

1. INTRODUCTION

1.1 There is a wealth of research being conducted within the rail industry and its supply chain, across a wide range of technical and other areas. This Technical Note draws together research conducted, guided or commissioned by relevant organisations in the rail industry in order to provide a comprehensive 'stock-take' of current research programmes. For the purposes of this Technical Note we have sought to identify research which has either been recently published, is in progress, or is in preparation.

1.2 The rail industry organisations involved in research included in this Technical Note are as follows:

- Rail Safety and Standards Board (RSSB);
- Department for Transport (DfT);
- Network Rail;
- Rail Research UK (RRUK) and other UK universities;
- European institutions;
- Rolling Stock Companies (ROSCOs).
- Association of Train Operating Companies (ATOC) and Passenger Demand Forecasting Council (PDFC);
- The rail freight industry;
- Passenger Focus and London Travelwatch;
- Transport for London (TfL);
- Office of Rail Regulation (ORR).

1.3 This Technical Note has drawn heavily on two sources of data:

- The DfT Rail Evidence and Research Strategy 2007/08; and
- An RSSB Board Paper dated 14 June 2007 on 'Industry risks and opportunities – Research and Development'.

- 1.4 In addition, information has also been obtained direct from certain organisations, including Passenger Focus, ORR, Transport for London and the Rail Freight Group.

What this Technical Note does *not* cover

- 1.5 This Technical Note focuses only on research and development programmes and does not look at any evidence-gathering and analysis (such as is included in the DfT ERS). This note does not set out a comprehensive compendium of all published rail research, although for certain organisations it does identify a number of pieces of recently completed research.
- 1.6 Research conducted outside the UK without the involvement of UK organisations is not covered.
- 1.7 The RIRS covers the heavy rail sector in Great Britain, but not research and development related to light rail.

2. CURRENT RESEARCH PROGRAMMES

DEPARTMENT FOR TRANSPORT (DfT)¹

2.1 Rail research in the DfT is carried out by five sections of the Rail and National Networks group. Planned research activities are set out below, grouped by DfT section.

(i) Network Analysis & Modelling

- Model development.
- Optimism bias.
- Assess benefits of improved performance.
- Estimate option value of rail links.
- Crowding valuation and modelling.
- Productive use of travel time.
- Valuation of station improvements.

(ii) Rail Systems

- Rolling stock reliability benchmarking.
- Hydrogen feasibility: next steps.
- Hybrids study.
- Train energy metering.
- Smart ticketing - scope & risk.
- Limits to capacity.
- European rail traffic management system capacity critical analysis.
- Non-road mobile machines directive issues study.
- Security issues study.
- 3G energy efficient DMU.

(i) Rail Service Analysis

- Passenger demand forecasting.

(ii) Customer & Stakeholder Relations

- Community rail.

(iii) Rail Strategy

- Evolving fares regulations.

RAIL SAFETY AND STANDARDS BOARD (RSSB)

2.2 RSSB has a major rail research programme, grouped into three sections: Engineering, Management and Operations. The volume of research activity is set out in Table 2.1; Appendices A1-A3 contain details of all the projects that the RSSB has published, are in progress, or are in preparation.

Table 2.1 – Number of RSSB Research Projects

	Published	In Progress	In Preparation	Total
Engineering	77	78	13	168
Management	56	21	5	82
Operations	87	33	26	146
Total	220	132	44	396

2.3 Table 2.2 below summarises the industry clients for the RSSB research programme by research topic.

Table 2.2 - Industry clients for RSSB research programme²

Topic	Principal client group	Other client groups
Vehicle Track Interaction	Vehicle/Track SIC , its Technical Advisory Group and Permanent Project Group	Adhesion Working Group UK Wheelsets Working Group Wheelset Maintenance Best Practice Group INS Standards Committee RIA T&RS Standards Committee ATOC Engineering Council Rolling Stock Standards Committee
Rolling Stock	Vehicle/Vehicle SIC	Rolling Stock R&D Group RIA Standards Committee ATOC Engineering Council Rolling Stock Standards Committee

¹ Annex 6, Draft Rail Evidence and Research Strategy 2007/08, DfT. The extract above excludes evidence-gathering and analysis activities.

