports research and development through its subsidiary TTCI. The latter operates the research centre at Pueblo, Colorado on behalf of the FRA.

The main points to note are:

- Total deregulation in 1980 brought unprecedented productivity gains. These were passed on to customers through sharply reduced rates.
- There was also a dramatic improvement in safety.
- There has been a significant increase in traffic volumes.
- The improvement in services has been supported by substantial investment in new technology and in R&D.

- TTCI is probably one of the most advanced and extensive railway research organisations in the world.
- TTCI has worked for Network Rail on wheel/rail interface issues.
- TTCI has worked for ORR on rail asset lives.
- TTCI would be a worthwhile visit in its own right to see research and development into remote condition monitoring, wheel/rail asset life optimisation, train condition monitoring, vehicle/track performance etc.
- The USA railroads achieved their safest year ever in 2006.
- Train accidents per million train-miles have dropped 24% since 1990.
- In the last 10 years, US Class I railroads have laid 5.8m tons of new rail.
- US Class I railroads are spending in excess of $16bn per annum on capital and maintenance of infrastructure

Document No AAR05 contains a presentation from the AAR that gives a useful profile of US Freight Railroads including how they have changed since 1980, the current picture and the challenges for the future. It indicates future growth areas and areas where additional capacity will be needed.

4.2 Federal Railroad Administration (FRA)

We met staff from the FRA in their Washington offices on 01 October 2007. The meeting was led by Barbara Pelletier, Director International Program. Three presentations were made, the first by Ed Pritchard (Director for Safety and Compliance) on the safety role of the FRA, the second by Jane Bachner (Deputy Associate Administrator for Policy) on policy and the third by Barbara on the general background of the US railroad industry and purpose of the FRA.

The presentation is available in hard copy (FRA01).

The FRA has five principal objectives:

1. To promulgate and enforce rail safety regulation
2. To administer railroad financial assistance programs
3. To conduct research and development in support of improved rail safety
4. To develop national rail transportation policy
5. To administer grant agreement to Amtrak.

Safety

The FRA has a more intrusive safety role than its equivalent, the HMRI in the UK. For example it owns five geometry measurement cars, three of which are self propelled. All are operated by Ansco on contract. Each car inspects approximately 30,000 miles of track pa. Inspections concentrate on routes that carry heavy tonnages, the Amtrak passenger routes and routes carrying hazardous materials (ethanol is becoming a serious concern)

It also owns a Sperry Car for detecting rail flaws. It also owns a special train that is fitted with a Gauge Restraint Measuring System (GRMS) for testing

lateral resistance. This applies a lateral force of 14000 lb to test rail fixings and ties. It always operates accompanied by the relevant railroad staff and the geometry and defect data is supplied to the railroad concerned. FRA also occasionally put signals to danger to see if train crew are alert.

FRA chooses not to cover metropolitan passenger authorities but oversees commuter routes. Some states can be certified to monitor safety in particular disciplines on behalf of the FRA.

One of FRA's principal safety concerns is the extensive amount of dark territory – where there is no signalling. In these areas, speed is limited to 50mph.

FRA rules require brake tests every 1000 miles but new electronic braking systems may extend this to 3000 miles.

Policy

Capital and maintenance expenditure by railroads is monitored but FRA has no authority to instruct railroads to spend.

RSAC is a safety consultation committee that permits input from the railroads before new regulations are introduced. Cost benefit analyses are carried out prior to any regulatory changes. Proposals to relax regulations can be promoted by railroads. Disputes are usually on legal issues. FRA provides the technical expertise.

Federal government sets Amtrak's annual budget. In recent years the agreed budget is less than FRA consider necessary. Track access charges are fixed.

General

Amtrak is not profitable because Federal government mandates services on unprofitable routes. Nevertheless Congress presses for continual efficiencies.

National Transportation Safety Board investigates major accidents including railroads but has few rail experts.

Congestion and traffic growth (traffic expected to double by 2020) are major issues. Federal government prepared to make grants (or give tax credits) to enhance capacity but railroads reluctant (mistrust of government) as they are making reasonable returns without support.

FRA has its own R&D department separate from TTCI.

A hard copy of the US Railroad Industry briefing (third presentation) is available as FRA02 and it is available in Powerdocs #289965

4.3 Canada

As part of its presentations CN explained the regulatory regime. There are three regulatory authorities in Canada.

Transport Canada (TC) sets regulatory safety standards driven from primary legislation. There have been less than 10 prosecutions in the last 17 years.

Rail Safety Consultative Committee includes Transport Canada (TC) plus other stakeholders. Industry develops the rules and revisions for approval by TC

Union Pacific Crenellated Ties Newly Installed at Grand Island

5. Findings

Topic	Organisation	Findings	Evidence
Organisational Structure	All	1. Most engineering work carried out in-house. External suppliers limited to a few specialist items (such as vital processors supplied by Alstom) or to meet peaks (created by enhancements for example). General view that contracting out is not cheaper overall. What lessons might Network Rail learn about the benefits and dis-benefits by reviewing American practice of managing all engineering works in-house?	Discussions with all engineers. 95% of all CN infrastructure engineering carried out in-house
	All	2. Progressive concentration of control to regional centres. Where appropriate, co-located and closely linked with Electrical Control Rooms. Extensive use of radio communications with drivers and everyone on track. 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	Discussions and visits with all four railroads

