Section 9

Plans by asset type

Introduction

Our generic approach to asset stewardship strategy, planning, and delivery was outlined in sections 3, 4 and 5. This section provides further details of the application of this generic approach to each asset, setting out detailed plans for the following asset categories:

- Track;
- Structures;
- Signalling;
- Electrification and Plant;
- Telecoms; and
- Operational Property, which incorporates stations, depots and lineside buildings.

Track

Asset stewardship strategy

Objectives

The objective of our track stewardship strategy is to deliver a safe, reliable railway, through the proactive management of track assets at the optimum life-cycle cost. We aim to deliver improvements in the current serviceability and condition of track that are compliant with, or in excess of, the targets set by the Regulator. The delivery of these targets for asset performance will contribute to improvements in operational performance and the safety of the network. The key output targets are:

- a further reduction in the number of broken rails to no more than 300 per annum;
- progressive reductions in the number of temporary speed restrictions (TSRs) due to the condition of track; and
- improvements in track geometry, measured through reductions in the number of L2 exceedences per track mile, to no more than 0.9. We also aim to reduce the proportion of track where geometry is classified as poor.

Asset overview

The track asset portfolio comprises the rail, sleepers, ballast and switches and crossings (S&C) that form the permanent way, and the associated formation and drainage. Also featured are off-track assets including the cesses, vegetation management, fencing and certain signage. The table below summarises the overall volume of track assets.

Figure 9.1 Track assets

Asset	Volume
Route kms	16,400
Track kms	31,700
Switch and crossing units	20,383

About 76% of the track network consists of continuous welded rail (CWR) while the remainder is formed of jointed rail. Around 70% of the track is supported by concrete sleepers, 25% by timber and the remainder by steel.

The current condition and rate of degradation of the track infrastructure reflects years of under-investment in both maintenance and renewal activities. This has led to the current situation where a significant part of the network requires renewal or extensive maintenance to restore it to an appropriate condition. This has been compounded by the considerable growth in traffic over recent years, which has increased the rate of track degradation and restricted engineering access opportunities.

The challenges raised by the management of this infrastructure are being addressed by a range of initiatives including:

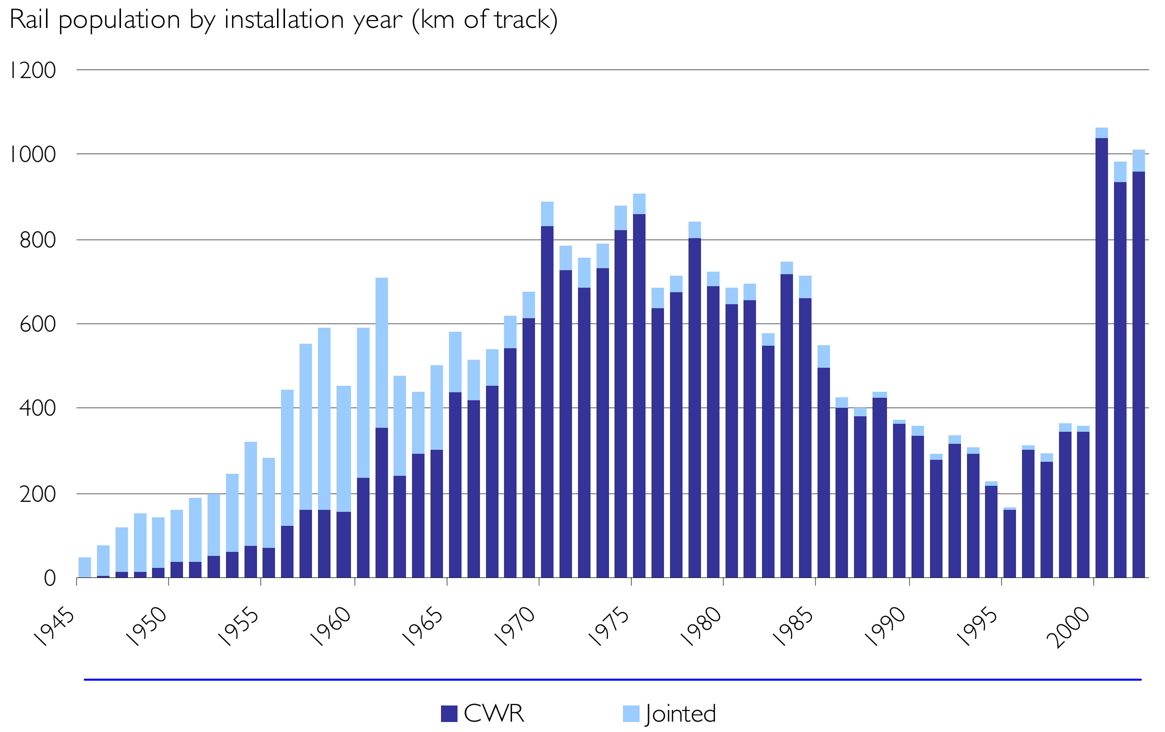
- improving control of maintenance activity by taking it back in-house;
- standardising work planning;
- introducing more sophisticated inspection techniques;

- improving competency through structured training and assessment;
- increasing renewal volumes, particularly for S&C;
- pursuing heavy maintenance options where appropriate; and
- investing in new plant and machinery.

Age profile of asset

The age profile of plain line track is illustrated in the figure below. It shows the volume of rail installed in each year since 1945 that is remaining in track, showing that renewal rates have been relatively low over the last two decades in comparison with the previous 30 years when renewal rates were typically around 2.5 to 3% per annum. The increased volume of rail renewal activity from 2000 reflects the extensive rerailing programme to address rolling contact fatigue (RCF) and continued targeting of track showing clusters of defects. The recent increase in track renewal activity needs to be sustained over the period of this plan.

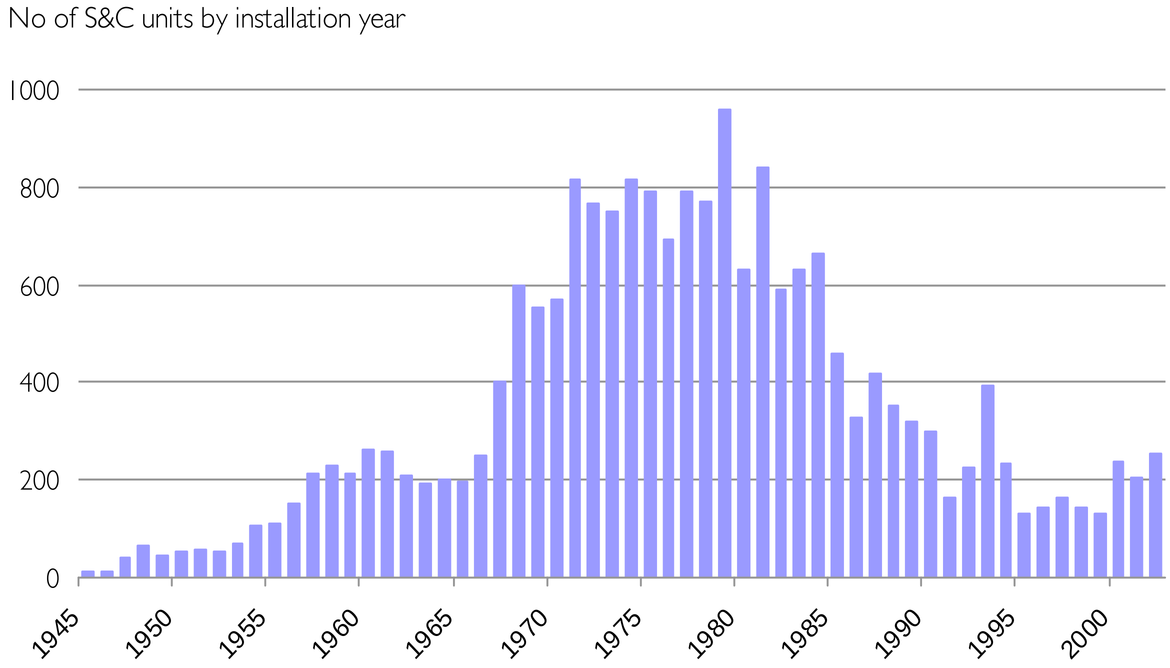
Figure 9.2 Rail age profile (post-1945)



Prior to 1962 the majority of renewals were jointed rail on timber sleepers with a gradual move from bullhead to flat bottom rail. During the 1960s and 1970s CWR was introduced as the standard for renewal of main line routes. A large volume of the remaining jointed rail on timber sleepers, together with much of the subsequent peak of CWR on concrete-sleepered track, is now reaching the end of its serviceable life.

The age profile of S&C is similar to plain line and is shown in the figure below. The current condition of S&C is a key concern, with over a third of track segments containing S&C having at least one geometry parameter classified as very poor, compared to less than 5% for plain line. The need to address this has been accepted by ORR and the interim review determination made explicit provision for increases in S&C renewal volumes over the next five years. In addition to increasing renewal rates we are carrying out more heavy maintenance at key junctions.

Figure 9.3 Age profile of S&C units



Track reaches the end of its service life when the component condition deteriorates to the point where it no longer meets the level of safety or performance requirements. Beyond this point, the maintenance input and associated costs will increase disproportionately in order to try to maintain the required outputs, but the condition and performance will continue to deteriorate, eventually leading to traffic restrictions or closure. Hence, if renewals are not undertaken in a timely manner, the maintenance costs of the asset will rise steeply, and the condition may deteriorate rapidly.

Traffic growth

Since 1995, following a period of declining traffic levels, the network has seen substantial growth in traffic. Total tonnage on the network has increased by 27% since 1995/96, with gross freight tonne miles increasing by around 50% and passenger tonne miles by nearly 20%. This has increased the rate of degradation of track assets, particularly on routes that have seen step changes in the level of traffic, drawing forward the need for track renewal and increasing the required volume of maintenance. At the same time, the use of additional capacity has reduced the availability of track access to carry out the necessary activities.

In addition, recent years have seen a significant increase in the replacement of rolling stock across the network. New rolling stock designs have improved acceleration and deceleration capabilities, together with higher maximum speeds, increased weight and larger bodies. They have also been designed with stiffer vertical and lateral suspensions which impart much higher dynamic forces on the track and increase the wheel/rail interface contact stresses. This has led to a step change in the generation of RCF in rails, together with faster degradation rates of other track components, resulting in reductions in their service lives.

Weather

The very hot summer experienced in 2003 had a significant impact on train performance as a result of the imposition of speed restrictions caused by the risk of track buckles and the impact on track geometry of the settlement of embankments.

The total number of rail buckles during 2003, 136, was similar to previous hot summers. However, we believe this level was unacceptably high, as were the delays associated with the imposition of speed restrictions. We are taking a number of actions to reduce the risk of buckles and the number and extent of associated speed restrictions, including:

- a review of the methods for stressing S&C layouts;
- continued implementation of a standardised process for recording stress free temperature records, highlighting any missing records and supporting decision making in periods of very hot weather; and
- an increased emphasis on the maintenance of rail joints and ballast condition.

Asset policy

The latest edition of the track engineering policy was produced in February 2002 and will be updated this year. The policy details the output objectives, the causes of track asset degradation, and the actions that should be taken to prevent failure. It identifies the sources of information required for correct decision-making and the available decision support tools. It also specifies restrictions on the use of existing track components due to known performance or safety limitations, primarily for use in considering increases in traffic or speed.

The document defines policies on inspection and condition monitoring, decision-making, and maintenance and renewal practice for plain line and S&C. These policies are defined by track category and are therefore related to line-speed and tonnage, and cover how activities are to be carried out, at what frequency, and what materials are to be used when performance or condition requires the replacement of existing materials.

The policy is informed by economic analysis and international best practice, including work undertaken for the company by international research bodies. Variation from the policy is permitted by agreement with the Head of Track Engineering where compliance would cause disproportionate cost.

Standards

We have been working with the Railway Safety and Standards Board (RSSB) to review the Group and Company standards relating to the requirements for managing broken and defective rails to ensure that these are appropriately risk-based. This review will be completed during 2004. We have already changed our company standards away from the past practice of reinspecting small rail defects to one of requiring their removal.

In March 2002, we started a two year project called Rail Mentor whose aim is to produce a suite of instructions for track work. These define in detail how specific work is to be undertaken on the track, and will assist in improving the specification, consistency, monitoring and quality of work. The new track work instructions will be completed during 2004 and will be introduced progressively in parallel with the transfer in-house of maintenance activities.

There is a comprehensive suite of "good practice guides" for track maintenance activities which has recently been supplemented by a guide on the installation and maintenance of adjustable stretcher bars on switches. A guide on the management of RCF is due to be published by early summer. Guides covering track renewals, tamping and stoneblowing are at an advanced stage of development, whilst further guides will continue to be produced and updated when required on an ongoing basis.

We have revised our standard on alumino-thermic welding, tightening tolerances on weld acceptance, and defining minimum actions for defective welds. Our specification for arc welding has also been revised and expanded to standardise industry practices and procedures for arc weld repair of rails. Through the Institute of Rail Welding we have worked with our contractors and suppliers to set cross industry standards for the training and assessment of track welders to ensure we achieve consistently high standards.

Asset knowledge

Asset degradation

Track assets comprise a complex system and the deterioration of individual components has an adverse effect on the others. Degradation of the key track components is mainly due to the volume and type of traffic that runs over it. Traffic loading causes degradation through two basic degradation mechanisms: wear and fatigue. Repetitive cycles of loading on track assets will lead to degradation and ultimate failure as fatigue life is used up. Rails suffer wear due to the mechanical action of the train wheels on the rails (including sidewear, loss of rail depth and foot gall), which leads to increases in stress in the rails. Sleepers suffer mechanical wear due to the attrition between the sleepers and the ballast. Additionally environmental factors can dominate degradation, for example timber sleepers on low density routes may require replacement due to rot, before they reach the end of their service life due to fatigue.

Ballast degrades due to the "rounding off" of the individual stones, under the pressure of the traffic loading. Tamping contributes to this process, which results in a deterioration in the ability of the ballast to support the track to the required standard of geometry. This gradual degradation of the ballast leads to clogging of the free drainage with fine particles and dust. If the track drainage system is inadequate or the existing system is not functioning, then the degradation rates for all track components will be accelerated significantly.

The other major influence on degradation of track components is the quality of maintenance over the life of the asset. If the inspection and maintenance regime is inadequate, then the degradation rate may increase significantly and the serviceable life of the asset will be reduced accordingly.

The interaction between traffic and track is complex and a range of vehicle characteristics can affect their impact on track. In particular, aspects of the design of new vehicles have been shown to be a significant influence on RCF. The condition in which vehicles are maintained also has a significant impact on the amount of damage they do to track assets, for example, as a result of the forces exerted by wheel-flats. The management of the wheel/rail interface is therefore critical to the efficient stewardship of track, and it is necessary to monitor the condition of vehicles as well as of track components.

Given the degradation processes described above, it is essential that the information set out below about the track assets and their condition, and about vehicles and their impact, is available to inform decision-making on the stewardship of track assets. The table summarises the key requirements, the present state of knowledge and identifies initiatives to address the weaknesses. Much of the additional information required will be gathered from the specific inspection and examination initiatives outlined in more detail below.

Figure 9.4 Track asset information

Information required	Status
Asset data *Age and component type*	Available in GEOGIS database to about 90% reliability as data not fully maintained over recent years. A project to update age and S&C location data in GEOGIS is underway and a detailed programme is being developed.
Track geometry *Standard deviation data by 1/8 mile and individual defects*	Data is available; we plan to increase inspection frequencies through the use of the upgraded high speed inspection equipment and new fitments to in-service trains.
Rail defects/breaks *Detail of all in-track defects and defects/breaks removed from track*	All defects, except RCF, and breaks are recorded in national database. The use of more train-based systems will improve the reliability of data. RCF database under development.
Rail profile/wear *Details of rail sidewear, depth and gall*	Data currently held by contractors. However, laser rail profile equipment has recently been fitted to ultrasonic test trains.
Sleeper condition	The recording of sleeper condition, piloted in Cornwall, has been extended to cover lines in Lincolnshire.
Traffic data *Past, present and future tonnages*	Databases record current traffic data but there are no systematic records of past tonnages. Future freight tonnages by route are difficult to predict.
Wheel/rail interface	Detailed research on the wheel/rail interface continues – this is discussed in more detail below.
CWR stressing records	Stress Route package adopted to ensure consistent recording of stress free temperatures.

In addition, understanding track position and its design geometry is an essential requirement for gauging and clearances. The completion of our national gauging project in April 2004 will provide us with the control process necessary to monitor and maintain infrastructure clearances. This will assist customers planning new services and new trains and facilitate the vehicle acceptance process. The gauging train is being upgraded with a laser scanning system, which will allow the train to operate during daylight hours as well as facilitating faster operation and data analysis.

Inspection and examination

Work undertaken on track assets is primarily driven by monitoring of asset condition and deterioration rates, and intervening before defined levels are reached. The existing methods of collecting track condition information include periodic running of track geometry recording vehicles, but tend to rely on manual inspections, together with manual ultrasonic testing of rails to identify metallurgical defects.

Our strategy is to continue to develop new and innovative inspection techniques to provide the necessary information to enable a more proactive maintenance and renewal regime, resulting in improved asset performance, overall reductions in whole-life cost of the assets, and a reduced need for staff to spend time on the track. The key areas being targeted include track geometry recording, track component condition monitoring, and rail vehicle condition monitoring. A key element of the strategy is to increase the frequency of measurements in order to improve our understanding of deterioration rates, and allow planned interventions instead of reactive ones.

Intervention is planned based on condition and deterioration rates with economic and safety criteria defined in our standards. During the past year we introduced the Track Inspection Handbook to improve the consistency of reporting, identification of actions and the determination of timescales for rectification of items identified during these inspections.

Track geometry recording

Track geometry is measured to a frequency related to line speed and tonnage using track geometry recording vehicles, with more frequent measurements on primary routes. The introduction of the high speed New Measurement Train has facilitated more effective and frequent use of the existing high speed track recording coach, enabling it to be operated at up to 125 mph within the working timetable on high speed lines.

We are supplementing the existing track geometry recording vehicles by working with train operators to fit unattended geometry measurement system equipment on service trains. These record track geometry information for dissemination to local engineers. Following a successful pilot of this technology on the Chiltern route, we are currently deploying additional systems on our major routes. These will provide measurements at much shorter intervals than was previously possible, facilitating trend analysis and leading to more accurate targeting of maintenance activity.

The increased frequency of train-borne geometry measurement reduces the amount of patrolling that needs to be carried out during daylight hours. This provides significant train performance benefits as it reduces the need for disruptive daytime possessions.

Component condition

Component condition is monitored by a combination of visual inspection and measurement, including ultrasonic testing and other non-destructive techniques, with inspection frequencies determined by line speed and tonnage. These include frequent inspection by patrollers and less frequent inspection by supervisors and engineers. Additional special inspections are carried out at defined frequencies for items such as longitudinal timbers, switches, cast crossings, rail sidewear on curves, corrosion of rail in tunnels and RCF.