² RSSB Board Paper 14th June 2007 – Industry Risks and Opportunities – Research and Development.

Topic	Principal client group	Other client groups
Infrastructure	Vehicle/Structures SIC	INS Standards Committee UK Aerodynamics GB Working Group RIA Standards Committee ATOC Engineering Council
Control, Command & Signalling	Vehicle/Train Control & Communications SIC	CCS Standards Committee RIA Standards Committee ATOC Engineering Council
Energy	Vehicle/Traction Supply SIC	Future Fuels Technology Group Energy Standards Committee Sulphur Free Diesel Group RIA Standards Committee ATOC Engineering Council
Safety Policy and Risk Management	Safety Policy Group	Safety Decisions Programme 'Think Tank' Practitioners (Risk) Working Group
Strategic studies	Technical Strategy Advisory Group	
Sustainable Development	Rail Sustainable Development Group	Sustainable Development Steering Group
Workforce Development and Competence	Rail Industry Skills Forum	Workforce Development and Competence Advisory Group
Operations	Operations Focus Group	Traffic Operations & Management Standards Committee ATOC Operations Council Industry Safety Liaison Group
Public Behaviour	Community Safety Steering Group	Rail Personal Security Group Railway Crime Working Party
Level crossings	National Level Crossings Safety Group	
Occupational Health	<i>SPG Considering</i>	Train Operations Safety Group

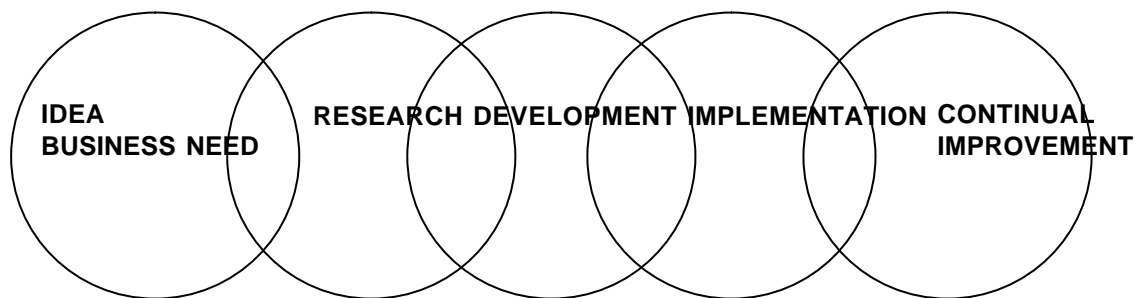
NETWORK RAIL³

2.4 Network Rail undertakes substantial research and development activity primarily aligned to its main duties as asset owner and operator. Recently these have increased in scope to include environmental issues, system wide issues such as performance, weather and seasons management, capacity,

³ Extract from ERS Annex 4

safety, human factors and the optimisation of the cost of the network. This is delivered primarily through collaborative projects in the UK and Europe, involving suppliers, universities, dedicated research providers, TOCs/FOCs, and other infrastructure managers.

- 2.5 Network Rail's research and development activities are fully integrated into the business so that research delivers value into the business, so that research does not become an end in itself. This is shown schematically below:



- 2.6 Network Rail's research and idea generation occurs primarily from business needs, universities and suppliers. Business sponsorship of research is co-located with the Network Rail research function. Business needs are then fed into the research process. Fundamental research is conducted primarily through Rail Research UK at which Network Rail is currently supporting 60 projects. Network Rail also sits on the steering and management boards of RRUUK making sure that its voice is heard and directing research activities.
- 2.7 Applied research is often taken forward through EU framework programme projects. Network Rail is currently a lead partner in 4 of these and actively involved in progressing a further 5. The output of these is usually trials on infrastructure, usually with a supplier or TOC/FOC as partner before the research is fully integrated into the business. Alternative outputs of EU research are European level standards which can then be applied in the UK. Once the research is being actively used in the business it becomes subject to the normal improvement programmes ongoing in the company such as six sigma, of which Network Rail has around a hundred projects underway.
- 2.8 Research is then a small part of the process that Network Rail is using to transform its business and meet the long term expectations of its stakeholders.