Topic	Organisation	Findings	Evidence
Asset Policies	UP	1, UP has a very structured approach to track renewals. Asset policies provide clear, firm rules on capitalisation (>¼ mile rail per mile of track, >250 sleepers replaced per mile, all ballast renewals, all rail grinding). Every 1/10 mile assessed. Life extension of track encouraged. Tie replacement based on condition sampling and minimum defective ties replaced to achieve a 1 in 8 year visit (cluster buster approach). Varies according to location. Ranking of condition determines action Clear policy on rail grinding Clear policy on tamping frequency Network Rail should review the UP structured approach for track renewals as a possible application in UK	Discussions with infrastructure engineers
	NJT	2. 90% of S&C renewals are partial replacement only. Only if more than 50% of a switch is faulty will it be replaced as a unit. Network Rail should review its policies for the partial versus full replacement of S&C assets to ensure least cost whole life.	Advice from engineers

Topic	Organisation	Findings	Evidence
Asset Management	NJT	1.Uses sophisticated fault analysis from fault reporting at control centres. Standardised coding (200 discrete codes of which 40 are infrastructure)	Discussions with infrastructure engineers
	NJT	2. Uses a pragmatic approach to bridge inspections. Visual inspections as required by FRA, a desktop analysis using Arime and a sense check using FE analysis What work has Network Rail done to compare its fault recording and analysis systems with other systems being used elsewhere?	Discussion with infrastructure engineer
	UP	3. Strong recycling ethos. All old timber ties recycled after replacement, either refurbished for re-use or sale or chipped and used as fuel Can Network Rail demonstrate that it adopts best practice in recycling of used materials?	Discussions with engineers on site visit to Grand Island Saw recycling plant at Grand Island
	NJT	4. Ditto – used rails taken out in ¼ mile strings and sold on to freight railroads.	Discussions with track engineer

Topic	Organisation	Findings	Evidence
Asset Management cont	NJT	5. On lightly used lines, partial tie replacement process adopted on a production line basis. Still highly mechanised with many items of simple kit and multi-tasking workforce 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 learnt may be adapted for British conditions.	Observed at Port Jarvis
	UP	6. Uses MIMS to schedule track equipment. Have achieved a 70% reduction in recycling ballast cars (quarry to quarry) Network Rail should demonstrate that it adopts a formal best practice approach to scheduling of engineering materials trains to ensure high utilisation	Part of presentation

Topic	Organisation	Findings	Evidence
Asset Management cont	Amtrak	7. Adopted a formal asset management approach using MAXIMO that will take years to implement but doing it in stages. The end result will be that all maintenance and renewals will be driven by condition or performance, that there will be accurate tracking of all work done, what labour was used and complete breakdown of costs Network Rail should make full use of the features within its chosen asset knowledge and works management systems	Part of formal presentation by Amtrak engineers
	CN	8. CN uses an objective, numerate approach to form its rail renewals programme. Avoidance of TSRs is high priority. RSI (Rail Severity Index) measures and classifies the number of rail defects in each mile of rail. RDI (Rail Defect Index) uses RSI plus tonnage and time. See document No CN09 Network Rail should compare its approach to the creation of the rail renewals programme to ensure it matches or improves on the CN approach.	CN presentation

Topic	Organisation	Findings	Evidence
Asset Management cont	CN	9. Uses SAP and mobile technology for its main asset management activities to achieve a “Precision Engineering Strategy”. It does not believe that it has a formal asset management system in place	Part of CN presentation
Performance Monitoring	AMTRAK	1. Amtrak has developed a system, driven from Maximo, that provides comprehensive monitoring of engineering operations supporting a continuous improvement process. An impressive feature was the daily morning conference call that involved the Chief Engineer and section heads who analysed the previous day’s performance and issues arising. This also looked at safety and production. The weekly report analysed failures by engineering discipline over last week and compared with ytd. The monthly review summarised performance and production and compared divisions to nominate “best improvement” The annual report analysed capital and labour productivity performance for the year against goals and sets new goals. Performance of the flagship high speed Acela service is monitored as a proxy for all services	Presentation by Amtrak with paper copy of typical outputs covering daily, weekly, monthly and annual performance across main engineering disciplines (AMTRAK06)

Topic	Organisation	Findings	Evidence
Performance Monitoring cont		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	AMTRAK	1. Amtrak uses a geometry test car that runs over the core network twice a year. Foot inspections are twice weekly.	Part of presentation
	CN	2. 99.9% of inspections are made from hi-rail cars. All areas for concern must then be inspected by foot Network Rail to advise on the practicality of carrying out all track patrols in the UK from road-rail vehicles	Part of presentation

Topic	Organisation	Findings	Evidence
Asset Inspections cont	FRA, CN	3. Extensive use of a gauge spread measuring train (GRMS) for testing lateral resistance of ties and fixings CN uses outputs to determine annual programme of chemical tie plugging, tie replacement and renewals programmes Network Rail to advise how it routinely measures track gauge and whether the equipment used in North America should be adopted.	Advise from FRA and confirmation from CN that they make extensive use of the process
	UP	4. UP has good knowledge of asset condition obtained from hi-rail inspections. Delays caused by: 1st surface geometry 2nd tie condition 3rd S&C (track and signalling) 4th hot boxes	Discussion with track engineer
	UP	5. Plasser recording car uses laser scanning to profile ballast and identify shortfalls for subsequent automated ballast dropping	Advised by engineers
	UP	6. New ballast cars will be automated and will only drop on shoulders, not at level crossings (5% saving in material)	Advice from engineers