The trials of the new ultrasonic rail testing train, UTU2, fitted with Sperry ultrasonic equipment, have been successful and the train is now replacing the existing manual regime on the WCML, although for the time being manual verification of defects identified is still required. Our older ultrasonic test train UTU1 is being reconfigured with Sperry equipment and is programmed to be back in service during the Spring. Two road-rail ultrasonic test vehicles have just started trials in Scotland.

This equipment will enable frequent, accurate inspection to identify rail defects at a much earlier stage in their propagation, allowing their removal from track to be undertaken in a planned and cost effective manner that avoids delays to trains and reduces the need for staff to work on track. Additional equipment has been fitted to one of ultrasonic test trains to measure rail profiles, which will aid decision-making. If trials are successful then more units will be phased in over the next three years.

New handheld ultrasonic rail inspection “walking sticks” are now in use across the network following successful trials last year, and are improving the accuracy of manual testing. We plan to introduce additional equipment for testing S&C units during this year in place of the electro-magnetic array equipment currently in use. The ultrasonic testing programme is being supported by risk-based modelling to identify the appropriate inspection frequencies.

The development of guided ultrasonics for the inspection of alumino-thermic welds, which currently account for about 30% of rail breaks, appears to offer a quicker and more cost effective solution than the use of radiography. Development of this process and equipment will be progressed during 2004/05 and will become an integral element of our non-destructive examination of rails.

Vehicle condition

The equipment and processes for monitoring the wheel impact loads using Wheelchex are now well established and form a part of the routine protection of the infrastructure from wheel-induced damage. Train operators are receiving the output data and using it to help manage their wheelset condition. Additional equipment has been procured and will be installed at sites selected in co-operation with train operators. This will improve the network coverage and provide a monitoring service to more operators with consequent benefits for the industry.

Trials of further wheel condition measuring systems are being progressed. Further analysis of parameters such as wheel tread profile, lateral track forces, and axle angle of attack is necessary to improve our understanding of the affect of rail vehicles on infrastructure degradation. Train operators and manufacturers are being included in the assessment of the trials to ensure that there is consensus for the development of the data capture, distribution and analysis systems.

Managing rolling contact fatigue

We are moving towards a full preventative regime with respect to RCF. We have made significant progress over the last year with rail grinding, which is the predominant activity in controlling RCF. We now have five plain line rail grinding trains and two S&C rail grinding trains in use with one further plain line train and three S&C grinders due to come into service this year. Productivity has been improved with two plain line grinders now working as "slow moving trains", timetabled on a three-monthly cycle on our main routes. We are implementing a programme of gradual preventative grinding, where the grinder undertakes a single pass three or four times per year, gradually bringing the rail to the correct profile. Grinding will significantly prolong rail life, but service lives are still expected to be only 50-70% of those achieved before the advent of RCF. The volume of rail renewal driven by RCF will remain at a relatively high level over the next few years.

In addition, we have worked with the Canadian National Research Corporation on rail profiles for the control of RCF. As a result we have adopted a universal high rail profile with gauge corner relief and a new standard profile for the low rail on curves and straight track. Grinding activity is now being undertaken to meet these profiles.

Managing the wheel/rail interface

Research into the causes of RCF has identified vehicle characteristics as a significant factor in rail deterioration and highlighted the importance of understanding the impact of changes in vehicle design on our infrastructure. During 2002 we established a traction and rolling stock team to address this. The team includes international experts in vehicle dynamics modelling and are working with train operators and suppliers to measure and monitor wheel and rail conditions during changes to routes and fleets.

Invaluable data obtained from studies of the introduction of new rolling stock by First Great Western and c2c has been used to advance our understanding of RCF. The factors within the track and vehicles that contribute to the growth and propagation of RCF have been identified and control measures are being developed. The same factors are related to the increase in wheel fatigue that is an emerging problem on the network. While this work is continuing a number of key findings are emerging. In particular, the new vehicle designs have excessively stiff primary suspensions which, in conjunction with track alignment irregularities, contribute to the development of RCF. Further investigation is required and is being discussed with representatives from vehicle owners, operators and builders.

We are also working with these other parties in assessing the impact of introducing new vehicle fleets, notably in the Southern region. The findings to date suggest that introducing new fleets can change the balance between fatigue and wear, alter the ride quality and fundamentally change the interplay between vehicle and track. As a result, we are producing information for train operators and manufacturers to consider when designing, building and maintaining rail vehicles so that the systemic control of RCF can be most effective. These cross industry efforts are beginning to foster a realisation that the track and vehicle must be tuned to optimise overall system performance. Making our knowledge widely available through media such as papers at learned bodies and conferences and through full participation in cross industry bodies is a key part of our RCF control strategy.

The increased understanding of the effects of worn wheel profiles for both track and vehicle maintenance costs means a review needs to be undertaken on the effectiveness of the network coverage of wheel turning facilities. Work is planned to commence on the construction of a new wheel lathe facility at Old Oak Common, which will provide additional capacity in a location with easy access for many operators. Design and development work will start on the replacement of the Hornsey wheel lathe to improve throughput. We are also working with operators of existing wheel lathe facilities to improve such factors as access and control systems to increase capacity and enable train operators to improve the maintenance of their wheelsets.

Decision support tools

We currently have three decision support tools that help inform decision on track renewal and maintenance.

The Track Strategic Planning Application (T-SPA) is our key model for long-term forecasting of track renewal volumes and the assessment of alternative output scenarios. T-SPA was used in the production of the 2003 plan and extensively during the interim review process. The ORR viewed it as a significant improvement on previous modelling and have encouraged its further development. The model will be the subject of further development and validation.

The Infrastructure and Maintenance Model (IMM) is a rule-based model used for forecasting volumes and expenditure on inspection and maintenance activity. Rules are identified for around 170 track maintenance activities and have been used to derive benchmark volumes and costs forecasts for each contract area. These benchmarks are used to evaluate annual area maintenance plans during the review and refinement of the business plan submissions. We are currently working on the integration of IMM with T-SPA to produce a complete track activity plan.

Trackmaster is widely used to analyse trends from track geometry measurements, thereby supporting the identification of future maintenance work.

Ten-year business plan

Our 10-year plan combines our assessment of the long-term activity requirements, derived from central forecasting tools, with detailed regional workbanks for the next three years. In the 2003 plan we set out our assessment of the volumes of work necessary to tackle the backlog of investment and deliver substantial improvements in track condition outputs and performance. The proposed increases in activity and expenditure were substantial and were subject to challenge during the interim review process. A number of alternative scenarios delivering different levels of output were evaluated during the interim review, including a number of options published in our plan update in September 2003.

In particular, ORR challenged:

- the scope of items in the existing workbanks, the independent consultants suggesting that significant savings could be made by reducing the scope of individual works to the minimum necessary; and
- the level of activity forecast for the longer term.

The interim review determination assumed that volumes could be significantly reduced in the early years and that no increase in plain line activity would be required after 2005/06. The review process also resulted in some of the output targets being set at less demanding levels than were assumed in our previous plan.

Since the completion of the review our key focus has been on reviewing the scope and prioritisation of activity in the workbanks for the next two years. We have developed tighter guidelines on the choice and optimisation of the chosen track renewal treatment and reviewed the prioritisation of renewal expenditure across the national workbank. This has led to reductions in the scope of works, particularly on lower category routes where the emphasis has shifted to maintenance solutions rather than renewals.

We have not yet carried out any further review of the longer-term forecasts, which have been carried forward from the September plan update. An independent assessment of the longer-term renewal requirements was made during the interim review process, which provided broad support for the rates of renewals being proposed. Further refinement of our forecasting process will be informed by the improved visibility of and control over maintenance activity and by a developing understanding of the relationships between inputs and outputs as the volume of consistent data increases progressively.

Our projections for the second half of the plan therefore show some increase in volumes compared to the assumptions made in the interim review. The impact on expenditure is partly offset by the assumed efficiency improvements. The impact on track renewal activity of increasing traffic volumes, particularly the impact of the introduction of new fleets of trains on Southern region and the possibility of step changes in freight traffic on some routes, will have to be managed by prioritising within the available funding but will make delivery of the required outputs more challenging.

Methodology

The long-term planning of track maintenance and renewal activity and expenditure is informed by detailed modelling work using a combination of asset degradation models and broader average service life assumptions. The T-SPA model is a key building block within an overall process, which has a number of stages, outlined below:

- T-SPA has been used to predict the renewal volumes for the primary, London and south-east commuter, and secondary routes, which together comprise about 80% of the total network track miles;
- engineering assessments have been made to derive estimates of steady state renewal volumes for rural and freight-only routes, typified by lower linespeeds and train densities; and
- maintenance costs have been assessed by using the IMM to review the main work volumes in the regional submissions for the early years of the plan and make a broad assessment of the required volumes that are consistent with the planned renewals.

T-SPA modelling

The T-SPA model uses knowledge of the service lives of track components and degradation mechanisms that have evolved from research and experience over many years. It incorporates a number of asset behaviour relationships which represent the way in which track components degrade and fail during service and how this could impact on train performance. The model can provide long term predictions of renewal activity and key track output measures and facilitate the evaluation of alternative output targets or maintenance and renewal strategies.

Inputs to the model include information about track assets, including type and installation date, track geometry and rail defect history and traffic volumes. The model uses service life relationships for each track component. The key determinants of the service life are age and the cumulative tonnage, measured in equivalent million gross tonnes (EMGT). These relationships provide an estimate of the combination of age and usage at which an asset would normally be replaced by relating current annual tonnage to the maximum cumulative tonnage life and hence to the expected life in years.

More sophisticated condition-based models have been developed to predict rail and ballast lives. T-SPA calculations are generally performed using both the condition models and the service life relationships, to provide complementary perspectives on the necessary levels of renewal.

The T-SPA rail model forecasts the life of rail by predicting the incidence of rail defects and the rate at which these will result in rail breaks, and applying an intervention threshold on the predicted rate of breaks per mile per year. The model predicts rail defects (including bolt holes, squats, tache ovales and welds, but not RCF) as a function of rail type, age, cumulative tonnage, track geometry and proximity of structures such as tunnels. The rate at which these defects develop into breaks has been derived from empirical analysis. The renewal criterion is a threshold value for the predicted rail break rate per mile per year, which was initially set at a level to deliver a significant reduction in the annual level of broken rails over the ten-year period.

The sleeper renewal forecasts are based on the service life relationships, which are defined for each type of sleeper: concrete, hardwood, softwood and steel. These were reviewed during 2003 and the life predictions for concrete sleepers were increased by around 10%. The forecasts for the renewal of S&C are linked to the lives of the bearers and ballast under each unit.

Ballast renewal forecasts are derived from linked models of track geometry deterioration and ballast condition. The deterioration of the geometry of individual track sections is predicted based on the impact of traffic, the condition of the ballast, and historic geometry records. Intervention in the form of tamping is assumed to occur when necessary to keep the geometry in line with track standards, with renewal being triggered when the tamping frequency becomes excessive or the ballast condition has degraded to the point where it is no longer effective.

On some low tonnage rural and freight-only routes, particularly where the quality of historic maintenance has been good, activity is likely to be managed through heavy maintenance, including selective component replacement, rather than renewal. T-SPA is not currently configured to address this sort of approach and renewal requirements for the rural and freight only routes, comprising approximately 20% of the network, were therefore assessed separately, based on knowledge from inspections over the last two years.

Workbanks

Within the framework set by the strategic plans, workbanks of specific renewal activities are developed at regional level. Track renewals are proposed when either defined limits are approached (e.g. on rail depth), failure rates are high (e.g. for rail breaks), or where geometry or component condition has reached the state where maintenance is uneconomic, or cannot deliver the required performance. During 2003 we introduced a new procedure for the management of track renewals proposals, which is being applied to all new proposals. It provides a consistent methodology for demonstrating the need for a renewal, including specification of the required supporting data.

The introduction of this procedure also facilitates the formal peer reviews of renewal workbanks which are carried out each year for the second year of the current plans. This peer review is focused on ensuring consistency of decision-making and specification, appropriate prioritisation, and compliance with the asset policy. The agreed regional programmes then form the detailed business plan for the next three years. The annual peer reviews demonstrate increasing consistency in decision-making across the company.

Maintenance

Long-term maintenance costs have been assessed using the IMM model in conjunction with the detailed annual plans developed in the regions for each contract area. The IMM model applies rules for around 170 individual maintenance and inspection activities to the track asset population to produce a benchmark assessment of work volumes and costs in each area. These benchmarks were used for a high-level review of the detailed annual plans submitted for each area, concentrating on the twenty major activities, to validate and propose changes where appropriate.

This comparison of plans and benchmarks was also used to set a 10-year profile for each activity, taking account of the output objectives and the planned renewal volumes. This resulted in a number of changes in future work volumes being assumed including:

- increase in the use of stoneblowing and a corresponding reduction in tamping and manual geometry correction;
- increase in replacement of pads, insulators and fastenings in line with asset policy; and
- reductions in some other activities as some of the backlog of maintenance is cleared and renewal volumes start to increase.

This process, while relatively simple to date, is another important step forward in improving the robustness of our planning capability, increasing the transparency of the activities and costs underlining maintenance expenditure forecasts and enabling a balanced assessment of the overall level of maintenance and renewal activity for track. Further work is underway to improve the model as a benchmarking and forecasting tool that is integrated with the MIMS maintenance system and T-SPA forecasting capability.

Expenditure

The figure below summarises the forecast expenditure on track renewals.

Figure 9.5 Track expenditure

£ m (2003/04 prices)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Total	609	703	678	674	669	837	848	828	807	791

Activity and unit costs

The planned volumes of renewal of track components, excluding those being carried out under the WCRM project, are shown below. The plan makes provision for activities other than core track maintenance and renewal, such as the renewal of track in depots and network sidings, lineside fencing, replacement of longitudinal timbers and track slabs, level crossing decks, and track drainage.

Figure 9.6 Track renewal volumes (kms and S&C units)

Asset	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012 13	2013/14
Rail	736	848	804	804	804	1045	1046	1044	1044	1044
Sleepers	559	685	696	696	696	991	994	991	989	989
Ballast	575	747	780	780	780	1025	1028	1017	1017	1017
S&C	349	425	506	580	655	745	821	820	808	808

The most significant increase in renewals volumes over the period of the plan is in S&C, which ramps up from under 400 units in 2003/04 to a sustained level of over 800 units per year from 2009/10 onwards (a renewal rate of about 4% per annum). The relatively low level of S&C renewals over the last 20 years has left the network with a significant volume of units which are beyond the end of their service lives, the majority of which are on our busiest routes: the main lines and commuter routes in the south-east. Their condition is having a major impact on track geometry, which cannot be corrected in a sustained way by maintenance. The profile of the forecast renewal volumes over the period of the plan reflects the supply chain constraints on delivery of these volumes.

We have established a process for recording and monitoring the unit costs of track renewal activities, which is used to establish benchmarks for contracts, make comparisons between regions to identify best practice and to monitor delivery performance. The unit costs applied to the volumes in the later years of the plan are composite rates for rail, sleepers and ballast, derived from analysis of the actual unit costs over recent years. The move to direct maintenance and the increasing use of MIMS will facilitate more detailed analysis of the unit costs of maintenance activity in the future.

The delivery of the higher volumes requires the use of the higher output track renewals plant that is currently being procured, which in turn requires a commensurate access regime to enable it to be used efficiently. In addition to the direct cost efficiencies from improved access, there are benefits to be gained in the quality and durability of work that can be completed during longer possessions, with consequent savings in whole-life costs. Undertaking renewals in short possessions results in more joins, affecting the quality of geometry and rail profiles. Maintenance to correct track geometry problems can also be difficult when access is constrained and lower quality outputs may be delivered.

New track renewal contracts for plain line and S&C for the next five years have been competitively tendered. Preferred bidders have been selected for each track renewal contract area and we are concluding contractual arrangements with each selected supplier. A rolling programme of contract award commenced in February 2004 with the East Midlands contract area.

We are investing in new equipment to deliver track renewal activity, notably two new high-output ballast cleaners and a second high-output track relaying system. Pre-production trials of the first ballast cleaner are due to commence during the summer with introduction into full service in the autumn. This will be followed by the introduction of the other equipment during the summer of 2005. We plan to use one of the ballast cleaners and the track relaying system exclusively on the Great Western Main Line during 2005 and 2006 to tackle the major renewal requirements on that route. We have also ordered a second mechanised sleeper replacement system, using specialised plant and road-rail machines, following the successful use of this method for spot resleepering on rural routes. This will come into operation in 2005.

Outputs

The figure below shows the forecast asset condition measures associated with the maintenance and renewal volumes in the plan.

Figure 9.7 Track output forecasts

	2004/05	2005/06	2006/07	2007/08	2008/09
Number of broken rails	343	303	290	280	280
L2 exceedences per track mile	1.03	0.97	0.91	0.91	0.91
L2 exceedences on lines with speeds > 40mph	0.77	0.72	0.67	0.62	0.57
Track geometry index	1.09	1.06	1.03	1.00	1.00
Poor track geometry	3.6%	3.2%	2.8%	2.5%	2.2%

Our understanding of the relationships between activity and output measures is improving, but we do not yet have the tools to predict the outputs with confidence. The task is complex because the key output measures are affected by the level of maintenance and renewal activity and the manner in which it is all targeted, not simply by the aggregate volume of renewals. Other factors, notably weather conditions, will also have a significant influence. These forecast outputs are therefore all subject to a significant degree of uncertainty.

The level of rail renewal will contribute to further reductions in the number of broken rails. These will also be influenced by other activities including improved inspection regimes, rail grinding and better management of welds. The overall level of activity is expected to meet the output target of less than 300 broken rails per annum from 2006/07 with a forecast level of 280 to be sustained over the period of the plan.

For the track geometry measures the forecast improvement is very closely linked to the delivery of the S&C renewal volumes contained in the plan. For the outputs that are driven largely by the ballast condition, L2 exceedences and poor track geometry, we believe that the renewal volumes are sufficient to deliver the baseline output targets.

Commentary

A major risk to the plan is in the estimation of rail renewal and grinding volumes following the introduction of the large new fleets of rolling stock to replace Mark I stock on Southern region. The rail renewal volumes allow for the significant increase in tonnage that results but do not include additional volumes resulting from the anticipated adverse effect of the new stock on RCF. The true impact will only emerge over the next few years and we are working with the train operators to benchmark the current track condition, and to establish a monitoring regime to identify changes in degradation rates and asset lives.

Structures

Asset stewardship strategy

Objectives

The objectives of the structures policy are:

- to ensure the infrastructure is managed in the most cost effective way to comply with standards and other corporate and statutory requirements;
- to optimise the short-term and long-term effects that structures management has on the performance of train operations; and
- to develop a skill base for structures engineering to meet future business requirements.