2.9 In addition to these direct activities Network Rail is heavily involved in research strategy activities. Involvement here includes:

- Membership of the steering board of Rail Research UK.
- Membership of the European Rail Research Advisory Council.
- Membership of the UIC Research Coordination Group, the International Rail Research Board; the Technology Steering Group; the Infrastructure Forum.
- Membership of the EIM (European Infrastructure Managers), the creation of the EIM technical strategy, Membership of the Technical Management Platform.
- Membership of the Client Group of the European Construction Technology Platform.
- Participation in numerous standards drafting groups and their implementation, including ETCS, TAF, GSM-R, TSIS, ENS, JPC-R.

2.10 Network Rail has defined its vision of the 2030 railway which aligns to the DfT Technical Strategy. This vision is being shared in the strategic fora described above and being implemented on the GB national network via change in asset policies which in turn drive what is done to the network. It is already driving new research and development activities in the fields of vehicle engineering and propulsion systems.

2.11 An important aspect of this is the move to a 7 day a week railway and increasingly to a 24 hour railway. The intelligent infrastructure initiative is being used to move from a maintenance philosophy of find and fix to predict and prevent supported by the national measurement train, the engineering data centre and remote condition monitoring to create an intelligent infrastructure that monitors itself and notifies the maintenance teams when it will need attention.

2.12 In terms of the identified categories of research Network Rail is undertaking research in the following areas:

- Impact on environment.
- Impact of climate change.
- Vehicle mass/energy source.
- Other environmental issues.
- Infrastructure.

- Operations.
- Workforce (not as a cost, but in terms of safety and maximising efficiency of possessions etc).
- Policy (primarily at EU level).
- Capacity – efficiency.
- Rolling stock capacity.
- Infrastructure capacity.
- Demand requirements (RUS).
- Ageing population.
- Customer experience.
- Intelligent infrastructure systems.
- Standards.
- Infrastructure.
- Rolling stock.
- Operations.
- Human behaviour.

2.13 Other research themes include: construction techniques, structures, performance, weather mitigation, stations, PRM.

2.14 In conclusion, Network Rail is engaged in a substantial programme of research and development activities into all areas of the railway system, its management, operation and development. These are all integrated into a process that allows the output of the research to be incorporated into the business thereby deriving direct benefit. In addition to this network rail has developed a future vision of the 2030 railway that is consistent with the DfT Technical Strategy and this is being used to develop further the research and development programme and the development of the national railway network.

UNIVERSITY SECTOR

Rail Research UK (RRUK)⁴

2.15 A partnership of British Universities focusing on railway systems research, RRUK has a large number of research projects underway, as outlined in Table 2.3

Table 2.3 - Rail Research UK Research Projects

Title	Contact
Technical Advice for Axle Project	University of Newcastle upon Tyne
Rolling Contact Fatigue	University of Newcastle upon Tyne
GRACE (Generalisation of Research on Accounts and Cost Estimation)	University of Leeds
Low adhesion estimation - feasibility study	Loughborough University
Low Adhesion Detection Stage 2	Loughborough University
Use of ride data in derailment prediction	Manchester Metropolitan University
Pan Sway	Manchester Metropolitan University University of Birmingham
Wheel Profiles	Manchester Metropolitan University
T613 Rolling contact fatigue	Manchester Metropolitan University
Peer review of vehicle acceptance standard	Manchester Metropolitan University
Virtual Test Track	Manchester Metropolitan University
EURNEX	Manchester Metropolitan University University of Birmingham
INNOTRACK	Manchester Metropolitan University University of Newcastle upon Tyne University of Birmingham University of Southampton
TSM (modelling the dynamic behaviour of vehicle and track interaction)	Manchester Metropolitan University
Gauging	Manchester Metropolitan University
Vegetation And Movements Of Railway Tracks And Embankments	University of Southampton
Pile Stabilisation of Large Landslides	University of Southampton
An experimental and analytical study of dry-stone retaining walls	University of Southampton
Track Stability	University of Southampton
Effect of Train Vibration on the Performance of Laptop Users	University of Southampton
Quieter railway and tram tracks - part of EU	University of Southampton