Topic	Organisation	Findings	Evidence
Asset Inspections cont	UP	7. 47 No service locomotives monitor track geometry and send back data by gsm. All lines covered at least once per day.	Advice from engineers
	NJT	8. Dapco road-rail vehicles used to carry out bi-annual ultrasonics inspections Network Rail to advise how it identifies innovative best practices world-wide and what formal evaluation processes are followed (5-8 above)	Advice from engineers
Capability, Maintainability, Reliability	NJT	1. At critical locations, faults are fixed before they delay trains. Multi-function standby teams on duty during peak hours to fix faults. Teams revert to routine inspection and maintenance outside peak periods At which critical locations does Network Rail adopt standby fault fixing teams and are these multifunctional?	Advice from engineers
	All	2. Good haul roads alongside the track to provide ease of access (also enables tie replacement by removing them laterally) On which routes does Network Rail already have haul roads to access infrastructure and are there plans to extend these for busy, remote locations?	Statements from engineers and observations and usage on site visits

Topic	Organisation	Findings	Evidence
Engineering Access	NJT and CN	1. Possessions typically take 5 min to set up from the control centre. No secondary protection. If adjacent line affected, requires protection boards on site. Typically 55 hours to commission an interlocking	Discussions with staff at Broad Meadow ROC Observed directly with CN during site visit to Victoria Bridge
	Amtrak and CN	2. Amtrak rarely completely shut a route for Resignalling. The approach is "gradually improving functionality" where switches are initially plain lined to keep trains running then tested for turnout	Part of discussions with engineers
	CN	3. CN has a well defined Service Plan approach to minimise engineering impact on the operational railroad. There are tight constraints (e.g. loaded/empty cycle for material trains) and resulting engineering implications (plant availability and reliability, on time take up of possession, shorter blocks etc) Which of these approaches (1-3) will Network Rail adopt as part of its 7 Day Railway development?	See draft presentation CN05
Engineering Innovation (Materials and Components)	UP	1. Scalloped crib faces for concrete ties provides substantial lateral constraint and obviates need for ballast shoulders	Explained at concrete tie manufacturing plant in Grand Island and observed on relaying sites

Topic	Organisation	Findings	Evidence
Engineering Innovation (Materials and Components) cont	UP	2. Concrete ties have electronic tags embedded to allow for whole life tracking	Observed at concrete tie manufacturing plant in Grand Island
	NJT	3. Installation of platform edge rub rails on high platforms – following damage from freight trains to hard edges	Observed from test car and discussed with engineers
	NJT, UP, CN	4. Usage of steel ties and experimenting with resin ties largely abandoned except for special circumstances. Fixings on steel ties prone to corrosion or fatigue failure	Discussion with track engineer
	UP	5. 100% usage of head hardened rail for longer life (410 Brinnell sourced mainly from Japan). 50% reduction in rail defects	Discussions with track engineer. After 2gmt, number of defects halved compared to non-treated rail
	CN	6. Widespread use of head hardened rail (300 Brinnell for tangent track, 325 on large radius curves and 380 on sharp curves and S&C	Statement by CN engineers
	UP	7. UP have two test sites on the network where six or seven different types of rail are subjected to normal traffic conditions	Discussions with UP staff
	Amtrak	8. Amtrak installs track circuit connections in ducting (inserted using steered auger bore machinery) below ballast cleaner cutter bar	Part of presentation

Topic	Organisation	Findings	Evidence
Engineering Innovation (Materials and Components) cont	UP	9. To provide rail support under IBJs, a strengthening plate had been developed Network Rail to advise how it identifies innovative best practices world-wide and what formal evaluation processes are followed.	Discussions with track engineer
Remote Condition Monitoring	NJT	1.Points heaters are monitored from control centre with fault diagnostics. (Also inspected manually during the fall)	Discussions with staff at Rock Control Centre
	CN	2. Use of a wide range of trackside monitoring equipment including hot bearing detectors, brake dragging detectors, wheel impact load detectors and wheel profile monitors Network Rail to explain its strategy for more widespread adoption of RCM both in extent and in variety of measurements taken	Part of CN presentation
Wheel/Rail Interface	UP	1. Rail grinding is an important process for rail life extension. Two approaches, correction of plastic flow on plain line and to repair damage on curves and S&C	

Topic	Organisation	Findings	Evidence
	UP	2. Development of top and side lubrication to reduce wear but maintain adhesion. Application of friction modifiers to rail head has proved successful 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 worldwide.	
Modern Infrastructure - Plant	NJT	1. Extensive use of Holland mobile flash butt welding equipment	Site visit Port Jarvis
	NJT	2. Use of a Geismar Rewiring train should enable replacement of compound catenary (3 wires) in one pass. Typically 1 mile should be replaced in 3-4 hours	Advice from electrical engineer
	UP	3. The advanced track renewal train is the TRT909 (although the Matissa P95 may be better). Included in the train is rail heating and stretching equipment to reach stress free state on completion of renewals. Use of a gopher or ballast shoulder cleaner increase productivity.	Advice from track engineer

Topic	Organisation	Findings	Evidence
Modern Infrastructure - Plant cont	UP	4. Surface treatment (tamping) frequency should be based on traffic load (typically 80-100 mgt)	
	UP	5. UP is working on a modification to remove badly defective wooden ties ahead of the TRT909 to avoid clogging up the removal process	Advice from track engineer (observed Amtrak doing this manually at Bryn Mawr track relaying site)
	UP	6. UP is working on a modification to position the new rail more accurately as it is fed in by the relaying train 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 (5,6 above)	Advice from track engineer
Skills, Technology and Staff Issues	Amtrak	1. Personal accountability of all staff strongly enforced	Daily 8am "call in" conference calls by section heads to analyse performance in previous 24 hours. Evidence of good relations between managers and workforce
	Amtrak	2. Use of League tables to motivate section heads. Recognition that some areas more difficult than others by using "Best Improver" approach	In built with Maximo system where performance is recorded and visible to all.