We plan to meet the baseline output targets set by the Regulator at the interim review, which are to:

- maintain existing network capability for maximum permitted axleloads on any route, as reflected in the route availability measure;
- return structures condition and serviceability to 2001/02 levels by the end of 2008/09; and
- reduce the number of temporary speed restrictions (TSRs) due to the condition of structures and earthworks from 152 in 2002/03 to no more than 100 by 2008/09.

Asset overview

The structures asset portfolio covers bridges, earthworks, tunnels, sea defences, culverts and retaining walls. A summary of assets in the structures portfolio is shown in the following table:

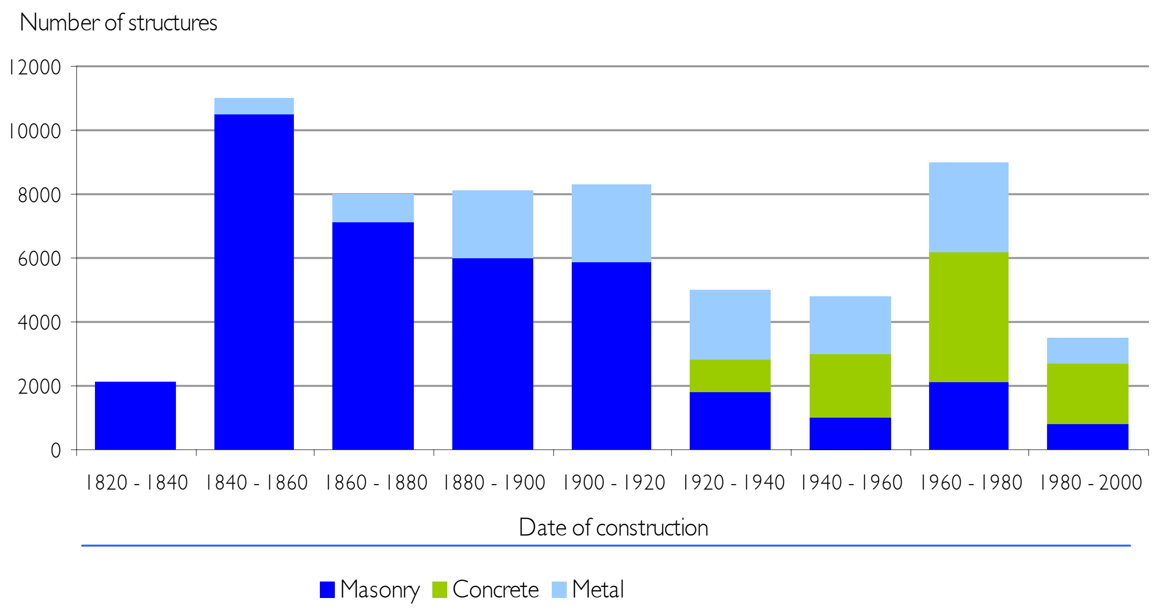
Figure 9.8 Structures assets

Asset type	Unit	Volume
Bridges – under, over, side and footbridges	Spans	68,000
Culverts	Number	21,300
Earthworks (measured each side)	Miles	13,000
Tunnels (each bore measured separately)	Miles	200
Sea and estuarine defences	Miles	120
Retaining walls	Miles	1,500
Miscellaneous structures – signal gantries, OLE masts etc	Number	145,000

Structures assets have long lives and the majority date from the original construction. Subsequent works may have improved or strengthened the assets where original works have not met contemporary requirements. While some bridges have been rebuilt as an economic alternative to extensive repair, the majority are the original construction. A small proportion of bridges have been replaced to accommodate increased loads from rolling stock or road vehicles, or requirements for increased clearances.

Approximately half the spans in our bridge stock consist of masonry structures, which are typically 150 years old. Metallic bridge spans account for approximately 42% of the total, the majority of which are wrought iron or early steel structures dating from 1880 to 1920. Earlier cast iron structures still exist, predominantly on overbridges, while post-1930 metallic bridges are usually steel fabrications. The remaining 8% of bridge spans are concrete structures with the majority dating from the 1950s and 1960s. The current average age of the bridge stock is around 100 years.

Figure 9.9 Age of bridges by main material type



Asset policy

The latest version of the Structures Asset Policy was produced in May 2002 but will be subject to review following the extensive debate over the appropriate strategy during the interim review.

Our 2003 plan proposed a substantial shift in the policy for structures management away from the largely reactive historic approach, towards a more pro-active policy aimed at minimising life-cycle costs. This approach was costed for the plan and resulted in substantially higher levels of forecast expenditure in the medium term. A number of alternative policy approaches were discussed and evaluated as part of the interim review process, during which our plans and the underlying models were the subject of independent review. The three broad policy options are summarised below.

- policy A: improving the overall condition and performance of structures by applying a whole-life intervention strategy;
- policy B: delaying interventions until repair or replacement becomes necessary to maintain the safety and operational capability of the network, but ensuring that work is then carried out as comprehensively as possible to maximise residual life and minimise future costs; and
- policy C: a purely reactive approach that seeks to minimise short-term costs.

Figure 9.10 Structures policy options

Policy	Rationale and consequences	Strategy
Policy A		
Return and maintain the stock to steady state by the use of maintenance activities that will improve performance levels and the remaining life of existing assets.	Improved reliability of performance is achieved. Condition is held at a relatively higher level to minimise the risk of early or unexpected failure.	Carry out regular pro-active maintenance to control deterioration. Where renewal or major repair is required, use whole-life analysis to determine the least present-day cost option.
Policy B		
Allow structures to deteriorate until repairs or replacement are essential to maintain operational requirements. At the time of intervention, carry out works that achieve lowest long-term costs for the structure.	Intervention is delayed until performance is affected by further deterioration. Interventions are carried out on a comprehensive basis to maximise longevity of individual structures.	Evaluate essential intervention requirements using whole-life costing analysis to determine the most economic lifetime plan for individual structures.
Policy C		
Allow structures to deteriorate until intervention is essential to maintain safety standards or raise performance levels to an acceptable level.	Short-term expenditure is kept to an absolute minimum. Lower overall condition carries higher risk of performance restrictions and minor failures. Increased examination and monitoring regimes required.	Carry out work on a restricted basis to keep current expenditure to lowest possible level.

The long-term benefits of life-cycle management of structures were identified in the detailed projections of maintenance and renewal costs carried out during the last three years. This work developed our understanding of how maintenance policies could be varied according to affordability and required outputs. The cost projections were made in a study called the Structures Annual Cost Profile (SACP), which concentrated initially on the least whole-life cost approach to managing each structure. Preventative maintenance activities, such as painting, vegetation removal and waterproofing formed an essential part of this policy in order to reduce deterioration rates and reduce the risk of unplanned network disruption.

Adopting policy A would have allowed us to return the asset stock to a steady state condition by pro-active maintenance, improving long-term performance and extending the remaining life of assets. This would have been a marked departure from the predominantly reactive approach adopted in the past. The purely reactive approach, policy C, is characterised by delaying any form of intervention until it becomes essential in order to maintain safety standards or restore performance. The continuation of the reactive approach would have resulted in a steady deterioration of assets, eventually resulting in declining operational performance, and the need for substantially higher spending levels and major possession requirements for the repair or replacement of neglected structures in the future.

In moving from reactive maintenance to life-cycle management a steady increase in the annual volume of interventions was planned. This controlled increase offered a practical solution to the lack of both funding and resources in the short term.

In his interim review conclusions, the Regulator agreed that the continuation of the reactive approach was not sustainable and that a significant increase in the level of activity was required. However, he was not convinced that a move to policy A represented the best value for money over the next five years and the settlement provided increased funding to support the gradual implementation of policy B from 2006/07 onwards.

The main characteristic of policy B is to obtain maximum benefit from interventions by addressing all deficiencies in individual structures at the point when remediation is essential. This provides a substantial improvement on the reactive approach in recent years by addressing long-term performance of individual structures using whole-life-cost techniques. We are working to develop more detailed guidelines on the practical application of this policy approach.

Asset knowledge

Asset degradation

The asset life of existing structures is often indeterminate as a result of the variable nature of the materials and the environment conditions, and because most assets are still in their first life-cycle. The complexity of this life-cycle precludes the use of a simple generic profile that can be used for forecasting. Instead a more useful approach is to model the intervention cycle of different types of structure based on engineering principles and to incorporate these into a statistically based model.

Knowledge of the characteristics of engineering materials and their behaviour in an operational and environmental context is fundamental to the overall management of structures. An understanding of the process and the effects of erosion, corrosion, and fatigue are essential to determine that the structure remains fit for purpose and safe for the operation of trains.

The impact of traffic causing fatigue is a key driver of degradation of bridges. In addition to the cumulative loading, the maximum impact is a key factor. The drive for higher speeds for heavy/high axle-load traffic introduces additional risks for structures, particularly in the older metallic bridges. A preliminary study will be carried out in 2004 to assess the risks associated with the continuing use of 100-year old metallic structures carrying rail traffic, and in particular the use of heavy axles at higher speeds. Maintenance cost forecasts do not include any allowance for the effects of traffic growth on fatigue and deterioration. The study will include consideration of the likely residual life of metallic structures based on present traffic levels.

Increased levels of rainfall in recent years have led to a significant increase in the number of embankment slips. Inspections have revealed that approximately 6% of our earthworks have an increased risk of failure in unfavourable weather.

The management of our 200 miles of tunnel is heavily influenced by access for inspection and for carrying out maintenance. The management of tunnel shafts, particularly those sealed top and bottom and hidden from view, requires special consideration to ensure that risks are properly evaluated and addressed. Many of the concerns related to tunnels arise from the ingress of water, which not only increases the deterioration of brickwork linings but also adversely affects track and signalling systems.

Sea defences represent a major liability with some sites requiring heavy investment to ensure routes remain open. The development of a national strategy for coastal protection will provide long-term benefits.

Asset information

In view of the ways in which structures assets degrade, the key information required for stewardship comes from regular inspections and examinations to record the current state of structures and to inform the rate at which they are degrading.

The structures inventory and location information is held in a number of repositories including GEOGIS, RAR, and local databases containing additional information including examination and assessment records and future work plans. There is an ongoing data quality improvement project to consolidate and improve this information by matching all data sources against GEOGIS so that all data held on any individual structure can be accessed readily. The process is being developed in Midland region to establish the methodology, costings and programme.

The structures condition marking index (SCMI) is designed to provide a consistent assessment of the condition of structures by marking each structure out of 100, based on the extent and significance of defects noted during examination. This will enable a quantified evaluation of the structures population, and allow the deterioration of the overall portfolio and individual elements to be monitored. New condition data arising from SCMI inspections and enhanced earthworks examination will be combined with existing databases and used to support the development of our strategic life-cycle models.

SCMI was originally developed for bridges and is now being extended to include tunnels, retaining walls, culverts and footbridges. The trials on these structure types will continue in 2004 and data collection will start in April 2005. For embankments, cuttings and rock slopes we are developing soil slope and rock slope hazard indices to provide condition scores for these assets. These hazard indices have been trialled in the North West region and will introduced across the network in 2005. The first full cycle of examinations which include these indices will be completed in 2015. However, a preliminary evaluation of all sites has been carried out to identify sites in poor condition and these will be examined annually.

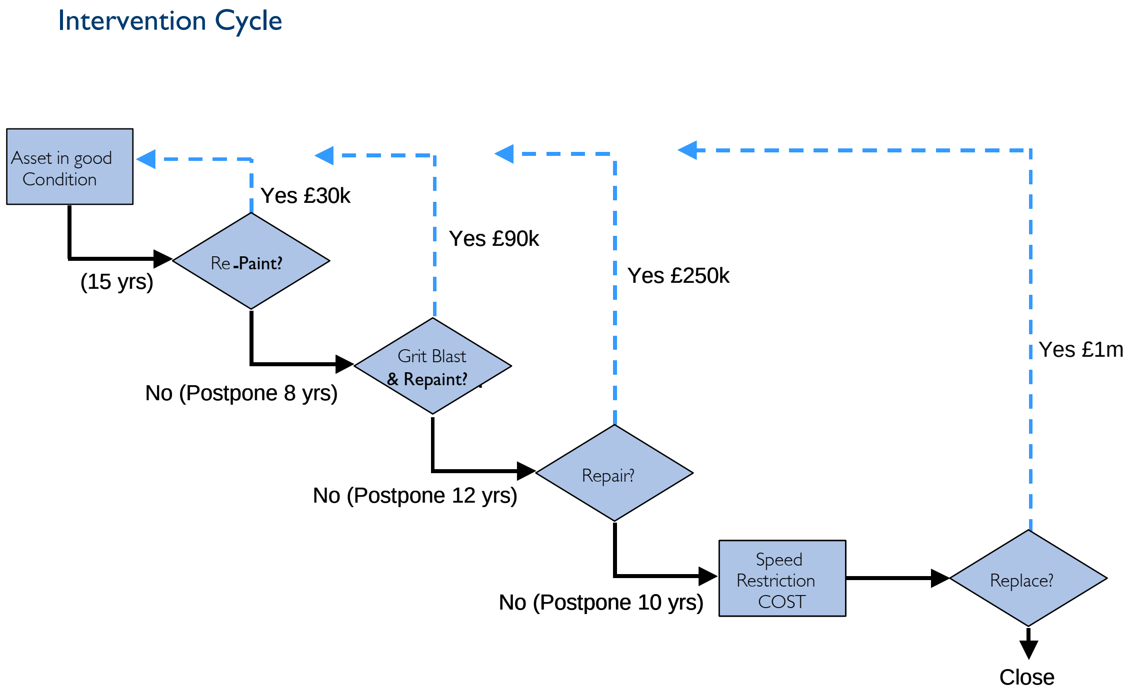
Decision support tools

The management of the safety of structures is underpinned by the inspection and structural assessment programme and this informs the decision making process. The option to monitor or carry out work on a structure will depend on many factors, including any financial constraints. Life-cycle maintenance attempts to determine the level of intervention to give the optimum level of expenditure.

The structures asset management process (STAMP) models the intervention cycles for individual structures and provides the costs of different scenarios so the optimum scheme can be adopted. As the availability of asset information increases continual improvements are made to the STAMP methodology. As STAMP is applied to more structures, a library of possible intervention scenarios will be compiled, simplifying its use and increasing its effectiveness. The figure below is an illustrative intervention cycle, showing alternative interventions, costs and consequences.

The progressive adoption of STAMP, supported by the increasing availability of SCMI data, will enable future estimates of maintenance and renewal requirements to be less reliant on extrapolating statistical samples and to include quantified condition data.

Figure 9.11 Illustrative intervention cycle



Ten-year business plan

Overview

Our 10-year plan combines regional workbanks for the next three years with the longer-term assessment of the costs of the shift in the overall policy approach to structures discussed earlier. The projected expenditure over the later years reflects the Regulator's decision that it was appropriate to fund the policy B approach.

The policy guidelines will be applied to the SACP model to establish what further work is required to develop SACP as a forecasting model for future spend and output. The study will also include consideration of indicators which enable the effectiveness of the policy and its impact on performance to be measured.

The adoption of policy B represents a significant change in the approach to maintenance and renewal, and requires the development of an improved system for prioritising work to achieve the required outputs. During 2004 more detailed rules and guidelines on how policy principles are to be applied to each structure type will be developed and used to refine and prioritise workbanks. In the short term the reviews of annual workbanks focus on ensuring that only essential works are carried out.

Methodology

The SACP model provides the basis of the long-term forecasts of structures maintenance and renewal requirements. The methodology has been developed over a number of years. SACP covers all the assets in the structures portfolio and has been used to produce 100-year projections of activity. It provides a framework within which alternative life-cycle policies can be applied.

The initial "prior" model uses asset data including type, age, construction and material type, and the most recent assessment of condition. GEOGIS is the major source of asset data, supplemented by regional databases. Condition data is primarily derived from the application to date of SCMI and will be progressively updated as more SCMI results become available. Other inputs include unit costs for activity, performance and possession impacts.

For each bridge type, generic intervention cycles have been developed by an expert panel of Network Rail and external structures engineers. The other assets use defined intervention cycles driven by asset characteristics and current condition. SACP applies these generic models to the detailed asset data inputs and produces the prior forecast of interventions and costs.

The forecasts produced by applying the prior model are then improved using Bayesian statistical techniques incorporating the results of specific case studies using STAMP. This generates a new model (called the posterior model) which is used as the basis for our future predictions. STAMP models alternative intervention cycles for individual structures and provides the costs of different scenarios so that the optimum scheme can be adopted. STAMP takes inputs on asset condition, possible interventions and their impact and degradation rates and develops alternative intervention cycles. The output is a set of costed options to guide engineering decision-making by identifying the least whole-life cost intervention plan for individual structures.

The SACP modelling process was the subject of extensive independent review by Mouchel as part of the interim review process.

Detailed annual work plans for the next three years are developed in each region from the results of the structures inspections, each structure being subject to a visual inspection every year and a detailed examination every six years. Depending on the complexity and the nature of the defects, feasibility studies are carried out and other interested bodies consulted in order to secure the optimum solution. Larger schemes may take two to three years to complete, particularly where multiple options must be evaluated and designs completed before extended possessions can be sought. Formal peer reviews are carried out by HQ of each regional workbank. This involves scrutiny of the whole workbank, detailed review of selected schemes, and a number of site visits. The process is used to monitor and influence the prioritisation between regions and sub asset groups.

Expenditure

The table below summarises the forecast spend on structures. The SACP results indicate that a significantly higher level of renewal activity will need to be sustained over the medium term under policy B. The plan assumes that activity is increased progressively between 2005/06 and 2008/09 to the level that the modelling work indicates would need to be sustained.

Figure 9.12 Structures expenditure summary

£m (2003/04 prices)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Overbridges	48	45	51	60	57	56	55	54	53	52
Underbridges	102	94	108	125	119	116	114	112	110	108
Tunnels	46	42	49	56	53	52	51	50	49	48
Earthworks	61	57	65	74	70	69	68	66	65	64
Major structures	32	30	27	26	25	24	24	23	23	22
Other structures	12	11	14	15	14	14	14	13	13	13
Total	301	278	315	356	338	331	325	318	312	306

Activity and unit costs

The plan represents a deliverable increase in spending to levels that are required for the application of policy B. This approach is a move away from the reactive policies that been employed previously towards a whole-life approach. The workbanks for 2004/05 and 2005/06 are predominantly reactive maintenance and repair activity.

The SACP model produces forecasts of costs associated with a range of types of intervention including:

- routine and preventative maintenance;
- strengthening and repair; and
- replacement.

The SACP model uses the total cost of an intervention, built up from current rates and costs and modified from recent examples of work for the different types of structure. We have now implemented a benchmarking exercise of unit costs based on current contracted schemes. These actual unit prices are available to improve subsequent versions of the model, although an initial comparison suggested that the costs were reasonably comparable.

The procedure for the reporting of unit costs was issued in October 2002. This requires all projects to be classified by structure type, activity and volume, and for consistent recording of the costs in a database. Over the last 18 months this database has been populated with the costs and volume of all works costing over £100k. We are using this data to set cost benchmarks and efficiency targets for the regions. The reporting process will provide greater visibility and understanding of cost drivers, and facilitate the reduction of unit costs.