⁴ RSSB Board Paper 14th June 2007 – Industry Risks and Opportunities – Research and Development

Title	Contact
project, "SILENCE"	
Numerical Methods in the Wavedomain for Railway Applications	University of Southampton
Vibration in Railway Bridges and Tunnels	University of Southampton
Determining the 'added value' of two NWE INTERREG IIIB projects	University of Southampton
HST Connectivity Study	University of Southampton
Forecasting the Use of New Stations and Services Using GIS.	University of Southampton
Evaluating the Long Term Impacts of Transport Policy: The Case of Passenger Rail Privatisation	University of Southampton
Dynamic / aerodynamic interaction	University of Birmingham Manchester Metropolitan University
Rail materials	University of Newcastle upon Tyne University of Birmingham
Cost Modelling	University of Leeds Imperial College University of Birmingham
Condition Monitoring	Loughborough University University of Southampton University of Birmingham
An intelligent railway safety risk assessment predication system for rail design and maintenance	University of Birmingham
Application of fuzzy reasoning approaches into railway safety risk management process	University of Birmingham
Improving rail safety risk assessment	University of Birmingham
Scientific study of new rail instrumentation	University of Birmingham
Condition monitoring of track circuits	University of Birmingham
Remote defect and rail analysis equipment – spinning rail	University of Birmingham
Intelligent integration of railway systems (InteGRail)	University of Birmingham
Winter Conductor Shoe Testing	University of Birmingham Manchester Metropolitan University
Capacity Evaluation	University of Birmingham
The Safer European Level Crossing Appraisal and Technology (SELCAT)	University of Birmingham
TRAIL – Transfer of Technology in Railways	University of Birmingham
Quantifying the effects of climate change on the rail network in the UK.	University of Birmingham
External Factors Data Extension and Modelling	University of Leeds

2.16 A full description of each of these projects is set out in Appendix B.

Research Themes of Imperial College Research Centre⁵

2.17 The research themes of Imperial College Research Centre (co-sponsored by Hitachi and the Royal Academy of Engineering) are:

- Energy consumption.
- Environmental impacts of rail vehicles.
- Train power analysis and performance.
- Fatigue, fracture mechanics analysis of rail components.
- Maglev, high-speed rail comparisons.
- Track deterioration mechanisms and maintenance costs.

EUROPE

2.18 European rail research involving UK interest focuses on two key areas. The EC Framework Programme 7, and European Rail Research Network of Excellence (EURNEX).

EC Framework Programme 7⁶

2.19 The first call for EC Framework Programme 7 (FP7) has only recently been announced, so this section briefly outlines a summary of potential GB involvement in the work programme, drawing together the known planned involvement of UK railway companies, and other planned projects which are yet to include UK participation in their plans, but where UK organisations have expressed an interest in becoming involved.

2.20 Topics from FP7 Sustainable Surface Transport Theme are outlined in

⁵ ERS Annex 2A/B

⁶ RSSB Board paper, Appendix 6

Table 2.4. Table 2.5 looks at the FP7 Security Work Programme, whilst Table 2.6 explores the FP7 Energy Work Programme.

Table 2.4 – Summary of Potential GB Involvement in FP7 – Sustainable Transport Theme