Topic	Organisation	Findings	Evidence
	UP	3. Recognition that UP is dependent on an aging work force to operate. It needs to recruit younger staff by changing work practices, by providing a career structure etc Network Rail to explain its management/staff philosophy including staff motivation and how it intends to manage emerging personnel issues	Discussions with UP senior staff

6. Unit Costs, Production Rates and Expenditure

6.1 Materials Purchase and Installation Costs

This section lists a selection of rates for materials. These are indicative only and cannot be compared without normalising what is included or excluded.

Component	Amtrak	NJT	UP	CN	
Single tie - softwood			$40		
Single tie – hardwood		$35	$43	C$40-50	NJT use American oak (softer than UK oak)
Single tie - concrete		$63	$60	C$70	
Head hardened rail			$18		410 Brinnell
Single tie replacement – all in			$100	$115	
Overhead electrification – all in including supply per mile		$2m			
Undercut, renew ballast and tamp per mile				C$180000	1/3 labour, 1/3 materials
Turnout Installation 1:12				C$170000	
Turnout Installation 1:20				C$22000	
Installation of grade (level) crossing single track without gates				C$150000	
Ditto with gates				C$250000	
Supply and install rail per mile				C$400000	

6.2 Renewal rates

This section provides some typical norms for common tasks.
As with the previous table these are provided as indicators and should not be compared without understanding what is included and excluded

`Task	Amtrak	NJT	UP	CN	Comments
Tamping (miles per day)			2-3		
Track Relaying (TRT 909)			4000 ties per 9 hour shift		50% of this rate observed on site.
Single turnout renewal	2 turnouts in 50hrs (2x12hr with SLW)	12hours			
Partial Tie Replacement		700 ties per shift (5 working hours)			
Single rail replacement including de-stressing				1500 ft in 5 hours	
Tie replacement				200 in 5 hours	
8” depth undercut ballast clean including 2 tamping passes				2500 ft in 6 hours	Not returned at line speed

6.3 Miscellaneous

Document CN06 provides useful data on productivity and unit costs for the year to date for tie replacement and demonstrates how CN monitors its performance.

6.4 Typical Annual Expenditure

The following figures give an indication of the annual levels of expenditure on different railroads. They should be viewed as an indicator only as different activities are included and accounting practices vary between railroads.

NJT	$79m pa for day to day infrastructure maintenance including stations.
	$65m pa ditto excluding stations
	$60m pa capital (average) of which $20m pa is track renewals
CN	C$900m pa of which 67% on track, 15% structures, 6% signalling and 11% miscellaneous.
	Core lines take 82% of spend
	Typically $60000 per track mile for M&R on core routes, $10000 on feeders

6.5 CN Asset Lives and Interventions

Pre 1986 steel rail is good for 25 years at 40gmtpa (1000gmt)

Post 1986 steel rail from Japan is good for 33 years at 40gmtpa (1500-2000 gmt)

Ballast cleaning is carried out after 700mgt

Thermit welds have only 1/3 life of parent rail

CN Freight Train crossing the Victoria Bridge over the St Lawrence Seaway, Montreal

List of Appendices

Appendix A Meetings and Visits

Date	Time	Organisation	Attendees	Purpose	Key Findings
30 Sept		Travel to USA			
01 Oct	09.30 - 12.30	Association of American Railroads (AAR)	Robert C. VanderClute Senior Vice President Safety and Operations Craig F.Rockey Vice President, Policy and Economics James G. Britton, Jr. Senior Director-Special Projects Safety and Operations Louis T. Cerney, P.E. Track and Bridge Specialist Consultant to AAR	Introduction to the American railroad structure and organisation Railroad legislation and regulation	American railroads are almost entirely devoted to freight with one or two notable exceptions. The railroads have developed extensively since deregulation following the 1980 “Staggers” Act. Rates have decreased, safety has improved and profitability improved. Lack of capacity for further expansion is becoming critical. The FRA has a key role in safety. Strong research ethos through TTCI
	12.30 - 13.30	Association of American Railroads	Robert Vanderclute	Working lunch to conclude discussions	
	13.30 - 16.30	Federal Railroad Administration (FRA)	Barbara Pelletier Director international Program Ed Pritchard Director for Safety and Compliance Jane H. Bachner Deputy Associate Administrator for Policy	To understand the role of regulation relating to railroads within the USA	The FRA has a very active safety promotion, monitoring and compliance role – including ownership of test cars. It is responsible for freight and passenger railroads but chooses not to oversee metropolitan passenger authorities. It has a role in safety research and development It owns the Pueblo test site (managed by AAR)

Date	Time	Organisation	Attendees	Purpose	Key Findings
					It is responsible for development of national rail transport policy. It administers federal grants for Amtrak
	18.00 – 19.31	Amtrak		To ride on North East Corridor "Acela Express" service from Washington to Philadelphia	Ride was lively. Speeds did not seem to exceed 100mph (line speed 130mph)
02 Oct	09.00 – 17.00	Amtrak	Frank A. Vacca Chief Engineer Reuven Shiloh Director, Business Operations Engineering Department Steven C. Falkenstein Deputy Chief Engineer, Maintenance Charles G. McMahon Director Roadway Equipment and Vehicles Robert J. Verhelle Deputy Chief Engineer, Electric Traction David E. Staplin Deputy Chief Engineer, Track E. Keith Holt Deputy Chief Engineer Communications and Signals	To look for best practice in infrastructure asset management by the national passenger railroad	Good, progressive application of asset management to achieve fit for purpose infrastructure at lowest cost Impressive development of MAXIMO AM package to support all activities. People issues recognised as key to efficiency