The majority of the structures examinations and maintenance and renewal work will be delivered through 10-year collaborative alliance contracts, regionally based with co-located teams. One-off major projects will generally continue to be procured through separate arrangements to suit specific work requirements, whilst national strategic specialist contracts are being considered for certain areas of work, such as tunnel works and steel fabrication for bridges. This year we will be reviewing the strategy for delivery of minor works.

Outputs

The primary output for structures is to maintain route availability and prevent any permanent restriction to the network by the introduction of weight or speed restrictions. This will be achieved by ensuring that all structures are fit for purpose and remain in this condition. The plan does not provide for any increase in capability.

We believe that our plans are broadly consistent with meeting the output targets for condition and serviceability set by the Regulator at the interim review, which are to return these measures to 2001/02 levels by the end of 2008/09 and to reduce the number of TSRs due to the condition of structures and earthworks from 152 in 2002/03 to no more than 100 by 2008/09.

The key established measure of structures condition is the bridge condition index, evaluated through the SCMI, which has been reported since 2000/01. The average condition over the last three years has been 2.0, on the scale of 1 to 5, with the proportion of the bridge population that has been assessed increasing steadily. A complete set of benchmark figures for bridges will not be available until 2007 when all bridges will have been covered by SCMI. We believe our plans are consistent with meeting the output.

Commentary

The move towards implementation of the policy B approach represents a substantial step forward towards appropriate management of the structures portfolio. While it requires a lower level of expenditure in the medium term than the policy A approach that we have advocated, this is not the case indefinitely and further increases in activity will be necessary in the future to ensure that we do not store up problems for future generations.

There are a number of risks associated with forecasting interventions for structures assets that are not specifically addressed in the modelling. These are often related to issues with a low probability of occurrence but with potentially severe consequences, including:

- limitations in asset knowledge, including underbridges unable to withstand external impact loads, overbridges with sub-standard parapets, early metallic bridges with design details which do not meet current fatigue criteria, and hidden tunnel shafts;
- external risk of vehicle incursions on approaches to bridges; and
- the control of weight restrictions on overbridges.

There are a number of initiatives currently being progressed which will significantly improve the confidence levels of the SACP forecasts. These include extending SCMI to all assets and the associated collection of condition information, undertaking a broader range of STAMP analyses to improve the sample size used in the SACP posterior model, and consolidating and improvement of national and regional structures databases.

In the short term our effort will be directed at developing and analysing alternative policy options, providing volumes and costs at a regional level, and developing specific asset plans for major structures.

Signalling

Asset stewardship strategy

Objectives

The objective of the signalling asset strategy is to retain the network in a steady state condition whilst providing incremental safety and performance at an affordable cost. In doing this we seek to optimise the signalling renewal programme by combining condition-based renewals of individual interlockings to larger contiguous areas. This route-based approach to signalling renewals will require targeted life extension and early renewals of some interlockings, but offers a range of benefits.

Following the completion of the interim review, a cross-industry Signalling Development Group is being established to review the development of our medium term signalling strategy. The work of this group will inform the further interim review of signalling expenditure from 2006/07 onwards being undertaken by the Regulator.

We plan to meet the regulatory output targets for signalling, which are:

- no reduction in the capability of any route for broadly existing use from April 2001 traffic levels;
- no deterioration in signalling asset condition from the 2003/04 level; and
- no deterioration in the serviceability of signalling assets, as reflected in the number of asset failures causing delay.

Two signalling asset failure measures are included in the Asset Stewardship Index, which provides an incentive for out-performance:

- the number of signalling failures causing delays of greater than ten minutes; and
- the total number of points and track circuit failures causing delay.

Asset overview

There is a wide range of signalling systems and equipment of varying technologies and ages in use on our infrastructure. These fall under the following asset types:

Signal boxes and signalling centre systems

- control systems, including hardwired control panels and visual display units. These are operated by signallers in order to monitor the state of the railway and control train movements;
- train describers record the identities of trains and track their movement through the network;
- interlockings process train position information and execute the safety logic, which translates route setting requests from the control system into computer-based and electro-mechanical commands to move points and operate signals (we have approximately 1,650 interlockings);
- remote control systems allow control and indication data to be transmitted over long distances along the line side; and
- mechanical signal boxes; approximately 650 remain in use.

Lineside assets

- signals, both colour light and semaphore;
- point operating mechanisms, either electric point motors, hydraulic, pneumatic or mechanical;
- train detection systems, comprising track circuits and axle counters;
- level crossing barriers or gates, warning lights and audible alarms; and
- other: including automatic warning systems (AWS), train protection systems (TPWS/ATP), equipment cases and cables.

Figure 9.13 Signalling assets

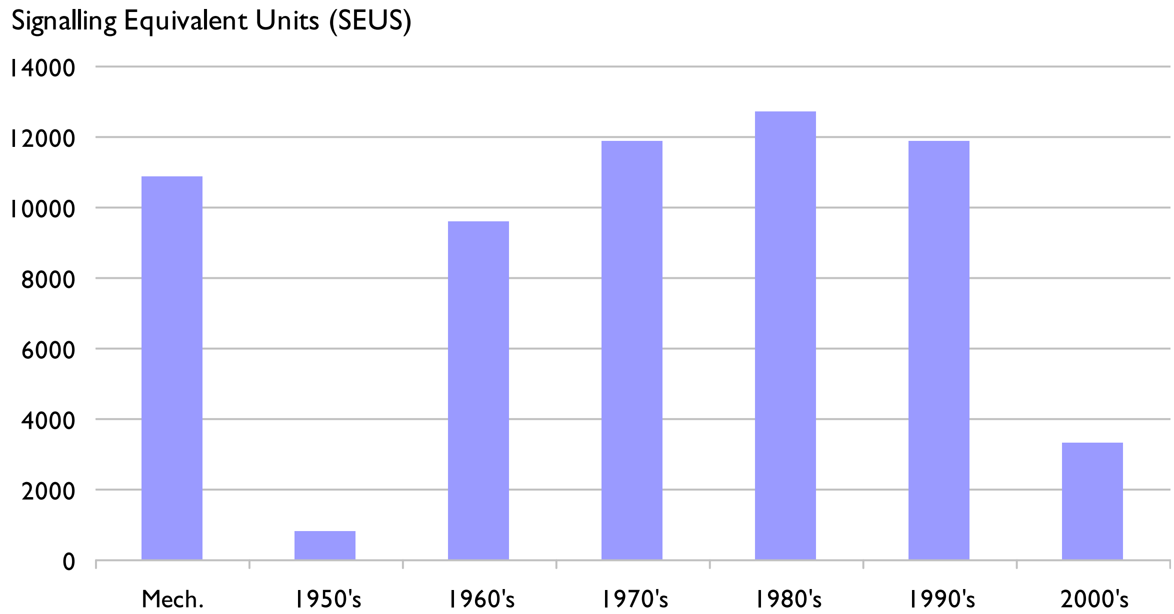
	Signalling centres / boxes	Signals	Point mechanisms	Train detection sections	Level crossings
Number of assets	906	38,017	14,786	60,994	8,612

The key strategic issues in the signalling plan are:

- the change from condition-based renewals of individual interlockings to route-based renewals; and
- the transition to risk-based maintenance regimes for signalling equipment.

The increasing age of signalling assets means that a significant increase in signalling renewals volumes from current levels is required during the 10-year plan period. The figure below illustrates the age profile of the existing assets. Large quantities of electro-mechanical systems installed in the 1960s and 1970s are at or approaching the end of their design life. Unlike older wholly mechanical systems, this technology does not lend itself to life extension. The unit of volume in the figure is signalling equivalent units (SEUs), where each unit is a single element controlled by the interlocking e.g. a signal, ground position light indicator, subsidiary signal, point-end, or level crossing.

Figure 9.14 Age profile of existing signalling assets



Asset policy

No significant alterations to the signalling asset policy have occurred since the last version was issued in March 2003. This will be subject to review, including a financial and safety risk assessment, as part of the activity of the Signalling Development Group.

The current policy aims to retain the network in a steady state condition whilst providing incremental safety and performance at an affordable cost. This will be achieved through the adoption of a route-based approach to signalling renewals, using standardised equipment and providing a development path for the implementation of the European Rail Traffic Management System (ERTMS). The benefits of the move from condition-based renewals of individual interlockings to a route-based approach are discussed later in this section.

The policy will provide a long-term framework for the development and support of business critical asset types. Within each asset category the optimal number of approved products will be determined to meet business needs and to minimise acceptance and long-term support effort. In the long-term the development of standardised product interfaces will be undertaken to minimise interfacing problems between equipment from different suppliers.

Asset knowledge

There are two primary causes of asset degradation associated with the different signalling equipment types: age and mechanical wear. Wire and cable degradation in electromechanical signalling systems is primarily caused by chemical reactions between the wire conductors and the insulation, which in turn is influenced by age, temperature, and other environmental conditions. Various strategies are used to mitigate the effects of these phenomena depending on specific site conditions and remaining asset life, and a register of wire degradation sites is maintained. Mechanical wear associated with mechanical signalling systems and components is managed by component replacement and scheduled overhauls.

The availability of components is a key issue affecting the stewardship of some older systems, requiring the development of obsolescence strategies. These are being developed in conjunction with suppliers for solid state interlockings (SSI) and integrated electronic control centre (IECC) modules in order to ensure that these systems remain operational when original components can no longer be obtained.

The key components of asset information required to facilitate efficient stewardship are the asset inventory, the measurement and recording of condition, and the recording of asset fault history.

Inventory and location information

High-level information on the nature and location of signalling assets is held in the RAR database and the MIMS work management system has now been populated with more detailed asset data. A document management system is being implemented which is delivering significant improvements in the management of detailed signalling records. Currently approximately 40% of these records are in electronic format, and the remainder of hard copy records are being progressively scanned. The transition to route-based signalling renewals will enable more efficient correlation and updating of records prior to project implementation as well as providing better coordination of design activities.

Asset condition

Signalling infrastructure condition assessment (SICA) surveys are the principal method of determining the condition and estimated remaining life of signalling installations. These surveys have been undertaken independently from the maintenance contractors in order to provide impartial data in a consistent format across the network.

The surveys are conducted at two levels. Primary SICA surveys give an overview of the condition of a signalling installation. Approximately 75% of signal interlockings have already been assessed by primary SICA or an equivalent method, and we are on target for all interlocking areas on the network to be assessed to this level by the end of 2005. Further surveys are scheduled based on the initial results and are carried out more frequently as the estimated remaining residual life is reduced.

Secondary SICA assessments are undertaken at specific sites where the primary results indicate a need for a more detailed assessment. Condition assessment scores are entered for twenty-two separate components and weighted condition scores calculated, enabling the signalling engineer to determine whether targeted sub-system renewal, such as cable replacement, will be effective in extending the life of a signalling installation. If the condition of the majority of the sub-systems is poor or they cannot feasibly be life extended, then complete replacement with a new signalling system is necessary.

The SICA approach is being extended to cover level crossings with the methodology being developed to allow initial assessments to commence this year. A training programme will cover the use of the new process for level crossings and increase the pool of skilled resources available to implement all types of SICA assessment.

Fault history

Signalling fault reporting and incident logging is currently undertaken using the FRAME and SINCs systems. The data from FRAME is used to manage the real time rectification of faults, to review performance in rectifying faults and to produce trend analysis of failed equipment by site and type. The SINCs system enables incidents with safety risk implications to be analysed in greater depth. A replacement system for FRAME and SINCs, known as the Fault Management System (FMS), is in the process of being introduced. It will be capable of handling a much wider range of assets and uses MIMS data to locate assets. The greatly improved data quality in FMS will facilitate more robust real time management and subsequent analysis of events. Phase one of the project, which improved the fault control operators' interface equipment, was completed in June 2003. Phase two, which replaces the central systems, is now to be rolled out with the company restructuring program.

In cases of high-risk failures, such as wrong side failures of signalling systems and equipment, independent technical assessments are undertaken by WS Atkins. In 2002/03 approximately 250 separate investigations were undertaken as a result of a wrong side (or alleged wrong side) failure. These generated approximately 260 discrete recommendations. Whilst a few of these led to emergency action being taken to withdraw or modify equipment, the majority were minor, such as actions on equipment suppliers to modify their designs or improve quality control procedures. The key benefit (which is unquantifiable) of this technical investigations contract is in the prevention of future incidents or accidents by the timely identification and rectification of problems.

Maintenance strategy

Signalling maintenance is undertaken on a cyclical basis at prescribed intervals. We are continuing the drive to standardise maintenance regimes for signalling assets, supported by the updating of existing signalling maintenance specifications and the roll-out of MIMS, to ensure that signalling maintenance is undertaken in a consistent manner across the network. The standardisation of activities supports the establishment of common competence assessments for all maintenance personnel.

Following the national audit of IMC compliance in 2002, we are continuing to tackle the problems that were identified:

- a risk-based approach is being applied to prioritise recovery programmes where significant backlogs in activity had been identified;
- a number of engineering conversion courses covering signalling maintenance have now been completed and others are ongoing to address the shortage of skilled resources; and
- a national signalling defect management system is being developed for completion by the end of 2005.

Our maintenance strategy is to continue the move to a risk-based approach to optimising maintenance regimes for critical signalling assets, following successful trials. Analysis of the performance of critical assets such as point machines and track circuits showed that the "one size fits all" cyclic interval maintenance regime resulted in some high risk assets (e.g. frequently used points machines in heavy traffic locations) not being maintained at an optimum level for their risk profile, while lower risk assets were being over-maintained.

Limited progress has been made with the implementation of this approach during the past year, as the focus has been on the move to take direct control of maintenance and it was not considered realistic to make changes to maintenance regimes in parallel. Once the changes to existing standards and procedures necessary to facilitate direct maintenance are complete, we will focus on identifying appropriate changes to standards and procedures to optimise maintenance activities.

Route-based renewals

The aim of the route strategy is to identify the optimal time for renewing the signalling on each route or area, taking into account signalling asset condition, S&C renewal plans, infrastructure enhancement aspirations, and ERTMS implementation plans. It is planned to establish procedures and guidance for the production of signalling route renewals strategies by developing a strategy for a specific route in cooperation with the SRA and other stakeholders.

The route renewals strategy is expected to provide the following benefits:

- improving the efficiency of the signalling supply chain through a smoothed work profile, leading to reductions in unit costs;
- greater stability in long-term planning, facilitating the development of detailed design for renewal schemes, improving resource utilisation and coordination with other asset disciplines (particularly S&C renewal plans);
- standardisation of technology, maintenance activities and key competency requirements for each route as a result of common equipment types and age profiles;
- easy integration into future route enhancement and upgrade strategies, facilitating achievement of early benefits;
- supporting the selection of optimum ERTMS system configuration and implementation strategy; and
- providing a clear framework enabling alternative route prioritisation policy options to be evaluated.

The route renewal approach will result in some signal boxes and interlockings being renewed earlier than strictly necessary, while others may require life extension works beyond the assessed renewal date to ensure that the system remains in working order to the full renewal date. Each individual route renewal strategy will be subject to business case review.

We will also develop guidance and templates for the production of signalling route renewals strategies for specific routes. These will be live controlled documents in which all relevant assumptions will be recorded. High-level documentation is initially envisaged, increasing in detail as planned renewals approach.

Decision support tools

The Strategic Asset Model for Signalling (SAMS) has been used in the development of the outline signalling route renewal strategies. SAMS is a detailed model of the network, containing information about all existing signalboxes and interlockings, including the estimated residual life of the equipment collated from SICA reports. The model is used to identify the optimal time period, considering asset condition only, to renew the signalling on a route or area. The information from SAMS is imported into a P3-based programming tool, which has been used to refine the renewals plan by smoothing the resource profiles. It is intended to integrate SAMS and the P3 programming tools further, allowing changes to be made to the signalling renewals plan under strict version control in order to react to emerging needs.

At equipment or sub-system level, an optimum maintenance decision support tool based on MACRO has been developed to facilitate the production of risk-based maintenance regimes for critical signalling assets. In addition a modification business justification tool, also using MACRO, has been developed to assist maintenance versus renewal decisions. Currently this is available for some types of points and track circuits. This tool was rolled out nationally during 2003.

Technology

We have recently introduced modern computer-based interlockings (CBIs) developed by Siemens and Ansaldo which are expected to deliver efficiencies in the medium-term. Each of these pilot schemes has exceeded the anticipated budget and timeframe, primarily because of the complexity of signalling principles and safety approval processes in the UK. We are therefore working with suppliers to optimise the overall design, installation and commissioning processes for these new technologies. A number of existing standards and engineering procedures may need to be modified to facilitate this, and a study is being undertaken to identify the required revisions. CBIs will be needed to facilitate the eventual roll out of ERTMS Level 2, once the UK application is mature.

In addition, both Westinghouse and Alstom are developing second generation SSIs that will be compatible with existing equipment.

A feasibility study is being undertaken to determine the technical and economic viability of developing Regional ERTMS, a European Train Control System (ETCS) based cab-signalling system for secondary lines. Regional ERTMS is expected to be able to be applied to around half of the network, taking advantage of the ERTMS vehicle fitment needed for the high speed lines, and the GSM-R network.

We are also looking at alternative technological solutions for some regional lines, using the Fixed Telecom Network (FTN) as the main bearer for transmission of signalling data, to see whether these could offer whole life cost benefits. The affordability of any new approach that requires initial investment in renewals to deliver cost savings later will need to be considered during the interim review of signalling costs.

Axle counters are not widely used on our network, generally being limited to specific locations where reliable track circuit operation could not be achieved. However, some recent resignalling schemes have proposed the use of axle counters in place of track circuits, justified by performance and safety benefits. A safety case was developed to ensure a consistent approach to the selection of sites for axle counters, identifiying constraints associated with specific sites, and defining issues to be addressed during safety approval, operation and maintenance. The current status is that existing track circuits can only practicably be replaced by axle counters on AC electrified lines. Further analysis is being carried out on the suitability of replacing track circuits with axle counters on DC and non-electrified lines. Issues still remain with respect to the resetting of axle counters following engineering works.

Further progress has been made with the introduction of LED and fibre-optic searchlight signals, which are designed to improve signal sighting and visibility in complex areas. Fibre-optic signals were introduced on the section of line between Paddington and Ladbroke Grove during Easter 2003 and positive feedback on their effectiveness has been received from the train operators using this complex stretch of railway. LED signals are being introduced as part of the WCRM signalling renewals programme during 2004.

Our signalling new works programme team manages the production of all resignalling plans. A key objective of this team is to reduce the time taken for scheme development and approval. They use existing sources of infrastructure information such as the Infrasoft gauging system and the Omnicom video surveys in order to reduce errors and delays caused by incomplete or inaccurate asset information. Development of these systems may allow direct download to computer-based design tools, ultimately reducing design time and costs. The Infrasoft virtual reality signal sighting system will be used for preliminary signal location and for minimising the time needed by on track signal sighting committees to finalise signal positions.