Topic	Aims / Objectives	Name of project(s) if known
Dynamic Stability of Lightweight Trains	To establish the practical physical limits on the lightness of future trains and carry out research to determine specific developments required for vehicle and infrastructure design to optimise train performances.	LITE (Low Impact Train Evaluation) <i>Note: not awarded funding in the first call under FP7</i>
Delivering ERTMS-Compliant Interlocking Systems	To define and develop specifications and hardware for a new regeneration of interlocking systems in line with the relevant European norms addressing railway operation and safety systems to facilitate the introduction of ERTMS systems.	Network Rail / UIC proposal
		Project AURORE (Assessment for the Use of Rules for Operations Running ERTMS) – Prepared by EURNEX Expected results of the project is the definition of the common understanding of operational safety as well as of its effects on operational and human performance in the domain of railways. Furthermore a set of rules for the assessment will be defined.
Meeting Customers' Expectations for Rail Travel.	The scope covers the provision of better service information, integrated journey planning including ticketing; dealing with ageing customer base.	In development
Safety and Security by Design	About technologies and methodologies for the design of transport systems with intrinsic safety and security characteristics	Virtual Homologation – likely to be about how software can be used for homologation in areas of virtual dynamics, aerodynamics, crashworthiness, current collection etc.
		RAMSSES – focus more on risks, hazard identification and evaluation, safety apportionment etc.
Integrated Safety and Security for Urban Rail	To establish a common foundation for a common control / command system for urban rail transport and a common approval process at European level as regards safety and security with the aim of leading to reduced approval costs, reduced implementation time of new technology and simplification of present legislative framework at local, regional and national level. Scope includes hazard identification; risk mitigation methods; determining SIL levels for Control Command	In development

Topic	Aims / Objectives	Name of project(s) if known
	system; Generic Safety Case; map of plans for Security Surveillance systems.	
Promoting the use of bio-fuels and alternative hydrocarbon fuels	Deals with adaptation and optimisations of existing power trains, system components and materials; new power train concepts, effective safe and clean delivery of these fuels at distribution points.	In development
Vehicle / vessel and infrastructure technologies for optimal use of energy	Covers vehicles and infrastructure technologies to further reduce energy consumption	In development
Human behavioural and physical components	Deals with biomechanics, man-machine interactions, computer based learning.	In development
Integral system solutions for safety	Deals with methods, tools and technologies for optimal safety solutions which are reliable, fault tolerant and which integrate aspects of human behaviour, preventive and impact mitigating passive and active safety.	In development
Enhancement of Knowledge Base of the Rail Sector	Encouraging modal shift and decongesting transport corridors	In development
Testing Innovative Strategies for Clean Urban Transport	Ensuring sustainable urban mobility: innovative strategies for clean urban transport.	In development
ERA-NET Transport II	A cross cutting activity which deals with knowledge management in the transport sector and the participants are the national and regional research co-ordinators in member countries.	In development
SYMPASS (Systematic modelling process for auxiliary supply systems)		
Railtox - Evaluation of toxic effects of fire effluents in railway transport by measurement of gas and smoke production		
Innovation in freight containers		
Wheelset protection		

Table 2.5 - Summary of Potential GB Involvement in FP7 – Security Work Programme

Topic	Aims / Objectives	Names of project(s) if known
Security of critical infrastructure relating to mass transportation	Increasing the security of infrastructure and utilities	In development
Integrated protection of rail transportation	Deals with protection of signal and power distribution systems against electromagnetic terrorism, the detection of abnormal objects on or under ballast; clearance of trains before daily use; control of access to driver's cabin, detection of unauthorised driver; new methods/tools to isolate and secure luggage etc.	In development
Understanding factors that cause citizens feelings of security and insecurity	Covers how society perceives security and insecurity	In development

Table 2.6 - Summary of Potential GB Involvement in FP7 – Energy Work Programme

Topic	Aims / Objectives	Names of project(s) if known
Hydrogen and fuel cells	A joint technology initiative is likely to be created, or which rail would be a small component	In development
Innovative strategies for clean urban transport	-	-

2.21 EURNEX has identified ten poles of excellence in particular thematic subjects, as set out in Table 2.7.

Table 2.7 - EURNEX Research Areas⁷

Poles of Excellence	Objective
Pole 1 – Strategy and economics	This pole focuses on research that develops and supports business case for railways. Issues looked at by this pole include the main drivers of demand and costs in railways; potentials and limitations of quality of service rendered by railways to the various market segments; actions from regulators and policy makers that could help to improve railway performance.
Pole 2 – Operation and system performance	The general objective of this pole is to understand and to evaluate the complex nature of the railway system and to assist its operational management. The specific areas looked at by the pole members are: stakeholders' requirements; interoperability; functional analysis and designing of system architecture and components relationships; modelling and simulation; operation planning and management; capacity