Date	Time	Organisation	Attendees	Purpose	Key Findings
			Conrad Ruppert Assistant Deputy Chief Engineer - Track Jim Harris Director, Production Field Operations Bill Bates Business Improvement Manager Robert D Santini Assistant Division Engineer Facilities and Structures Department Robert Prateri Safety Officer Jim Harris Director, Production Field Operations Steven J. Alleman Deputy Chief Engineer Construction James T. Sullivan Senior Officer Business Improvement, Industrial Engineering		
03 Oct	08.30 – 16.00	Amtrak		Site visit to observe track renewals at Bryn Mawr and Radnor	Good safety regime Effective use of fairly old track renewal train achieving reasonable production rates.

Date	Time	Organisation	Attendees	Purpose	Key Findings
					Economic use of new ballast
	17.34 – 18.29	Amtrak		To ride on North East Corridor "Acela Express" service from Philadelphia to Newark Penn	Again, ride was lively and not that fast
04 Oct	07.45 – 17:00	New Jersey Transit (NJT)	Glenn P. Sullivan Deputy General Manager Infrastructure Engineering Robert J. Young Chief Engineer – Track Infrastructure Engineering Geoff Hubbs Chief Engineer - Signal and Communications Rail Infrastructure Engineering S Conte Chief Engineer – Electrical Electrical Engineering Charles A. Maliszewski Jr. Chief Engineer of Structures John Acconzo Director Rail Infrastructure, Construction Infrastructure Engineering	To look for best asset management practices on an urban mixed traffic railroad	No formal asset management approach (limited infrastructure)
05 Oct	08.30 – 1.00	NJT	Robert J. Young Chief Engineer – Track Infrastructure Engineering Charles A. Maliszewski Jr.	Site visit to Port Jervis to observe spot re-sleepering and other surface treatments on a rural line	Efficient use of numerous items of simple mechanised equipment to reduce manual labour.

Date	Time	Organisation	Attendees	Purpose	Key Findings
			Chief Engineer of Structures	in New York State	Effective production line approach. Tie renewals targeted to minimum sufficient to keep track in usable condition
06 Oct	08.30 – 13:00	Amtrak	Richard E. Bernaski Division Engineer New York Division Engineering	Site visit to New York to observe a major dispatch centre, an electrical control room and plant and machinery under Penn station	Co-location of dispatch and electrical control Lack of security between public areas and machine rooms under station Level of redundancy in S&C at station throat
07 Oct		Travel to Omaha			
08 Oct	08.30 -20.30	Union Pacific (UP)	W.E. (Bill) Van Trump Assistant Vice President Engineering Dwight W. Clark Director Track Maintenance – Technology Engineering Hilario Alcorta II (Shop Co-ordinator at LB Foster – concrete tie manufacturer)	Initial meeting at UP HQ then site visit to: - Grand Island track relaying - LB Foster concrete tie manufacturing plant - Gibbon 3 track main line to observe heavy freight	
09 Oct	08.30 – 16.00	UP	Edward C Brown Director Track Programs Engineering J.C. (Craig) Domski AVP- Engineering Track Programs David A. Connell AVP Engineering –	To look for best asset management practices on a major Class I US railroad considered one of the best in class	

Date	Time	Organisation	Attendees	Purpose	Key Findings
			Construction Engineering Bill Breeden General Director M/W-Signals Engineering Deb Schafer Gen Dir MOFW – Environmental Engineering Brent D Star Track Planning Engineer Engineering - Scheduling		
		Travel Omaha to Chicago			
10 Oct	am 14.00 – 17.30	Travel Chicago to Montreal Canadian National (CN)	Nigel Peters System Manager – Engineering Standards Engineering Dwight Tays Chief Engineer – Signals Don Watts Senior Manager Regulatory Affairs Gordon Rybuck Brian Abbott	To look for best asset management practices on a major Canadian railroad. To follow up a visit to the UK of a Canadian consultant who compared Canadian and UK practices	

Date	Time	Organisation	Attendees	Purpose	Key Findings
	18.30 – 22.00	Working dinner with CN	Consultant Nigel Peters, Dwight Tays and Gordon Rybuck		
11 Oct	08.30 – 17.00 18.00 - 21.30	CN Working dinner with CN	Nigel Peters and Dwight Tays		
12 Oct	08.30 – 11.00	CN	Sal Pizzanelli, P Eng., Structural Engineer - Engineering, Planning/Inspection & Maintenance	Site visit to Victoria Bridge	
	11.30 - 24.00	Return to UK via Washington			
13 Oct	00.00 – 10.00	Ditto			

Appendix B

Papers Provided by Participants

Organisation	Reference	Details
AAR	AAR01	Presentation to ORR
AAR	AAR02	Catalogue of Publications 2007
AAR03	AAR03	Railroad Facts 2006
Amtrack	AT01	System Timetable 2007
	AT02	Electrical Operating Instructions AMT-2
	AT03	ITCS Incremental Train Control System)
	AT04	Tracklaying Machine Facts
	AT05	Overview of the Amtrak Signalling System
	AT06	Engineering Dept. Operational Monitoring & Continuous Improvement Process presentation to ORR
	AT07	Electric Traction Dept Inspection Manual for Catenary
	AT08	Electric Traction Dept. Inspection Manual for Sub Stations
CN	CN01	Signal & Communications – Standards & Practices (full document)
	CN02	Ditto condensed site version
	CN03	EWS comparison of selected maintenance & renewal practices (CN and NR)
	CN04	Schematic of various work type gang consists (e.g. High Production Tie Gang Consist)
	CN05	Signal & Communications Overview – draft of presentation to ORR
	CN06	Rail Tie Productivity 2007