Ten-year business plan

Our 2003 plan identified the need for a significant increase in signalling renewal activity to be sustained over a number of years. During the interim review process, further work on the deliverability of the activity was carried out and the profile was revised to reflect a more gradual and deliverable rate of increase in volumes over a number of years. The interim review settlement set funding for the next two years only and established a further interim review specifically focused on signalling renewals costs from 2006/07 onwards. This review will be informed by the work of the cross-industry Signalling Development Group on which Network Rail, ORR, the SRA and the HSE are represented.

In view of the further review planned over the coming months we have not made any substantive changes to the longer-term expenditure and activity projections set out in our September 2003 business plan update.

Methodology

The first two years of the plan comprise the detailed work plans developed by the regions. The third year of the plan combines the completion of the resignalling schemes in the regional workbanks with the output of the signalling route renewal strategy work. The expenditure projections in the later years of the plan have been developed centrally and reflect the route-based renewal strategy.

The plan assumes that priority will be given to replacement of life-expired existing relay interlockings on main lines, as life extension for this technology is generally not viable. Existing mechanical interlockings which are mainly located on secondary and rural lines will, wherever possible, be life extended until Regional ERTMS or similar signalling technology is available and viable to implement. A risk to this assumption is the availability of personnel competent to maintain and overhaul mechanical signalling although it is anticipated that the long-term plan will allow the industry to develop such expertise appropriate for the volumes to be maintained.

Our forecasting of signalling renewals activity is primarily driven by condition assessments that predict the remaining life of the installation and therefore the expected renewal dates. While we are moving towards the implementation of a route-based approach to renewals to programme the works in the most efficient manner, asset condition remains the key driver of the timing of renewals. This section outlines the approach to estimating signalling renewal costs in three categories:

- resignalling: complete renewals of signalling installations on a route basis;
- minor works: component or sub-system renewals; and
- life-extension works: where additional component renewals are needed to keep a system operational until full renewal is programmed.

The renewal volumes and costs in the later years of the 10-year plan have been estimated using signalling equivalent units (SEU) as the unit of volume measurement. This measure, developed from work done by the UIC, provides a fairly reliable method of estimating the costs of resignalling schemes. An SEU is a single element controlled by the interlocking e.g. signal, ground position light indicator, subsidiary signal, point-end or level crossing. A procedure has been issued which sets out the definition and use of SEUs throughout a project life-cycle.

Resignalling

The SAMS model has been used in the development of the outline route renewal strategies for the long-term plan. The model has been developed over the last two years and was used to produce renewals forecasts for the first time in the 2003 plan. It breaks the network into around 3,750 route segments which are analysed separately. These are generally between junctions and are therefore of variable size. Asset information is input to the model for all existing signalboxes and interlockings on each route segment, including the location, mileage, signal control, interlocking type, and the number of SEUs. The estimated residual life of the assets, collated from SICA condition assessments is also entered.

An initial assessment of the renewal date for each route segment in SAMS was made, taking account of the raw SICA dates and the packaging of work on adjacent route segments into appropriate delivery packages. This initial assessment in SAMS was then imported to a P3 programme management tool. Generic project profiles have been developed for costs and resources and combined with the SAMS output to allow a more detailed assessment of future workloads. Further analysis is continuing to reduce peak resource and cost demands and provide a smooth workload requirement within the capability of the supply industry.

To allow volume adjustments to be made, the initial route renewal dates have also been reviewed with the regional signalling engineers and adjusted to address particular concerns about asset condition. The results form the basis of the long-term business plan. Further refinement of the route renewals strategy will improve the robustness of the forecasts by addressing other factors including the timing of S&C renewals, enhancement aspirations and ERTMS implementation plans.

The use of the SAMS and P3 models to consolidate data across all routes allows scenarios to be assessed using alternative renewal dates to generate aggregate volume and expenditure profiles. The outputs of the model can be reviewed and analysed at network, region, strategic route and interlocking levels.

Minor works

As the components of signalling systems degrade at different rates, it is anticipated that component renewals will take place during the life of the assets to keep the system operational. Full resignalling takes place when the number of components requiring renewal renders it more efficient to replace the whole interlocking.

An estimate of these costs has been derived from analysis by Lloyds MHA of a sample of around 350 schemes on Eastern region. The detailed SICA sub-system condition scores were used to identify the works that would be required prior to the SICA renewal date and a number of generic works packages developed and costed.

Life extension works

In areas where the route strategy approach results in work being scheduled beyond the SICA estimate of remaining asset life then provision has to be made for the costs of life extension works in the intervening years to ensure that the systems continues to operate safely. These costs have also been estimated from the Lloyds MHA analysis of a sample of Eastern region schemes. The detailed SICA sub-system scores were used to identify the works that would be required and an average life extension cost per SEU for each year of life extension after the SICA date. These have been applied to the relevant resignalling schemes with the SAMS model.

Detailed workbanks for the next two to three years are generated by the regional signal engineers, from SICA assessments, audits and inspections, and periodic maintenance reports. The workbanks are validated by peer reviews undertaken by engineers from HQ and other regions. Whilst the SICA process is designed to provide an objective, consistent methodology for determining the remaining life of signalling assets, the peer review process is useful to ensure that all options have been considered. We are moving to centralised ownership of the national workbank to allow consistent prioritisation and ensure the most effective utilisation of resources across the network. The signalling route renewals strategies will provide a high level framework for workbank development.

Expenditure

The table below summarises the expenditure forecast for signalling renewals. It reflects a steady ramping up of activity over the period of the plan.

Figure 9.15 Signalling renewal expenditure

£m (2003/04 prices)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Signalling	301	376	421	500	524	540	629	740	777	761

Activity and unit costs

The forecast volumes of resignalling activity in the later years are derived from the SAMS modelling work which identifies the number of SEUs. The scope, timing and prioritisation of these works will be reviewed in detail over the coming months. The expenditure forecasts for the next two years are derived from regional workbanks. Specific schemes being undertaken over the next two to three years are detailed in the Route Plans.

A unit cost of £270,000 per SEU was applied to the resignalling volume forecasts to produce the long-term expenditure forecasts. This unit cost was established in 2003 by dividing the outturn costs of a number of recently completed resignalling schemes by their respective number of SEUs. The plan has not taken account of further analysis undertaken during the interim review process that was informed by the costs of the West Anglia Route Modernisation (WARM) project work. Unit costs will be a key area for refinement during the further review of the signalling strategy and expenditure.

Costs associated with any scheme are those related directly and essentially to the provision of the signalling element of the scheme, and therefore exclude non-signalling telecommunications costs, customer information systems, track alterations other than work associated with insulated rail joints, and safe cess pathways. The costs of related construction works, i.e. signal structures and bases, are included. The schemes used to derive the unit rate all used SSI technology and had relatively high SEU densities. Further work will be needed to establish unit rates for resignalling schemes that use other technologies or have fewer SEUs over longer distances.

Signalling investment demands specialist skills, the use of which must be optimised and developed to ensure future sustainability for the signalling renewals programme. While the overall volume of signalling activity has reduced recently following the successful completion of the TPWS fitment programme, there are constraints in some areas of the supply industry and over capacity in other areas. We are working with our suppliers to understand existing resources, develop the skills base, review existing processes and optimise the number of competent staff, thereby ensuring the most efficient use of design, testing and implementation resources across the industry to meet the demands of the signalling renewals plan.

The further development of the long-term signalling renewals plan provides clarity on future volumes allowing the supply chain to determine future resource levels to provide market sustainability. It is envisaged that with our signalling new works programme team developing scheme designs, a move to a greater use of fixed price contracts will be possible, although options remain for other contract arrangements should these be demonstrably cost effective.

Outputs

Our signalling renewal plans are consistent with meeting the regulatory output targets. Whilst the signalling condition index has yet to be baselined, our renewal plans are consistent with ensuring that the average condition of signalling assets does not deteriorate and that the number of signalling failures does not increase. Our ability to quantify the impact on the signalling condition index will improve as the quantity and accuracy of the data contained in the SAMS model improves.

The table below shows our forecast of the overall number of signalling failures causing more than ten minutes of delay, and the total number of failures of points and track circuits. These outputs are not directly driven by signalling renewals and will be influenced more by targeted maintenance activity and changes informed by the root cause analysis undertaken through the performance improvement action plan.

Figure 9.16 Signalling output measures

Year	2004/05	2005/06	2006/ 07	2007/ 08	2008/ 09
Signalling failures (>10 mins)	28,950	28,900	28,825	28,775	28,750
Points/track circuit failures	20,190	19,980	19,770	19,560	19,360

Commentary

Our plans will be subject to detailed review by the cross-industry Signalling Development Group during the coming months. This review will cover the underlying strategy, the robustness of the forecasts of activity and expenditure, and the deliverability of the plans. This work will inform the Regulator's interim review of signalling expenditure requirements from 2006/07 onwards.

The development of the SAMS and P3 models over the last two years represents a significant step forward in our forecasting capability by consolidating all the SICA assessment data from the regions into one model and supporting the development of the route-based renewal strategy. The current plans are therefore underpinned by reasonably comprehensive and consistent condition assessments. The deliverability of activity in the early years of the plan has been assessed, both in terms of our ability to develop complex renewal schemes and the supply industry's capacity to implement them.

A key issue will be to avoid any negative impact on network capability that resignalling to modern safety standards might cause. A resignalled line will not necessarily provide the same capacity and throughput as before as modern signalling principles tend to be more restrictive. The integration of signalling and track renewal plans is also critical to ensuring synergies between signalling design and track layout changes. Where appropriate, we are reviewing and challenging standards where they appear to be adding disproportional costs or capacity reductions.

Another key issue for the signalling plan is the WCRM project which accounts for a significant part of the current level of signalling activity and remains the subject of review of the precise scope and timescale. Final decisions on the WRCM project may have a significant impact on the scheduling and deliverability of other signalling renewals.

Electrification and fixed plant

Asset stewardship strategy

Objectives

The key objectives of the plan for electrification and fixed plant (E&P) assets are:

- to reduce the number of incidents caused by overhead line, or conductor rail failure that result in train performance delays in excess of 500 minutes to 133 by 2008/09;
- to maintain asset condition profiles for AC and DC electrification systems at 2001/02 levels;
- to keep all operational electrification and fixed plant in a safe condition; and
- to maintain the existing electrified route capability.

The current condition and age profile of some electrification assets, particularly distribution equipment, is such that substantial increases in the volumes of renewal activity are required over the period of the plan. This was acknowledged during the interim review process with a significant increase in funding over the next five years allowed in the Regulator's determination of access charges.

Asset overview

The full range of mechanical and electrical assets within the E&P portfolio range from high voltage (HV) electrical distribution equipment associated with traction power supplies, through overhead line and conductor rail contact systems, to a diverse range of mechanical and electrical plant including signalling power supplies, points heating equipment, depot plant and other operational equipment.

Electrification assets

Approximately 40% of the rail network is electrified and 60% of all rail traffic is electric powered. Two distinct electrification types are employed: 25kV AC overhead line electrification (64%) and 660/750V DC conductor rail electrification (36%). We also operate and maintain a 1500 V DC overhead line electrification network constructed for the Sunderland Direct project.

The electrification asset portfolio includes:

- overhead line equipment including structures, wiring, support and registration;
- conductor rail equipment including third/fourth rail, ramps, insulators and trackside cables;
- electrical distribution equipment including HV switchgear, HV cables, transformers, rectifiers and DC switchgear;
- grid supply points, connections to dedicated distribution network operator (DNO) and National Grid Transco (NGT) supply points; and
- supervisory control and data acquisition (SCADA) systems: to control and monitor the status of the electrification equipment.

The figure below summarises the volumes of some of the key assets.

Figure 9.17 Electrification assets

Strategic element	Description	Units	Volume
25kV AC electrification			
Overhead line equipment (inc structures, foundations, wiring and registration)	Length of system employed (inc sidings and depots)	Single track km	8,652
Distribution equipment	High voltage switchgear	Number	1,876
	High voltage cables	Km	500
	Booster transformers	Number	2,366
Third rail DC electrification			
Conductor rail equipment	Conductor rail	Single track km	4,847
Distribution equipment	High voltage switchgear	Number	1,477
	High voltage cables	Km	1,947
	Transformer rectifiers	Number	483
	D.C. switchgear (660 - 750V)	Number	3,930
1500V DC electrification			
Overhead Line equipment	Length of system employed	Single track km	38
Electrification System			
Grid supply points	Infeeds	Number	112
SCADA	Electrical control rooms	Number	14

Overhead line 25kV AC electrification system

The 25kV AC electrification system derives power from the high voltage national electricity transmission and distribution networks owned and operated by NGT and the DNOs. At each supply point located along the railway the energy is distributed along the track by means of overhead line equipment. The electrification system is divided into sub-sections by trackside switching stations that comprise a number of 25kV circuit breakers. Additional electrical sectioning is provided by means of section insulators, insulated overlaps and neutral sections. The electric trains collect current using roof-mounted pantographs, which make sliding contact with the contact wire suspended from the catenary wire. The security of the incoming electricity supply is paramount and duplicate circuits, each capable of supplying the traction load, are provided in most cases.

Third rail DC electrification system

The design of the DC conductor rail electrification system originates from the 1930s. It derives power from the high voltage national electricity distribution network. The power is distributed to substations via a high voltage cable network, usually contained in a concrete trough route adjacent to the track. At each substation, the voltage is transformed down, converted to 660/750V DC using rectifiers, and distributed along the track via the conductor rail. Trains are fitted with current collector shoes that make contact with the top surface of the conductor rail. After passing through the train the current flows back through the running rails until it is returned to the rectifiers in the traction substations.

Fixed plant assets

Fixed plant consists of a diverse set of assets, which are summarised in the figure below. These assets are accounted for in the plan under the heading "Plant and machinery", but for stewardship purposes they fall within Electrification and Plant. The two assets that have the greatest effect on the reliability of the operational railway are signalling power supplies and points heating.

Figure 9.18 Fixed plant assets

System	Component
Signalling power supplies	Diesel generator sets
	Uninterruptible power supplies (UPS)
	Low voltage switchgear and cables
	LV electricity supply from DNO or derived from traction power system
Points heating	Gas heaters and associated control equipment
	Electric cartridge heaters and associated control equipment
	Electric strip heaters and associated control equipment
	Gas and electricity supply and distribution equipment
Other major plant	Pumping stations
	Swing bridge mechanical and electrical systems
Depot plant	Wheel lathes, carriage washers, depot cranes and jacks, vehicle turntables

Asset policy

The electrification and plant engineering policy published in January 2002 outlines the technical requirements for effective maintenance and renewal of the E&P asset portfolio. The plan is based on the application of this policy and addresses a number of key challenges:

- the effective management of the renewal of electrification assets such as power transformers, cables and switchgear, which, if not addressed, will ultimately lead to unacceptable deterioration of safety and reliability of the network;
- the obsolescence of ageing assets which can make continuing maintenance regimes unsustainable;
- the level of disruption caused when electrification and plant is taken out of service for renewal whilst trying to maintain acceptable network performance and reliability;
- environmental issues concerning the use of oil as an electrical insulator;
- the management and removal of asbestos from switchgear and other assets;
- the increased operational demands on the infrastructure resulting in fewer opportunities to gain access/possessions for maintenance and renewal work; and
- the ability of the wider industry supply chain to deliver the increased renewal volumes.

The engineering policy will be updated to reflect the management of our high voltage distribution assets using age as a proxy for condition. Initially applied to HV switchgear, this approach has been extended to cover other distribution assets where asset degradation is strongly correlated with age, including DC circuit breakers, transformers/rectifiers and HV cables.

Asset knowledge

The degradation mechanisms for electrification and plant assets, and hence the asset information requirements, are varied. These are discussed below in relation to each key asset grouping.

The electrification condition assessment process (ECAP) has been developed for a number of assets to provide a consistent condition score. ECAP requires annual inspection and recording in a standard format of a proportion of the selected assets to provide a complete and representative condition assessment over a 5-year period. Average condition scores are reported in our annual return.

The move to take direct control over maintenance will facilitate the collection of more robust data on the condition and capability of our assets, through more effective specification of requirements and management of inspection activity.

Overhead line equipment

The life of overhead line equipment (OLE) is related to a number of factors including traffic frequency, traffic speed, magnitude of load current, environmental conditions, and outside party influences. Wear measurements indicate that the life expectancy of the overhead contact wire can be anywhere between 40 years and 100 years depending on traffic patterns and number of pantograph passages. The relationship between these factors is complex.

There are several generic designs of OLE in use on our infrastructure and there are a number of common failure modes that are associated with each design. Any identified weaknesses and failure modes are added to the national programme of "campaign changes" which manages the systematic removal of the weaknesses from the system.

Pantographs are a major interface between our infrastructure and rolling stock. Pantograph condition monitoring is undertaken using Panchex in order to prevent damage to the OLE by poorly adjusted equipment. We investigate the root cause analysis of OLE incidents where poorly maintained or damaged pantographs are involved, and work with train operators to improve inspection and maintenance procedures to the benefit of overall system performance. The MENTOR (mobile electrical network testing, observation and recording) vehicle is currently used to monitor and record the dynamic current collection performance of the overhead contact system, using an instrumented pantograph.

Conductor rail

Steel conductor rail deteriorates through corrosion, wear caused by the current collector shoe of the train, and the passage of electric current. It is necessary to ensure that the rail is physically sound and that its electrical resistance does not increase to an unacceptable value. Renewals are currently programmed based on gauge measurements. A profile gauge is used to measure the percentage of loss of the cross sectional area of the rail every ten years. The measurement frequency is increased to five years when the rail is found to have lost more than 20% of the original cross sectional area. On reaching 25% loss the rail is programmed for renewal, subject to an increased regime of electrical integrity checks.

At present there are insufficient records of gauge loss due to wear to enable route specific long-term renewal plans to be determined. On Southern region, which manages the majority of conductor rail assets, plans are being put in place to undertake a comprehensive conductor rail gauging survey by 2006/07. As part of this survey, options to increase understanding of rail degradation quickly through regular measurement at a set number of strategic gauging points will be evaluated.