Organisation	Reference	Details
	CN07	Basic Capital Guidelines
	CN08	Signals & Communications Standards and Instructions
	CN09	Rail Severity Index (RSI) and Rail Defect Index (RDI)
Federal Railroad Administration	FRA01	Federal Railroad Administration Agency Overview presentation to ORR
New Jersey Transit	NJT01	NJ Transit Facts at a Glance
	NJT02	Typical Monthly Report by Infrastructure engineering
	NJT03	Schematic of Network
Union Pacific	UP01	Quality System Process Planning for Maintenance & Repair Windows
	UP02	2007 Engineering Services Schedule Report by Gang
	UP03	Engineering Index – Family Tree
	UP04	Job Briefing – example Grand Island

Appendix C

List of 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 learnt may be adapted for British conditions.

4. Network Rail should demonstrate that it adopts a formal best practice 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 in order to drive up performance and reduce

delays due to infrastructure faults. “Continuous Improvement” must be the motto.

Asset Inspections

1. Network Rail to advise on the practicality 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 worldwide and what formal evaluation processes are followed.

Capability, Maintainability, Reliability

1. At which critical locations does Network Rail adopt standby fault fixing 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 but 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 worldwide.

Modern Infrastructure – Plant

1. Network Rail to advise how it identifies innovative best solutions worldwide 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.

Appendix D

Amtrak Meetings and Visits

1. Amtrak has ownership of about 750 route miles of track in the North East Corridor but has operating rights across much of the USA. The North East Corridor from Washington via New York to Boston is an electrified 2-4 track railway with line speeds up to 160mph in places. It is a mixed traffic railway with freight and commuter services operated by third parties. Because the line speed is generally greater than 79mph, cab signalling is mandated.
2. Meetings were held in Philadelphia on 02 and 03 October 2007 with the engineering department of Amtrak led by Chief Engineer Frank Vacca. All of his deputies attended the presentations and discussions.
3. Amtrak specialists made presentations on the main engineering disciplines in an overall context of asset management best practice.
4. Detailed notes on each presentation are currently held in notebooks but will be transferred to separate reports, time permitting.
5. The main findings are listed in Section 5
6. Other points to note are:

   <u>Asset Management</u>

   - A well-developed (and developing) asset management system, Maximo, is key to the inspection, maintenance and renewal of engineering assets. Amtrak believes strongly in “Knowledge and Order”.
   - Amtrak believe in asset management for four principal reasons:
     1. To do condition based maintenance
     2. To measure work done and to allocate the work to the assets so that tracking of who did what and when
     3. Record the costs of the work done
     4. To understand the relationship of asset deterioration and the tonnage of traffic using the network
   - Amtrak uses Maximo to ensure compliance, not only with the FRA regulations but also for its own standards. This ensures that inspections are carried out in time and that remedial actions comply with standards.
   - To date, track and signalling rules have been input and other disciplines will follow. (Signalling much more complex than track).
   - Within Maximo, an engineering infrastructure database was built up. Flymap was used for asset acquisition.
   - Maximo currently has 1000 users out of a total of 2800 employees.
   - The cost of every activity including labour plant and materials is recorded in the system.
   - “Maximo manages the process and manages the result”.

Miscellaneous

- On the NE Corridor, Amtrak uses the performance of the fast Acela service as proxy for all services on the route
- Amtrak is vertically integrated and the majority of all work is carried out in-house. Amtrak has its own signalling and plant maintenance workshops.
- Personal accountability of all staff is strongly enforced.
- Day to day management is “hands on” with all Section Heads on conference call every morning to deal with issues and report on progress.
- Amtrak use league tables to encourage each area to improve performance
- Maintaining line speed is a primary objective. Short-term solutions are often adopted ahead of programmed renewals.

Track

- Amtrak actively pursue a rail cascading process from higher to lower category lines.
- By good maintenance Amtrak gets a 1.2bngmt usage out of 40 year old rail (2bngmt out of modern rail).
- 8 No weather stations including thermocouples fixed to the rails to measure temperature and enable real time decision making with respect to the stressed condition of the rail.
- Amtrak looking at UK developed non-destructive stress measurement equipment called VERSE.
- No overall track statistical geometry measure but concentrate on real faults only (levels 1 and 2 only).
- Shoulder ballast cleaner used to improve drainage.
- Rail-vac used to clean ballast and to remove ballast from platforms and other congested or clogged areas.

Signalling

- External suppliers have failed to deliver, in-house capability retained.
- Commissioning times have been reduced substantially but nothing can be shut.
- Track-side phones no longer exist, radio for all communications.
- Cables in ducting away from track, inserted by boring.

Possessions

- Pressure to reduce night-time possessions – leading to 55 hour weekend blocks instead.
- Higher priority needed for engineering trains.

Amtrak Site Visit to Bryn Mawr and Radnor

This was an all day visit on 03 October to two locations north-west of Philadelphia on a 4 track secondary line.

The work observed was track renewals.

Points to note were:

- Successful use of 30 year old track relaying system despite its age.
- Lack of ballast shoulders and returning much of the old ensured the minimum of new ballast thus keeping costs down.
- Spot re-sleepering had been carried out previously to prolong the life of the track.
- Safety management was good with full trackside briefing before going on track and all work stopped whenever service trains passed.

Amtrak Site Visit to Dispatch Centre, ECO and Station

Plant at New York Penn Station

This was a half-day visit on 06 October to observe a major Dispatch Centre, the associated Electrical Control Room, a sub station, heating and ventilation equipment and track and signalling at New York Penn station.

Points to note were:

1. The extensive, complex network (>100 switches) controlled from a single centre. Station usage was by two or more operators.
2. Redundancy in routes so that daytime possessions possible for track maintenance and renewals.
3. The close proximity and coordination of the electrical control centre to the Dispatch Centre.
4. The electrical control centre covers a wide geographic area down to Philadelphia.
5. Signalling and permanent way multi-tasking gangs were on standby during the peak periods to deal with asset failures before they affected service running. In the off-peak hours they continued with routine inspection and maintenance.
6. Equipment and systems are so robust (Pennsylvania RR heritage) that days go by without failures.

Appendix E

New Jersey Transit Meetings and Site Visits

New Jersey Transit (NJT) is a public corporation running bus, rail and light rail suburban and commuter services in the state of New Jersey, to Philadelphia and across into New York.

1. The heavy rail sector serves 162 stations. It operates over 997 route miles of track and is responsible for maintaining and renewing 536 track miles. It has over 11000 employees. Annual costs are around $565m and passenger revenue is about $395m.
2. Meetings were held in Newark NJ on 04 and 05 October 2007 with the engineering department of NJT led by Chief Engineer Glen Sullivan. His deputies for each discipline attended the site visit and we met them subsequently for further discussions.
3. On 04 October, a self-propelled geometry recording car was used both for an inspection of the line and as a means of discussing how NJT carried out maintenance and renewals. This was followed by a visit to the Train operations Centre (ROC) at Meadows.
4. On 05 October a site visit was made to Port Jervis in New York State where NJT was carrying out spot sleeper replacement on a rural line owned by Metro North RR.
5. The main findings are listed in Section 5.
6. Other points to note:

<u>Track</u>

- All rail replaced is re-used, cascaded or sold for further use. Where suitable, rail is taken out, end cropped, welded in ¼ mile strings and sold on to freight RRs.
- CWR created by welding jointed 78’ lengths using “Holland” MFBW equipment.
- Very little ballast cleaning carried out as formation is free draining on top of a granite sub-grade so there is little contamination and sub-grade breakdown.
- S&C renewals almost always renewed as a partial process.
- NJT has developed a successful “leaf buster” train mounted high pressure water canon system to clean rails in the leaf fall season.
- Resin sleepers have been tested but not liked. May be used for bridge timbers.
- Few rail breaks – mainly 1970’s thermic welds. Currently only 9 rail defects on the whole of the NJT system (470 track miles).

<u>Signalling</u>

- NJT wires its own REBs and relay rooms.
- NJT does all its own commissioning, typically in 55 hours.

- All signal power is 110v, 100hz to avoid interference.
- Simple work scheduling for inspections based on FRA recommendations.
- Switches on main lines rarely fail.
- The worst interruptions are weather related – storms and icing.

Miscellaneous

- NJT adopting high platforms (51") as standard for DDA reasons but only after major refurbishment. Main stations have a short length of raised platform. Low platforms are typically 8" high.
- Fibre glass is being trialled for bridge decks.
- Top flanges on steel under-bridges suffering corrosion due to de-icing salts spillage from road tankers. This is no longer a problem.
- New tunnels under Hudson River will absorb much of the capital budget and may lead to lower spend elsewhere On more rural electrified lines the original timber poles need replacing – partly due to ant infestation. Curves will be addressed first.
- Bridge strikes about 120-140 but limited to 20-30 bridges.

Typical NJT Lifting Bridge over the Passaic River, Newark, New Jersey

Appendix F

Union Pacific Meetings and Visits

1. Union Pacific (UP) is a major Class 1 railroad owning and operating 32400 route miles of track. It has 51,000 employees and freight carried in 2005 was 549billion ton-miles using 8100 locomotives and 143000 freight cars.
2. Geographically it owns and operates lines west of Chicago to the Pacific coast and from the Canadian border south to the Gulf of Mexico.
3. It claims to operate a route in Nebraska that is the busiest freight railroad in the world, some 130-150 freight trains a day.
4. Meetings were held on 08 and 09 October at UP's headquarters in Omaha, Nebraska and a site visit was made to Grand Island and Gibbon.
5. The main findings are listed in Section 5
6. Other points to note:

    - 95% of UP staff up to and including the most senior are career railwaymen (not always UP).
    - UP Chief Engineer has just won "Railroader of the Year" at the age of 69!
    - The triple track section west of Gibbon Junction on the North Platte River carries 360gmtpa (one track carries 140gmtpa).
    - Ultrasonic testing is carried out every 15 days on the most heavy used lines.
    - Much of the rail on heavy used lines has carried 3bn gmt without any increase on number of rail defects.
    - UP in Nebraska believes that it suffers from the largest temperature range pa in the world.
    - UP believes that the key to its success in effective and efficient maintenance is "brute strength rather than European finesse"; i.e. heavily engineered infrastructure requiring lower subsequent maintenance.
    - Although they use the P909 P&T track relating train they would prefer the Matissa P95 but the latter is too expensive.
    - The P909 is claimed to work at about 800 ties per hour on average (at the Grand Island relaying site, it was nearer 500 ties per hour).
    - The trains carrying long welded rail carry 50 strings of rail, 1400 ft long.
    - S&C is normally installed using 2 or more John Deere shovel loaders in tandem. The S&S is delivered in units to track-side and then fabricated before installation.