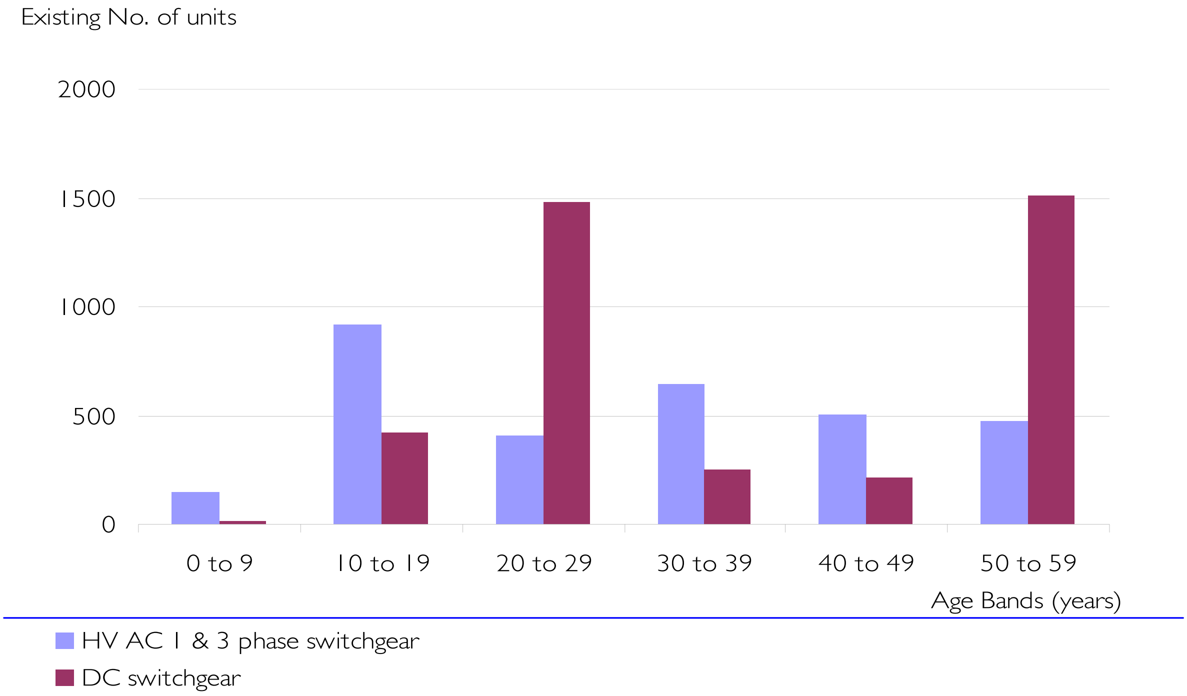
Distribution equipment

The life of electrification distribution system equipment is largely age-related and is independent of traffic volumes, assuming that load growth is controlled within the given rating of the plant. The extent of asset degradation is difficult to monitor from visual inspection. Asset failures tend to be catastrophic and it is not feasible to wait to observe gradual degradation in the form of declining performance or increased maintenance requirements before renewal.

In addition to visual inspection, other methods of assessing the degradation of electrical distribution assets include partial electrical discharge testing, switchgear trip time measurement and transformer dissolved gas analysis. The use of these forensic techniques will be evaluated further, and may be used to refine our approach to managing HV distribution assets. However, until robust techniques for measuring degradation are established, the assets will continue to be managed using age as a proxy for condition.

HSE guidance on the life of HV distribution switchgear indicates that plant achieving 35 years service should be considered for replacement because of the risk of catastrophic failure arising from insulation breakdown or mechanical failure. Much of our HV distribution switchgear is already more than 35 years old. The age profile for HV single and three phase AC and DC switchgear is shown below.

Figure 9.19 Age profile of DC & HV AC switchgear



During the last year we have focused on improving the accuracy of our inventory data for asset types, volumes and installation dates. We are also developing a methodology for assessing overall asset condition on the basis of a variety of factors including age, maintainability, type and configuration of equipment, operational history and local environmental factors. This methodology will be used to supplement ECAP in deciding on the prioritisation of renewals. In addition, we are undertaking a major survey of these assets in the Southern region to provide a benchmark of the condition, using visual inspection and intrusive testing techniques. The initial results of this survey are expected shortly.

Grid supply points

Energy for electric trains is delivered to the railway from dedicated DNO and NGT supply points. The management of these supply points, for which we are the sole user, is currently the responsibility of the DNOs and NGT. The lack of information over the condition and management of the DNO assets, which are critical to the operation of the railway, has been a significant cause of concern following the premature failure of some transformers. We are working with the DNOs to understand the root cause of these failures and assess the risks to other assets.

We are also working to ensure that the next generation of connection and maintenance agreements will require the DNOs to carry out an agreed maintenance regime and provide condition reports to enable us to develop a greater understanding of the condition of the assets and the likely future costs. We anticipate that revised connection agreements will be in place by April 2005.

SCADA equipment

The purpose of the SCADA system is to control and monitor the status of the electrification equipment that supplies electrical energy to the overhead line and conductor rail. A modern SCADA system is housed in an electrical control room and comprises:

- master station computers and workstations;
- a communications network (managed as a telecommunications asset); and
- remote terminal units, which interface with the remote equipment that is monitored and controlled.

Four of our ECRs use electro-mechanical relay technology introduced in the 1950s. Replacement parts for this type of equipment have now become difficult to source and the equipment is in need of renewal. The remaining ten control centres were installed between 1980 and 2001, but the rapid changes in hardware and software platforms have rendered some of the older equipment obsolete and in need of replacement.

Fixed plant

Signalling power supplies deliver electricity to trackside signalling installations at approximately 450 locations across the network. Diesel generators are installed at over 300 locations to provide a standby supply in case of failure of the normal electricity supply. Recent years have also seen the introduction of UPS equipment, which prevents the loss of signal supplies during the changeover of power supplies.

The degradation of signalling power supply assets is principally a function of age, with life spans typically in the range 20-25 years, subject to adequate maintenance and mitigation against mechanical damage. In particular, the performance of UPS systems is dependent on the condition of the batteries, which must be inspected and replaced at regular intervals.

Points heaters are fitted to many points installations to prevent them from freezing during cold weather. The use of electric strip heating has proved to be the most effective solution for most locations, although it is not always cost-effective in rural locations where an electricity supply is not readily available and gas point heaters are used instead. The equipment is not operated or monitored continuously. The life of the point heating installation is considered to be 15 to 20 years before major refurbishment is required.

The service life for HV non-traction systems is approximately 35 years when properly maintained. The majority of these installations are now being de-commissioned and replaced by dedicated DNO supplies, but it is likely that we will retain a small number of these assets.

Other plant assets

Pumping stations are provided at rail tunnels under rivers to remove water and prevent flooding, but are also provided at other locations to ensure adequate track drainage. They range in size from the Severn tunnel (25 million litres per day continuously) to a small bridge trackbed de-watering plant at Stratford (up to 700 thousand litres per day intermittently).

There are a number of swing bridges over waterways on the network with mechanical and electrical operating systems. These are designed for a 25-year life under normal maintenance. The structural elements of these bridges are managed within the structures portfolio.

Depot plant includes wheel lathes, which are used to ensure correct wheel profile of trains and interface with the rail. Depots also contain carriage washers, cranes, jacks, turntables, and often HV distribution systems, comprising of distribution switchgear, transformers, and cables. Some of the older installations use bulk oil switchgear, which is no longer commercially available.

Maintenance and renewal strategies

The current maintenance strategies for E&P assets are varied. They are based on existing company standards and have all been assessed against relevant electricity industry standards.

The rollout of MIMS is providing greater visibility of volumes and unit costs for inspection and maintenance. MIMS will be baselined against the current maintenance strategy, and the MACRO optimisation tool will be used to assess and identify any required adjustments. This will allow informed decisions to be made as to whether current regimes need to be challenged. The maintenance strategy will be revisited once the current work on MIMS and its associated work items for inspection and maintenance have been completed.

In view of the fact that electrification equipment is prone to sudden, occasionally catastrophic failure, rather than gradual deterioration in performance, great care must be taken to ensure that critical items, such as electrical distribution switchgear and transformers, are replaced in a timely manner. This is particularly important as some assets have long lead times for the procurement of replacements.

Due to the infrequent and specialist nature of major electrification equipment renewals, suppliers and designers suffer from highly irregular order cycles, which do not encourage steady development of equipment or maintenance of skills. Long-term relationships with selected manufacturers and suppliers need to be developed in order to deliver consistent asset replacement, enhancement, and ongoing support.

Decision support tools

We have developed a model to quantify the business benefits of retrofitting UPS installations to existing signalling power supply systems.

The strategy for future development of decision support tools and associated engineers degradation models will be considered in more detail over the coming year, in the light of the further work on developing measures of condition described above.

Technology

We are currently assessing electricity supply industry standard gas-insulated switchgear to determine its continued suitability for HV distribution asset replacement for rail network use, in the light of the experience gained with structure-mounted outdoor switchgear.

We will work with the electrical equipment supply industry to promote the reintroduction of air insulated vacuum modular switchgear. This has a proven reliability record verified by the performance of the equipment installed during the 1980s. Both this and anticipated lower manufacturing costs should lead to a reduction in expenditure.

We are currently developing a new system design to replace the existing Mark 3b OLE in areas which are targeted for renewal and are developing proposals for a trial site on the East Coast Main Line which will be completed in 2004. The new design will employ a copper-based catenary and contact wire system. Depending on the results of the trial, we will evaluate the business case for further application consistent with the national campaign change programme.

Overhead line inspection vehicular equipment (OLIVE), which is still under development, measures the dynamic forces and the interaction between the overhead line and the train pantograph, and is used to identify inconsistencies in the overhead lines. We are undertaking trial fitments of the equipment to service trains with a view to using the data to target maintenance activity effectively.

A high speed recording system to assess the spatial arrangement of overhead line equipment without the requirement to undertake inspections on the line is being developed. It is hoped that advances in this work will ultimately provide a replacement for MENTOR.

We are developing a system that facilitates the reconfiguration and changeover of signalling power supplies during maintenance. Additionally, the unreliable electro-mechanical voltage regulators that were used to condition the signalling supplies derived from the traction network are being replaced by modern static UPS equipment.

Ten-year business plan

Overview

The 2003 Technical Plan set out a comprehensive 10-year strategic plan for renewal of electrification and plan assets for the first time. The plan highlighted the need for significant increases in activity to address the operational and safety risks associated with the ageing asset portfolio. The plan was subject to independent review by MVA/Systra as part of the interim review process. This review resulted in a broad endorsement of the projected renewal volumes, as well as raising valid challenges over unit costs, and the funding provided for the next five years reflects this. The longer-term plans have therefore not been the subject of any significant change and our attention has focused on the prioritising of activity over the next three years.

The overall level of electrification renewals and enhancement activity over the period of the plan will be significantly influenced by two major projects:

- West Coast Route Modernisation (WCRM); and
- Southern Region Power Supply Upgrade (SRPSU).

This section does not cover these enhancement works, which are described in the Route Plans document. Both projects may be subject to further review, which may have implications for the rest of the renewals plan. The majority of overhead line renewal activity up to 2006 is being carried out under the WCRM project. Future overhead line equipment renewals will be programmed on a national basis to ensure that the best use is made of the skilled resources.

Methodology

As noted above, the E&P asset portfolio covers a diverse range of assets. The approaches taken to forecasting the long-term activity and expenditure requirements vary accordingly and can be broadly summarised as follows:

- OLE plans are largely built "bottom-up" from specific schemes for systematic component replacements (campaign changes) and workbanks for major renewals;
- conductor rail renewal plans are based on a steady state level of renewal derived from assumed average asset service life of 80 years;
- distribution asset renewals are also based on assumed service lives, together with maximum service life limits for specific assets (including HV switchgear) to ensure that safety risks are adequately controlled; and
- other electrification assets and fixed plant asset plans have been developed "bottom up" on the basis of assumed asset service lives.

These are discussed in more detail below.

The regional renewals work banks for the next three years are developed at regional level from the results of inspections, including the use of the MENTOR coach, and have been validated by peer reviews undertaken by HQ engineering to ensure that the renewals are prioritised on a consistent basis and that decision-making is robust and in accordance with the engineering policy and standards.

Overhead line equipment

Our renewal strategy for OLE support and registration equipment is based on life extension through component replacement in order to maintain safety and performance without major intrusive works. There are several generic designs of OLE in use on our infrastructure and there are a number of common failure modes associated with each design. Identified weaknesses causing failures are managed through "campaign changes", under which particular components are systematically replaced, typically over a number of years. Our strategy for electrification structures and foundations is for life extension through regular painting and timely repairs.

In some cases, it may be necessary to undertake complete refurbishment or renewal of a contact system. We are planning the complete renewal of the Mark 2 overhead contact system between Glasgow (Shields) and Gourock, where performance is poor. This approach is being taken due to the obsolescence of components, the route having been electrified with non-standard prototype components in the 1960s, which makes life extension inappropriate. It is planned to carry out this project by 2007/08. Significant wiring refurbishment is also programmed on elements of the West Coast routes not covered within the WCRM project, and we are currently developing a detailed strategy for refurbishment and renewal of the ECML contact system.

Conductor rail

In view of the limited data on rates of wear, the long-term forecasts of renewal volumes are based on an assumed average asset service life for conductor rail of 80 years. Given the current total of over 4,800 km of conductor rail, the plan translates the assumed life into a steady state renewal rate of 1.25% per annum, equivalent to about 60kms of rail. This represents a significant increase on recent volumes so we plan to increase activity progressively over the period of the plan.

Distribution equipment

HV distribution switchgear is critical to delivering the overall safety and reliability of both the AC and DC electrification systems employed on our infrastructure. The renewal strategy must ensure that replacement of these assets is correctly planned in order to continue the operation of the railway. Under the original electrification schemes of the 1950s and 1960s large volumes of HV electrical distribution equipment were installed over wide geographical areas in short periods of time. Much of this is still in service after 50 years and in urgent need of replacement.

As noted earlier, HSE guidance states that oil-filled switchgear older than 35 years old presents an increased risk of catastrophic failure, resulting in serious injury or death, and should therefore be considered for replacement. Much of our switchgear is already older than this.

Our long-term renewal plans are based on asset service life assumptions using average age and maximum asset age criteria as follows:

- no single oil-filled HV switchgear asset should remain in service longer than 60 years. This target will be continuously reviewed in line with asset stewardship reports; and
- maximum service lives for other HV switchgear assets are assessed in accordance with asset stewardship reports, but should not normally exceed 35 years.

A similar approach has been adopted for other distribution assets, including transformers and DC switchgear. The table below summarises the key asset service life assumptions.

Figure 9.20 Service lives for distribution assets

Asset type	Unit	Nominal Life (Years)	Maximum Life (Years)
HV switchgear, 25kV: oil-filled circuit breaker	No	35	60
HV switchgear, 25kV: vacuum circuit breaker	No	30	35
HV switchgear, 25kV: other	No	20	25
Booster transformers	No	30	35
HV switchgear, third rail: oil-filled circuit breaker (indoor)	No	35	60
HV switchgear, third rail: oil-filled circuit breaker (outdoor)	No	35	40
HV switchgear, third rail: vacuum	No	30	35
HV cables, third rail: oil-filled	km	55	60
Transformers/rectifiers	No	45	60
DC switchgear	No	45	60
Cables +ve/-ve	km	35	35
Grid supplies	Site	40	40

The maximum service lives are based on safety risks and the targeted nominal service lives are based on professional judgments. These assumptions were subject to independent review during 2003 by EA Technology, consultants with expertise in asset management in the electricity supply industry, who considered them to be reasonable. These asset life assumptions are combined with data on the age profiles of the equipment to derive the renewal plan, taking account of the realistic maximum number of renewals that can be delivered in a single year given the constraints of the supply chain, power system configuration and access to the network. The renewal programmes are profiled such that no asset exceeds the maximum life.

As an illustration of the approach, the asset renewal strategy for renewal of HV distribution switchgear assets on Southern region is set out below. The following table illustrates the age profile and populations of the 3-phase AC HV distribution switchgear types on the Southern region DC electrification network.

Figure 9.21 HV AC switchgear age – Southern region

Switchgear Type	Average Age	Population
Gas insulated switchgear	12	163
Sulphur hexafluoride (SF6)	12	125
Vacuum	16	40
Oil-filled JB424	30	307
Oil-filled K4	37	52
Oil-filled MF36	49	168
Oil-filled KA	50	32
Oil-filled KC	50	294

The renewals phasing for two types of AC HV switchgear used on the Southern region DC electrification system is set out below. These represent the two extremes in terms of age and remaining life. The ultimate asset life of each type of switchgear will be kept under continuous review in line with regional asset stewardship reports, and the phasing of renewals adjusted within the bounds of the prescribed policy. The age-based policy requires that:

- replacement of KC oil-filled switchgear (294 units, average age 50 years) should commence in 2004/05 and be completed by 2013/14, with the next renewal cycle commencing in 2038/39; and
- replacement of sulphur hexaflouride (SF6) distribution switchgear (125 units, average age 12 years) should commence in 2023/24 at the rate of 25 units per annum for 5 years, with the next renewal cycle commencing in 2058.

Power is distributed through the rail network via high voltage cables. A high proportion of these are ageing oil-filled pressurised cables, which are now susceptible to leakage. A programme is underway to replace these cables.

Grid supply points

A life expectancy assumption of 40 years has been made for the renewal of grid supply point assets.

SCADA

The plan provides for the replacement of the four electro-mechanical SCADA systems over the next eight years.

Fixed plant

The plan for fixed plant assets has been developed using assumptions about expected asset service lives in conjunction with asset inventory data and unit costs derived from recent experience.

Signalling power supply assets are assumed to last 20 to 25 years. They are often renewed in parallel with resignalling projects and the plans have therefore been developed in association with the signalling plans. UPS equipment will be installed on a selective basis to improve security of supply to signalling equipment where a robust business case can be demonstrated.

Points heating installations are assumed to last 15 to 20 years before major refurbishment or renewal is required.

The age-based approach described above for HV distribution switchgear assets has also been applied to other HV plant. The service life for high voltage non-traction systems is approximately 35 years.

Expenditure

The table below summarises planned expenditure on electrification and fixed plant. [Note that expenditure on fixed plant is accounted for in under Plant and Machinery in the business plan]. The forecasts for the early years of the plan are consistent with asset policies, but volumes will be constrained by access limitations (possessions and electrical outages). The table below summarises the output of the plans compiled using the methodologies above.

Figure 9.22 Electrification and plant renewal expenditure

£ m (2003/04 prices)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Electrification	47	60	88	91	86	95	93	91	89	87
OLE	22	25	30	32	20	22	21	19	17	20
Conductor rail	6	5	5	5	6	12	13	13	13	13
AC distribution	6	7	16	15	15	14	15	12	13	9
DC distribution	11	19	31	31	39	45	45	46	46	45
SCADA	3	4	6	9	6	2	0	2	0	0
Fixed plant	23	19	26	25	24	23	23	22	22	21

Activity and unit costs

The E&P plan covers a wide range of renewal activities with a variety of measures of activity volume. Some of the key volumes are summarised below.

Figure 9.23 Electrification activity volumes

		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
AC Systems											
HV switchgear	No	12	22	58	82	146	120	123	76	93	75
Booster transformers	No	25	12	14	8	12	-	75	47	50	54
25kV cable	Km	3	8	7	5	-	10	6	1	2	-
OLE rewiring – tension lengths	No	26	104	150	252	176	207	191	203	167	195
DC Systems											
HV switchgear	No	11	25	67	85	101	107	105	103	98	95
HV cables	Km	6	38	59	24	36	48	53	58	61	61
Transformer/ rectifier	No	4	7	23	22	31	33	33	33	33	33
DC switchgear	No	-	36	60	94	165	207	214	216	220	220
Conductor rail	Km	15	21	34	21	36	64	67	67	73	73

We do not yet have robust unit cost data to support our long-term plans. This is partly because, in recent years, there has been little or no renewal of assets, such as switchgear, which form a substantial element of activity over the coming years. The activity being undertaken for the Southern Region Power Supply Upgrade will be a key source of information on the unit costs of switchgear replacement.