      Concrete ties are made on a continuous casting bed and sawn to size. Fixings currently hand installed but may be mechanised. Loading onto trains using is computer controlled using a robotic gantry system.
    - Spot tie replacement is 1 in 3 or 1 in 4 to give an 8 year cycle before they need to revisit. Every 5th tie has to be excellent to maintain gauge. All fair and bad ties on curves are replaced. Other fair ties are plugged.
    - Rail grinding treated as capital as it gives life extension to the rail.
    - UP work to an annual budget of $1.5bn and do careful prioritisation to stay within budget.

Appendix G

Canadian National Meetings and Visits

1. Canadian National (CN) is one of two major Canadian freight railroads and is also a Class 1 railroad in the USA following its purchase of Illinois Central RR. In total it owns and operates about 20000 route miles of track. It has 218000 employees, uses 1900 locomotives and 117000 freight cars.
2. Geographically it owns and operates lines east-west across Canada and north south via Chicago to New Orleans.
3. Meetings were held on 10 and 11 October at CN's headquarters in Montreal, Canada and a site visit was made on 12 October to Victoria Bridge across the St Lawrence Seaway south of Montreal city.
4. The main findings are listed in Section 5.
5. An electronic and hard copy of the introduction and background to CN plus asset management, regulatory and safety performance are available (CN01-CN09).
6. Other points to note:

Asset Strategies

- Engineering in CN is viewed as a support organisation to the most important function of operations. CN is there to run trains and not to provide a playground for engineers. Track maintenance is grouped under operations/transportation with only an indirect link to engineering.
- CN is very clear on how much rail and tie renewals are needed each year to achieve a state of good repair.
- CN not keen on introducing concrete sleepers – wholesale renewal required that results in some timber ties being prematurely replaced.
- Asset assessment is generally condition based. For bridges, continuous monitoring adopted.

Expenditure

- CN engineering allocated a fixed percentage of predicted budget each year (currently $850m) then prioritise spend.

Track

- CN is achieving 1.5 -2.0 gbn tonnes per annum from head hardened rail.
- CN uses Zetatech from USA to advise on frequency of ultrasonic inspection.
- Hardwood ties are used almost exclusively except for the most heavily used routes. Hardwood tie replacement is nearly always on a spot basis
- Rail condition and management is the number one issue for engineering. The extremes of temperature (-20° and below in winter) lead to brittleness and growth of defects.
- CN suffers from 1200 rail breaks in a year – most from severe cold. When temperature reaches -20°, TSRs applied.

- Rail breaks are the biggest cause of derailments.
- RCF under control due to an extensive grinding programme.
- Tie renewals is 800 -1200 ties per mile minimum (3100 ties to the mile). 90% of ties are hardwood with only 3m concrete in 1000 miles on its most heavily used route (Jasper to Vancouver).
- It is not CN practice to replace all ties in a length (some will always have some life left).
- Re-ballasting is typically carried out in 6-hour blocks with a target of 3300ft (currently achieving only 2500ft). Within the block full ballasting and two tamper passes required. If an 8-hour block was possible, 7500-8000 ft would be possible.
- There is a backlog of re-ballasting and current 150 miles per year needs to increase to 450-500miles. Steady state would be 300 miles per year.
- S&C lives based on 40gmtpa typically switch and point 9 year, stock rails 7 years, RBM frog 6 years, swing frogs 14 years, Complete turnout 19 years.
- When replacing turnouts completely, the components are prefabricated off site, pre-assembled at the track-side and slid into place. If there is insufficient time to commission, the switch can be locked for the main line to get service trains running. Only an initial tamping during installation and return later to complete.
- 8% of delays due to track.

Signalling

- Detailed presentation covering all aspects of CN Signals and Communications available in hard copy (CN05).
- Only 2% of delays are due to signalling faults.
- Almost all signalling design and manufacture carried out in-house including wiring diagrams.

Miscellaneous

- At Montreal, CN has an Operations Management Centre covering its entire network. This is driven by two interactive management systems. TOPC (Train Operations, Planning and Control) that plans train movements and MPS (Motive Power Systems) that allocates locomotives to trains. Train delays and early running are colour coded on the display. There are tags on CN's locos that send back their position via trackside monitors. The system can be accessed at all times by all staff.
- CN has a system (Mobile net) that monitors engine hours run on locos, including yellow plant. It records times when engines switched on and off.
- Short possessions for engineering works can be taken using the site crew as local train dispatcher.
- Innovation is critical for taking and using possessions. Budgets are driven by revenue. Having got the budget agreed, the work volumes must be done. Using the TOPC system via a Blackberry, site teams could see real time running and plan short possessions (or longer?) between trains.
- Engineering related derailments mainly caused by broken rail (25 pa).

- Total derailments 220 pa.

Condition Monitoring

- Ultrasonic testing carried out on core routes 6-11 times pa, 128000 miles tested pa.
- Defective wheel sets are identified through RCM. Wagons are removed promptly and wheel sets are replaced at owners expense.
- HABDs installed every 15 miles (statute requires every 60 miles).
- Derailment detectors at critical locations Brittle bar).
- Unmanned systems to be installed on freight cars or locomotives.
- Very few rail defects in summer, most due to cold weather in winter.
- Switch motor currents monitored to predict potential failure.

Amtrak Passenger Train Overtaking CN Hi-Rail Truck on Victoria Bridge over the St Lawrence Seaway, Montreal

General View of Victoria Bridge and St Lawrence Seaway