We are currently developing cost models for E&P renewals, based on the roll-out of a new estimating package. It is anticipated that this will become the primary mechanism for capturing renewals unit costs as part of the development and investment review process for capital projects. The underlying cost drivers will be analysed in detail. A key part of the process is the establishment of common units of renewal activity. Further analysis will focus on the asset categories with the highest forecast spend over the next three years.

Outputs

The electrification maintenance and renewal activity volumes assumed within the plan are expected to meet the following output targets:

- no reduction in network capability, defined as the number of single track kilometres electrified;
- a reduction in the number of power supply failures causing more than 500 minutes of delay to no more than 130 per annum over the period of the plan; and
- no deterioration of average asset condition levels from 2001/02 levels throughout the period of the plan.

Commentary

The replacement or life extension of high voltage distribution assets and sub-station equipment such as circuit breakers and protection equipment is a significant challenge for the industry. Much of our existing infrastructure comprises old technology, where neither wholesale replacement nor continued maintenance on a like-for-like basis will be easy to achieve. Considerable work is also required on the replacement of oil-filled switchgear and cables.

We are developing partnership frameworks for the delivery of programmes of similar work over five or more years, such as HV switchgear renewals. This will encourage efficiencies and growth of the supply base and ensure continuity of support. These will be supplemented by procurement under competitive tender for specific packages of work, and call off contracts for minor works where there is limited design content. Suppliers have welcomed the greater transparency of future activity offered by our 10-year plans which is now supported by greater certainty over funding following the interim review.

We are establishing a national electrification and plant renewals programme team. This will help us to optimise the flow of work, enabling the continuous use of key specialist resources, and to maintain a sustainable level of in-house expertise. It will also support the identification of skill shortages in respect of future requirements in order that action can be taken to match supply with demand. The project management of electrification and plant renewals and enhancements will have strengthened leadership with expertise concentrated to support delivery in specific technical areas, including OLE, switchgear replacement, third rail/DC traction renewals, SCADA and fixed plant.

It will be essential to develop a robust outage strategy for renewals on the electrical distribution network. The programming of this activity will be constrained by the ability to take the electrical plant out of service without affecting the reliability and availability of the overall electrifications system.

The primary risk of deferring renewals of HV distribution plant beyond the maximum asset life is that there will be an increased risk of catastrophic failure resulting in potential safety hazards from fire, explosion or electrocution. If we cannot comply with the policy requirement to keep the age population within safe limits, then the equipment will need to be taken out of service with the resultant performance implications.

Telecoms

Asset stewardship strategy

Objectives

Our telecoms engineering policy is to procure, operate and maintain our telecoms assets such that the telecom services provided are consistent with the operational and business needs of a modern railway. There are no specific output targets for telecoms assets, but safety factors are a key driver of serviceability requirements.

The planned expenditure on telecoms renewals over the next ten years is dominated by one major project which consists of:

- the installation of a new national Global System for Mobile Communications for Railways (GSM-R) radio system which will provide secure voice and data communications over the whole of our infrastructure. GSM-R is also necessary to support the proposed adoption of the European Rail Traffic Management System (ERTMS) train control system; and
- the installation of a new national Fixed Telecom Network (FTN) to replace the existing life-expired network, and to support GSM-R and our operational and business telecoms needs.

Asset overview

There are three major components to our telecommunications network:

- bearer network;
- analogue radio networks; and
- fixed lineside systems.

The existing bearer network comprising transmission systems, optical and copper cables provides circuits for signalling and electrification control systems, train radio systems, lineside communications, level crossing CCTV and customer information systems (CIS), as well as more general information technology systems and business telephony needs.

At the time of privatisation, the majority of telecoms assets (optical fibre cables, copper cables, transmission systems and telephone exchanges) were leased to British Rail Telecom (now Global Crossing). The use of individual circuits is sold back to us under a linked Grant of Use (GoU) agreement. We also own and maintain some cable and transmission systems installed after 1994 to support resignalling schemes. The leased assets, with the exception of the optical fibre cables, will revert back to our ownership by April 2005, by which time much of the equipment will be life-expired. This will require new maintenance arrangements to be adopted from April 2005 and new contracts with Global Crossing for buying and selling capacity.

One of the drivers for the introduction of the FTN is the reduction of the GoU charges by transferring circuits off the leased network to the FTN. This cost reduction will commence in 2006/07 and will continue in line with the FTN programme until 2013/14 when circuit migration will be complete and charges will have reduced substantially.

We operate three analogue radio networks comprising base stations, antenna systems and control equipment supporting the National Radio Network (NRN), Cab Secure Radio (CSR) and Radio Electronic Token Block (RETB) systems. The NRN provides national trackside and trainborne communication, CSR provides secure communication between drivers and signallers in specific areas, and RETB provides data communication for single line token exchange as well as voice communication.

Fixed lineside systems provide communication between the signallers, drivers and the general public through telephones located at signal posts and level crossings. CCTV systems are provided on platforms where driver-only operation (DOO) services are operated and at some stations with sub-surface platforms. CIS and public address (PA) systems are provided at many stations including those leased by train operators.

Asset policy

Our Telecoms engineering policy was issued in December 2001. It is being updated to list the key objectives that will contribute to the achievement of our corporate objectives and will be reissued in the summer of 2004.

A substantial amount of work on company standards has been completed with 13 new or revised standards developed and published in the last year. These standards have focused on safety-related issues, such as:

- remedial action on the positioning and labelling of lineside telephones;
- the response to booster transformer outages to protect telecoms staff from the possibility of electric shock;
- reinforcing the requirements for management of safety related telecoms failures; and
- protecting the operational infrastructure from the potential effects of radio antenna systems.

Other issues addressed include:

- improving the management regime for critical equipment, such as inspection and surveillance of telecoms engineering activities, and the definition of network terminating points for maintenance activities; and
- the establishment of performance and design requirements for critical equipment such as radio mast lightning protection and earthing systems.

The new telecoms maintenance testing handbook was published in 2002 to ensure that operational maintenance follows good practice from the telecoms and signal engineering industries. It is planned to update this following the first year's experience.

Similarly, we want to ensure that all newly installed telecoms equipment performs to specification from day one. We are therefore developing a suite of standards, which will apply the principles of the new group standards being produced by RSSB, across a range of activities from system design through to the testing and commissioning of operational systems, for implementation in winter 2004. The standards produced will follow good practice from the telecoms and signal engineering industries.

As part of the company-wide Guide to Railway Investment Projects (GRIP) initiative a telecoms renewals manual was launched in autumn 2003. The purpose of this document was to define the key components required and provide a route to deliver efficiencies by using a repeatable process and consistent best practice.

An ongoing initiative, started in 2002, is the protection of signalling and telecoms operational systems from the potential threat of electromagnetic interference (EMI) transmitted from third party mobile operators radio masts located on, or close to, our land. A new company standard was issued in February 2004 to describe the technical clearance process to assess the risk and determine a safe clearance distance for new radio masts from operational systems. We have set up an engineering forum with the Mobile Phone Operators Association to investigate engineering solutions to site their radio masts safely on our land. As part of this initiative, the operators are participating in a detailed study into the EMI effects from radio transmitters. This work will be completed in Spring 2004.

Asset knowledge

Telecoms assets degrade due to age, equipment obsolescence, component deterioration and exposure to the environment. Asset information is contained in regional databases which generally record the equipment type, approximate date of installation and life expectancy, but vary in content. Some are more developed and contain a condition assessment rating of the equipment. A national initiative to develop an asset data dictionary, bringing together RAR and local databases within the regions was progressed during 2003. The 2004/05 operational maintenance contracts include requirements for the supply of asset data for inclusion in a single national database.

Asset management will be greatly improved by the implementation of the Telecoms Engineering Control (TEC) that will be installed as part of the FTN. The TEC will provide round the clock centralised network management of both the FTN and GSM-R systems, and will collect and collate robust data at sub-asset level. Whilst our detailed plans for the TEC are still evolving, it will support transmissions systems, fibre and copper cables, telephone exchanges, GSM-R base stations and control centres.

Key functions of the TEC will include:

- asset inventory, location details and condition;
- fault detection, isolation and correction management;
- help desk;
- installation and circuit provisioning management;
- performance reporting; and
- customer management.

The TEC will be operational from 2004 as the FTN is implemented.

The following tools are used by regional engineers to assist in the analysis of the asset condition. They are used in conjunction with stewardship reports provided by the maintenance contractors, audits, and survey reports to identify asset renewal priorities:

- TICA – Telecoms Infrastructure Condition Assessment is a condition scoring tool based on equipment life expectancy and maintainability (spares allocation, staff training and manufacturer support). It was implemented for telephone concentrator systems in November 2002;
- SINCS – Signalling Incidents System is a trend analysis tool for recording safety related telecoms failures. This tool can be used to identify life-expired or unmaintainable assets that are the fundamental cause of the failures; and
- FRAME – Fault Reporting And Monitoring of Equipment is a tool that records all telecom faults and failures.

FRAME and SINCS will be replaced with the new Fault Management System (FMS) during 2004/05. This is described in the signalling section.

The assessment of radio coverage on the existing CSR and NRN is monitored by measuring signal strength during scheduled track recording surveys. The feasibility of providing radio-surveying facilities on suitable infrastructure surveying vehicles is being examined.

Maintenance

Our maintenance strategy is based on securing improvements by ensuring full compliance with the maintenance contract requirements in 2004. The telecoms operational maintenance contracts, currently part of the IMC contracts, will operate as separate contracts for greater visibility and control in 2004/05. During the first half of 2004 we will be reviewing the future maintenance needs, comparing the costs and benefits of in-house maintenance with the option of continuing to procure this activity by territory wide or national contracts. This review will consider existing operational and network equipment, CIS/PA, NRN and new build FTN and GSM-R networks.

Life extension work has been completed on the NRN and remedial work is continuing on the CSR, for completion in the summer of 2006, to extend its working life until 2009. This is to minimise the risk of service failure prior to its replacement by GSM-R.

Ten-year business plan

Our renewal plans include:

- the FTN and GSM-R project;
- the life extension of the CSR radio systems until GSM-R is available;
- the replacement of life-expired equipment including operational communication equipment, CIS and PA systems;
- the replacement of systems with known high-risk failure modes or performance impact such as some selective telephone systems; and
- the replacement of existing DOO CCTV with a more robust system in order to improve passenger safety and operational performance.

The long-term forecasts for other activities have been developed with the regions, whose workbanks are centrally reviewed and collated for the plan. All renewal proposals are scored and prioritised, based upon a set of criteria which include business plan drivers, condition assessment, maintainability and route classification. This prioritised matrix enables the telecoms budget to be allocated according to the needs of the business to maintain safety and performance targets. This process will be developed further in 2004/05.

We are continuing to review the alignment of telecoms renewal plans with the national signalling renewals plan. The intention is to produce a co-ordinated plan which will as far as practical align:

- FTN and concentrator renewals with resignalling schemes; and
- GSM-R with axle counter schemes to provide emergency communication as a replacement for track circuit operating clips.

FTN and GSM-R projects

During 2003, as part of the interim review process, the FTN and GSM-R project plans were subject to review and challenge by a joint working group comprising Network Rail, ORR, the SRA and the HSE. The group evaluated a number of costed scenarios in detail, seeking to optimise the scope and timing of the works. They concluded that some of the works planned for 2004/05 and 2005/06 could be rescoped or deferred without comprising the integrity of the existing telecoms bearer network. Where the FTN is required to support a safety driven telecoms renewal, such as telephone concentrators, or a resignalling scheme then this element of works is aligned to the delivery of that scheme as far as practicable.

The FTN, comprising 65 interconnected resilient synchronous digital hierarchy (SDH) rings, connected through 11,000 kms of optical fibre cable, approximately 2,400 trackside equipment nodes and 16,000 kms of copper distribution cable, will provide the core network for our existing and future growth communication requirements. It will support our operational, retail and business requirements. The FTN is being installed in advance of GSM-R to provide a resilient communication path between the radio base stations and control equipment.

As part of the rescoping identified by the joint working group and a national cable condition survey, it was determined that some existing copper cables could be reused on secondary lines. On lines where copper cable is reused the extent of FTN cable route refurbishment will be reviewed and alternative methods of cable protection, such as installation of surface plastic duct, will be used to reduce costs.

The GSM-R digital radio system, comprising approximately 2,000 radio masts, trackside base stations and two core switching centres will provide full coverage of the UK rail network, including cuttings and tunnels, for secure communication between the driver and signaller and also for use by trackside, train and station staff.

GSM-R is a European standard which is being adopted to comply with Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail network. It will provide voice and data communication services to meet all the railway mobile communication needs, and it is necessary to support the proposed adoption of the ERTMS level 2 train control system on all high speed Trans European Network System (TENS) routes.

There are a number of factors driving the introduction of GSM-R:

- the replacement of the NRN, which does not provide complete coverage and has a number of known reliability weaknesses, and manufacturing support for key elements of equipment has been withdrawn;
- the Office of Communications (OFCOM) needs to reassign the frequencies in the UHF band used by CSR to align the UK with the rest of Europe. This means that we are required to give up the frequencies currently used by CSR by 2010. However, it should be noted that other users may be granted access to these frequencies as early as 2006, potentially resulting in interference in driver to signaller communications. We are currently reviewing the implications of this;
- recommendations of accident inquiries relating to signaller to driver emergency communication systems; and
- to provide a secure platform for the future implementation of on-board train control systems in line with European legislation for high speed routes under the interoperability directives.

The majority of FTN and GSM-R equipment will be co-located, reducing accommodation, power and other ancillary requirements and thereby maximising cost efficiencies. Work on the FTN and GSM-R projects has commenced with the following delivery priorities:

- Strathclyde area GSM-R area operational trial by Winter 2004;
- Cambrian area infrastructure to support ERTMS trial by Winter 2006;
- provision of GSM-R on TENS high speed routes by Winter 2006; and
- areas where the existing infrastructure is in poor condition by Winter 2006;

We are still reviewing the programme for the coverage of other routes, which will be finalised when there is better understanding of the following issues:

- the possible interference with the existing CSR radio frequencies from continental Europe;
- the degree to which secondary lines need to match the system design on primary lines;
- the migration of rolling stock to using GSM-R; and
- the ability to life-extend existing transmission infrastructure.

GSM-R is also being installed on the WCML and the CTRL, both of which will be integrated with the national GSM-R system at an appropriate time.

Value engineering will continue to be applied to the FTN project to assess the potential further economic benefits arising from:

- further use of alternative route materials and installation techniques;
- leasing dark fibre from public telecoms operators; and
- alternative means of communication such as microwave in remote areas.

Other operational communication systems

The 2004/05 to 2005/06 work plans are based on renewal of existing assets developed from the output of the inspection and assessment process and the requirements of the asset policy. The plan has been developed at regional level and has been extensively peer reviewed over the last twelve months and prioritised using the matrix of drivers, protecting safety driven renewals such as SPT concentrator renewals, level crossing telephone systems and DOO CCTV. Where practical, renewals are timed to coincide with the FTN project, and resignalling or remodelling schemes in order to maximise scope and cost saving benefits.

The forecasts of long-term renewal requirements for other telecoms assets comprise detailed workbanks developed in conjunction with regional asset stewards. The 10-year plan is based on renewals of the existing assets and, where known, the telecoms requirements for resignalling schemes. Forecast renewal requirements are based on the expected life the assets, combined knowledge of the age of the existing stock.

The issues driving renewal requirements over the period include:

- a large number of signal post telephone (SPT) concentrators located within signal boxes are approaching life expiry with some parts now obsolete. These systems, having high-risk failure modes, are being renewed as a priority. Selective SPT systems do not support calls initiated by signallers and are being replaced with central battery type as a priority;
- DOO CCTV installations on station platforms are being renewed to comply with the latest standard which mandates the optical performance criteria;

- public emergency telephone systems (PETS) at level crossings are being renewed within the 10-year plan period in line with the Safety and Environmental Plan requirements;
- voice recorders are being installed or renewed in electrical control rooms and in the majority of signal boxes to provide a record of all voice communications with the operators and signallers; and
- CIS and PA systems are being installed at stations to replace life expired systems to help meet regulatory targets for improving the quality of train information to the travelling public.

The asset life expectancy is the determined lifespan of the asset before maintenance costs become excessive compared with system replacement. The drivers for assessing maximum lifespan include the asset performance, degradation, high maintenance costs or technology change, leading to obsolescence of equipments or maintenance skills. The asset life assumptions, which have been derived from industry standards and historic data are summarised below.

Although the plan assumes renewal at these fixed lifespan periods, the asset stewards will undertake feasibility studies, supported by risk assessments, to assess the condition and possible remaining life of the equipment or system prior to project authorisation.

Figure 9.24 Telecoms asset lives

Equipment / category	Life Expectancy
Telephone concentrators (electronic)	10 Years
Voice recorders	7 Years
Public level crossing systems	10 Years
Optical fibre cable	30 Years
Copper cable	25 Years
Transmission systems	10 Years
Radio systems control processor	10 Years
Base station	15 Years
Uninterruptible power supply	10 Years
Rectifier / charger / battery	5 Years
Public address	10 Years
Customer information systems	10 Years
CCTV (driver-only operation)	10 Years
CCTV (retail)	7 - 10 Years

Expenditure

The table below shows the current 10 year expenditure projections for telecoms renewals. The majority of expenditure is directly attributable to the GSM-R and FTN project. The other areas of spend in the regional and major stations workbanks are summarised by asset category.

The expenditure profile for the next five years reflects the programme underpinning the interim review settlement with expenditure tailing off in 2008/09. The profile in the later years reflects a provisional view of the impact of the rephasing of some elements of the FTN and GSM-R project into this period along with our assessment of the other works that would be required in this period. This will be subject to further review which is likely to lead to some smoothing of the activity and expenditure profile.

Figure 9.25 Telecoms renewal expenditure

£m (2003/04 prices)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
FTN	125	128	147	143	7	50	54	31	15	0
GSM-R	66	37	71	71	5	24	24	28	18	0
CIS systems	9	4	12	10	12	13	7	8	7	11
DOO CCTV	7	6	5	5	1	6	4	5	3	4
Radio systems	2	2	5	1	3	0	0	0	0	0
Concentrators	13	11	20	20	19	16	21	24	26	23
Other ops comms	3	2	5	9	12	12	11	12	8	13
Total	224	189	265	258	58	120	122	109	78	59

Activity and unit costs

The long-term forecasts of renewals other than the major projects are compiled from detailed workbanks which are now managed within each territory by the territory engineers and centrally reviewed and nationally prioritised. The workbanks are subject to periodic peer reviews that challenge scope, cost, expenditure, progress and timing. Where practicable to do so, the renewal of lineside assets such as concentrators and resignalling schemes are aligned with the FTN timescales and scope in order to maximise synergies, deliver cost efficiencies, and drive towards national standards.

The unit costs used to develop the plan are based on recent costs for delivery of similar renewal schemes with the most recent contractor equipment costs. The FTN costs have been taken from the unit rates contained within the call-off contracts, supplemented where possible by tendered costs. Further work is being carried out to gather unit cost information for operational and retail systems and this will enhance the consistency of the planning data used in the regions. Generic work packages have been produced for each of the core activities within the plan.

A new procurement strategy is being implemented to improve the delivery of telecoms renewal projects. We intend to let national telecoms renewal framework contracts during spring 2004. This will coincide with the introduction of delivery teams dedicated to telecoms activity. The contracts will drive procurement and cost efficiencies by a combination of focused delivery for the delivery teams and a planned programme of works against which the selected suppliers can resource efficiently and achieve economies of scale. Call-off contracts have been let for cable route, copper cable, optical fibre and transmission equipment providing a lower cost base and standardisation of equipment.

Further cost savings will be sought from:

- the identification of further synergies in scope, installation and timescales between FTN, regional renewals and resignalling schemes;
- possible use of cheaper cable route methods; and
- greater use of standard products and solutions.

Outputs

While there are no specific output targets for telecoms assets, it is vitally important that their functional capability is maintained as the systems support other operational railway systems. For example the degradation or failure of the following telecoms systems would have an impact on safety and performance:

- failure of concentrators with selective circuits may result in miscommunication between train drivers and signallers;
- failure of DOO CCTV systems increase the risk to passenger safety and cause operational difficulties for the TOCs;
- failure of level crossing telephone systems increase the risk to the public and can cause train delays;
- failure of voice recorders in signal boxes and electrical control rooms would prevent the recovery of operational voice communications crucial to incident or accident inquiries;
- failure of cable and transmission systems carrying signalling circuits may lead to train delays; and
- failure of CIS systems will be disruptive to the public and could incur penalty payments to train operators under the proposed station abatement regime.

The introduction of GSM-R has potential benefits which may reduce train delay minutes, but this relationship has not yet been developed or quantified.

Commentary

The long term plans for telecoms are dominated by the FTN and GSM-R project. The scope, costs and phasing of these activities have been the subject of rigorous challenge and review by the joint working group. The cost profile of the FTN project still has significant risks associated with current cable route condition which will emerge as the programme rolls out nationally.

The primary focus for renewals has been on systems directly impacting on safety and operational performance. As a result there are a number of issues that surround the renewal of CIS at franchised stations. We are producing a new standard, which will be available in Summer 2004, to overcome some of the technical issues and implement a process of system standardisation. Many life-expired CIS require increased maintenance, or in extreme circumstances decommissioning, and we are working with train operators to agree the definitions of renewal and enhancements, and the treatment of legacy assets.

The whole life strategy for the RETB signalling systems currently installed on the Cambrian, East Suffolk, West Highlands and Far North lines has yet to be fully established, and this may have a major impact on what is expected of the telecoms assets that currently support the system. The telecoms assets are already life expired and are due for renewal between 200405 and 2006/07. The analogue radio systems are also affected by the revised timescales for the introduction of GSM-R agreed by the joint working group.

The leased copper and transmission assets revert to our ownership in 2005. Following this transfer it may be necessary to complete elements of renewals as a priority to overcome unknown problems as these assets are or will be approaching life expiry. We are compiling at-risk registers for transmission and microwave systems, together with copper condition surveys completed as part of the joint working group review of FTN to clarify the condition of the asset and allow appropriate mitigations to be undertaken.

Operational property

Asset stewardship strategy

Objectives

The key objectives of our plan for Operational Property are to manage and maintain each asset proactively to ensure that:

- existing capability, in terms of the number of stations and the facilities provided at those stations, is maintained;
- asset condition is suitable for safe and efficient operational use;
- a whole-life cost approach is taken, with a view to reducing forward maintenance liability; and
- decisions are made in a consistent manner across the network.

The assets are subject to two regulatory targets aimed at ensuring that there is no deterioration in the national average condition of assets from current levels, where the condition of individual assets is measured on a 1 to 5 scale. The values for these measures in 2002/03 were:

- average station condition index of 2.25; and
- average light maintenance depot condition index of 2.7.

Asset overview

Our operational property assets comprise a diverse range of building types, sizes and age profiles, many of which are subject to heritage constraints. Together these properties form four portfolios:

- lineside buildings - approximately 12,000 buildings many of which house essential operational equipment, including manned buildings (e.g. signal boxes) which are the place of work for around 5,000 of our employees, and unmanned buildings (e.g. relay rooms). The number of lineside buildings is likely to increase significantly in the near future as buildings previously managed by IMCs transfer to the operational property estate;
- light maintenance depots - 91 depots which are leased to train operators and house train-servicing functions;
- franchised stations - 2,490 stations which are leased to train operators; and
- 17 managed stations that we own and operate.

All properties are categorised according to their size, capacity and relative importance. The overall asset portfolio encompasses a wide variety of building fabric, building engineering services, plant, equipment, external works assets and mains utility supplies. Plant and equipment includes, for example, lifts, escalators and travellators, train and building fuelling equipment. The portfolio also includes the management of redundant and mothballed assets.

External legislation is a key driver of operational property activity and the impact of new legislation is reflected in our plans. Recent changes affecting this plan include the Control of Asbestos at Work regulations, changes to Building Regulations affecting energy and insulation, and Water Supply regulations. In addition, the Work at Height Regulations which come into force this year will have an impact on works to roofs and canopies. The financial effect of these regulations is currently being assessed.

It is important for effective asset stewardship of stations and depots that the obligations between the parties to the leases are clear and unambiguous. We have been working with the SRA, ORR and ATOC to design a clear matrix of responsibilities for the testing, maintenance, repair and renewal of assets at stations, which is intended to ensure that only one party is responsible for the whole-life of each asset. This is currently under industry consultation as part of the ORR's Stations Code proposals. The changes in responsibilities are unlikely to be cost neutral but the impact has not yet been evaluated and is not reflected in our expenditure projections.

Asset policy

The latest version of the asset engineering policy sets out core initiatives and defined outputs for stations and depots. The policy will be reviewed on an ongoing basis to reflect changing operational needs and to reflect industry developments as required.

The key aims of the engineering policy are to:

- generate a condition-based prioritised workbank of our renewal, maintenance and repair responsibilities to deliver our regulatory obligations;
- ensure that the available budget is consistently allocated to projects that minimise safety and operational risks whilst fulfilling our statutory, contractual and licence obligations as effectively as possible;
- ensure that the identified works are specified appropriately by formalising decision making processes whilst complying with industry standards and legislation; and
- improve manned lineside buildings to provide a basic level of facilities.

The engineering policy and supporting guidance documents ensure that both Network Rail and the train operators respond to industry standards and statutory legislation with respect to buildings.

Asset knowledge

Age and local environmental conditions are the principal drivers of degradation of most property assets. Other significant influences on the rate of degradation include the quality of historic maintenance, the level of usage and the impact of vandalism. The key asset information requirements are therefore inventory data including age, size and materials, and information on current condition including professional assessments of the residual life.

At present the key asset data is held in a variety of formats around the company. The most comprehensive source of data for stations and depots is the optimum maintenance system (OMS) database, which contains an extensive inventory of the majority of our assets with the relevant component volumes. The building fabric information is generally more robust than that for mechanical and electrical assets.

Our strategy for improving asset knowledge and information management is to:

- acquire consistent asset information through the new inspection regime; and
- standardise information management using a new national database.

To improve our asset condition information, we have developed a national inspections brief, specification and reporting template for a 5-yearly inspection regime of all properties, which will involve visiting 20% of these properties annually. These inspections will be comprehensive, covering all building fabric, external works and building engineering services/plant assets, and will include an assessment of remaining asset life. The new regime commenced in the first quarter of this year and will support the prioritisation of renewal plans and the targeting of maintenance activity.

The management of reactive works under the station and depot leases is carried out through Property Action Lines (PALs). We are currently undertaking a fundamental review of these facilities with the intention of introducing a national help desk facility with an enhanced IT capability.

We are creating a standard asset information format through the implementation of a national asset database and equipment register, which will form the core data for the MIMS for Operational Property (MfOP) system. The key inputs to this system will be the extensive data on the nature and condition of assets from inspections. The MfOP database will also contain details of prioritised workbanks and record non-urgent faults that are reported through the PALs.

Implementation of MfOP will deliver a single work and asset management system combined with consistent end-to-end processes. Detailed requirements have been established for a national planned maintenance system, business planning, and decision support tool linked to the MfOP database. This will allow the generation of a wide variety of reports and work schedules including functionality allowing the management of reactive works using on-screen mapping of lease obligations. Detailed design using MIMS has now commenced. An intermediate database to store the inspection data with basic reporting functionality was introduced in December 2003 and increased functionality will be introduced progressively until the full implementation of MfOP is rolled out from 2005.

Ten-year business plan

Our 2003 Plan set out a strategic assessment of operational property activity and expenditure requirements over a 10-year period for the first time. The plans combined detailed regional activity plans for the first three years with a strategic assessment of requirements for the following seven years. This highlighted a significant level of activity that had been identified in workbanks in the early years which would have to be deferred to later years in view of the constraints on funding and deliverability, and also assessed the steady state level of future activity. The longer-term expenditure projections showed a substantial increase in the overall level of expenditure being required to maintain the existing average asset condition in the medium term.

The basis of our plans was subject to independent review during the interim review process and received considerable criticism. In particular the Regulator concluded that:

- the review of regional workbanks indicated that significant savings could be made by deferring non-essential works that were packaged with other activity at the same properties; and
- the longer-term expenditure plans were not robust.

As a result, the interim review determination assumed reductions of around 20% in our proposed expenditure in the early years, which was already constrained, and no increase after 2006/07, other than that associated with activity at our managed stations. This presents a significant challenge as the proposed levels of activity in the early years were already constrained.

We recognise that some aspects of the challenge from the independent reviews were valid and have made clear that we recognise the need for considerable development of the forecasting methodology. The issues raised through the independent reviews will be taken into account in future refinement of our long-term forecasting.

For this plan we have adopted the expenditure levels identified through the interim review process for the next five years and are focusing on the prioritisation of activity in the next few years, responding to the challenge regarding the packaging of non-essential works. The expenditure projections in the later years are in line with the base plan in our September 2003 update and have not been subject to further review. We believe that a significant backlog of activity will build up over the next few years and that we will be continuing to manage the asset portfolio on a largely reactive basis for the foreseeable future.

Methodology

The detailed regional work plans for the next three years are the product of inspections augmented with local knowledge, feedback from train operators, information from the PALs and other fault history. The workbanks are subject to a general peer review undertaken by HQ engineers to determine that decisions have been made consistently, that all schemes have been prioritised correctly, and to check compliance with the asset policy and business planning guidelines.

All schemes are prioritised according to the categories in the table below:

Figure 9.26 Prioritisation

No	Criterion
1	Health and Safety
2	Performance/operational failure
3	Statutory
4	Contractual/Third Party
5	Just in time repair/renewal
6	Opportunity

In compiling the long-term plans we have evaluated the cost of fulfilling our responsibilities in all existing leases and access agreements, and of compliance with legislation. We have not taken any account of any station capacity enhancements that might be required to accommodate future passenger growth or for any enhancement works associated with compliance with the Disability Discrimination Act (DDA) at franchised stations.

The approach to developing long-term forecasts varies across the assets in the overall portfolio with some plans reflecting detailed workbanks, while others are predominantly based on asset life assumptions. Within each portfolio a number of specific aspects of spend have been considered:

- inspection;
- reactive maintenance; and
- renewals - the "steady state" levels required to maintain average asset condition.

Inspection

As noted earlier, the weaknesses in asset information with respect to coverage and condition are being addressed through the establishment of the new 5-yearly inspection regime covering all types of property. The volume of inspection activity under this approach is expected to be stable over the period of the plan, and the costs are based on recently tendered contract rates.

Additionally, a programme of inspections of properties that may have asbestos is being arranged to comply with the Control of Asbestos at Work Regulations 2002. Existing data is being used to target sites where detailed inspections will be necessary. A management plan will then have to be produced for each affected property, detailing how the risk of asbestos is to be managed. We are working with the HSE and ATOC to address this issue.

Reactive Maintenance

Estimates of the expenditure on reactive maintenance have been based on historic spend for each asset group over recent years. A significant backlog of deferred renewal activity has been identified by comparing the complete regional workbanks, which record all the specific activities that have been identified as necessary, with the available funding for the next three years. We expect that this will result in increasing levels of reactive maintenance work. This will have to be accommodated within the overall expenditure allowances and means that a greater proportion of the overall activity will be carried out on a reactive basis than had been assumed in the 2003 plan.

Renewals

The approach to estimating the core, or steady state, renewals requirements varies across the asset portfolios, which are discussed in turn below.

Managed stations

Forecast expenditure at our managed stations is derived from detailed 10-year planned workbanks for each station. These cover renewals only and do not cover potential enhancement schemes. Following review of these workbanks by independent consultants, the Regulator concluded that funding should only be provided for schemes in priorities 1 to 4 over the next five years. Our plans for the early years have been reviewed in this light. The deferral of planned works will result in increased levels of mitigation and reactive work being required.

The major items of activity are train-shed roofs with future plans including renewals at Kings Cross, London Bridge, Euston, Paddington, Victoria and Edinburgh Waverley. Some of these renewal schemes may be subsumed within broader redevelopment schemes. Plans for Kings Cross also include refurbishment of the office buildings either side of the train-shed.

Franchised stations and depots

The assessment of renewal forecasts for franchised stations and depots is based on assumptions about sub-asset lives. The forecasts are based on the following steps:

- identify the total quantity of assets on the network at sub-asset / material level;
- link these volumes to assumed asset lives for each component;
- calculate annual steady state volumes implied by these asset lives; and
- apply relevant unit costs to give the total annual expenditure on each asset.

The asset population data is primarily sourced from the OMS database. The quantities are identified at a highly disaggregated level, by component, location and material for more than 8,000 separate sub-assets. While not fully up to date, the OMS system represents the most comprehensive source of consistent data for planning purposes and it is considered sufficiently robust for the strategic estimation of national renewal volume requirements.

The assumed asset lives were derived from the Housing Association Property Manual (HAPM), where available, or through professional judgements. The independent review undertaken as part of the interim review noted that some of these lives could be considered conservative as they were derived for insurance purposes. The validity of these assumptions will be subject to further review.

The forecast annual volumes of activity were derived by assuming a steady state profile, with a constant proportion of the total stock requiring renewal each year. For example, for an asset such as tarmacadam surfacing which has a projected life of 20 years, we assume that we will renew 5% of the total asset volume per year. Similarly, for an asset that has a life of 40 years we will renew, on average, 2.5% of the assets each year.

Finally, composite unit rates from the property framework contracts have been applied to the estimated volumes with appropriate adjustments and uplifts, including allowances for listed building and heritage constraints and for the management of possessions. Our unit cost data is not robust and this will be a particular focus in improving our forecasting processes in future.

Lineside buildings

We do not have the same coverage and detail of asset data for lineside buildings that we do for stations and depots and we therefore adopted a different approach to the estimation of renewal volumes. While data on major manned installations such as IECCs and larger signal boxes is generally adequate, data quality for smaller unmanned buildings, such as relay rooms, is less reliable, and there are a large number of minor buildings where data is poor. This will be addressed progressively through the inspection regime. Renewal forecasts have been derived by combining the available data with average spend profiles which have been derived from recent regional experience for routine maintenance, renewal and improvements.

Expenditure

The table below summarises the forecast expenditure on operational property.

Figure 9.27 Operational property expenditure

£m (2003/04 prices)	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Stations	131	122	128	154	161	156	133	138	113	113
Depots	28	24	26	23	24	29	29	28	28	27
Lineside buildings	17	20	21	16	10	12	11	11	11	11
Total	176	165	174	193	195	197	173	177	152	151

Activity and unit costs

The nature of operational property assets is such that the volumes of renewal activity are difficult to summarise simply. Maintenance and renewal activity on property assets is conducted on an elemental basis, covering a wide spectrum of works, and rarely involves the complete renewal of a property. Works affect a diverse range of assets and sub-assets, including platform surfaces, lighting and fencing as well as building fabric. Meaningful units of volume, and hence unit costs, need to be defined at a very low level. Therefore this document does not include a summary breakdown of renewal activities or unit costs.

The development of the MfOP database will facilitate analysis based on more sophisticated volume measures, and through that of unit costs to inform future business plans. It will also influence supply chain strategy in relation to bulk purchasing and specialist contracts for certain activities. In the meantime, we are developing a high-level framework for comparisons of regional workbanks focusing on broad areas of activity such as roofing, platforms and car parks.

The activity we undertake, and the costs of doing so, can be significantly affected by external legislation. Recent issues include in building regulations affecting energy and insulation and legislation to prevent contamination of water supplies, and new Working at Height regulations will also have an impact. There is a continuing programme of works on drainage and building fuel oil installations at 42 light maintenance depots in order to comply with fuelling and drainage regulations legislation.

For lineside buildings, a key area of activity is the continuing programme of works to improve working conditions in signal boxes by providing basic amenities such as toilets and mess facilities.

Outputs

The key output measures are the station and depot condition indices which record the average condition of the assets where every property is measured on a 1 to 5 scale. It should be noted that both condition indices are relatively simple measures of the overall state of the asset portfolio that give equal weight to all assets and all stations regardless of size or importance. It is therefore difficult to forecast these outputs with any confidence.

We will endeavour to avoid any decline in average condition by concentrating on the prioritisation of activity and ensuring that every pound is spent wisely. However, we believe that maintaining condition over the long-term will present a major challenge as the levels of activity for which funding was provided through the interim review may not be sufficient to maintain average condition of stations or depots on a sustainable basis.

Commentary

The quality and consistency of the detailed plans for the next three years is fairly robust. The workbanks for 2004/05 have an adequate level of information including details of the location, element description, priority output and cost. The cost estimates are generally based upon historical data together with current contracted rates, and include an allowance for possession management. The quality and level of detail of the information in the workbanks is lower in 2005/06 and 2006/07. However, ongoing inspections at locations where works are planned in the next couple of years will continue to improve the quality and accuracy of our workbanks. The overall consistency in the development of workbanks will improve progressively as the new inspection regime becomes established.

The long-term plans have been compiled using the best available data and at a considerable level of sub-asset detail. Future improvements in the planning process will be supported by the development of the MfOP database and improved asset condition information from the embedding of the new inspection regime. These initiatives will deliver progressive improvements in asset knowledge, both in terms of the inventory and the understanding of the rates of degradation, which will facilitate the development of more robust plans in the future.

A key area of risk around the anticipated level of activity concerns the changes to responsibilities for maintenance and renewal of stations being proposed by ORR though the new Stations Code. We have highlighted that this is unlikely to be cost neutral and the financial consequences of the changes will need to be evaluated.