⁷ ERS ANNEX 3B

Poles of Excellence	Objective
	management and optimization.
Pole 3 – Rolling Stock	The Pole aims at developing innovative solutions to the challenges of tomorrow's rolling stock. Specific objectives of the pole include: improving the performance and the attractiveness of passenger and freight vehicles; maintaining and enhancing safety and reliability; provide scientific and technical foundation for innovative solutions and supporting the establishment of new standards for rolling stock.
Pole 4 – Product qualifications methods	The pole aims at improving the effectiveness of testing and modelling and at developing product qualification methods for new techniques and technologies supporting the implementation of TSIs throughout the enlarged Europe. Activities would include research and development to improve methods of assessment; test procedures; test facilities (equipment); modelling; knowledge management system on PQM. The pole would also tackle assessment of conformity of standards and cross-acceptance procedures, as well as education and training for product qualification and TSI implementation through enlarged Europe.
Pole 5 – Intelligent mobility	"Intelligent mobility" covers new communication, navigation and surveillance (inside or outside the vehicle) technologies able to answer the needs for lean, clean and clever transport systems. The pole would look into the following domains: information systems (passenger, freight, remote diagnostics, predictive maintenance, traffic management), ticketing and payment/refund systems, security (systems and users), railway system management.
Pole 6 – Safety and security	The objectives of the pole are to monitor safety, develop new technology and to promote safe and secure systems of operation that reduce risks with diminishing costs. The pole will cover the following areas: safety and security management; active safety and passive safety requirements and assessment; incident/accident database and learning; risk analysis and assessment; technical and operational safety; occupational health and safety; safety impact of maintenance; new technology for security; psychological aspects of security; prevention of terrorism.
Pole 7 – Environment and energy efficiency	This pole will cover the following environmental topics: energy consumption and saving in electrified and diesel traction systems; electromagnetic pollution; noise and vibration not only on board but also on ground; influence of weather conditions on railway operation; water and air pollution. This is a transversal pole, where the knowledge coming from infrastructure, rolling stocks, signalling systems, operation and economy are oriented to the analysis of environmental impact of the railway systems.
Pole 8 – Infrastructure and signalling	The main objective of the pole is to optimise the cost, reliability and availability of the railway infrastructure. The pole will cover the following areas of research: track including sub-grade and rail; switches and crossings; level crossings; wheel/rail interface; signalling and control systems; line-side equipment; railway structures, cuttings and embankments; remote condition monitoring; electrical power distribution; maintenance procedure; catenary; life cycle cost (e.g. in relation to maintenance); noise, vibration and corrugation; signalling compatibility; interlocking.
Pole 9 – Human factors	The pole will focus on understanding the roles, capabilities and needs of all stakeholders in the rail system. The pole will cover the following aspects: integration of human factors within rail research and development; holistic approach embracing cognitive, physical and organisational human factors; promotion of systems ergonomics within a systems engineering philosophy; development or adoption of appropriate

Poles of Excellence	Objective
	human factors theories and models.
Pole 10 – Training and education	The pole has the following objectives: to create a pool of short training courses; to support the running of short training courses; to implement international PhD and Master programs; to launch a European University of Railway; to promote interdisciplinary contacts (collaboration across poles); to be a permanent forum for prospective studies; to promote exchange of knowledge ((e)-learning material, publications etc); to promote dissemination of knowledge out of research project results and publications; to use research results in education programs and short training courses.

ROLLING STOCK COMPANIES⁸

2.22 Three companies have taken over the majority of the rolling stock operations since privatisation in 1996. Research priorities of each of the three rolling stock companies is described below.

i) Porterbrook

2.23 Porterbrook is involved in work to improve the performance of its existing fleet of trains and looking towards the characteristics of the next generation. Areas of investigation include diesel emissions, diesel fuel and propulsion systems. In particular Porterbrook has been involved with the first application of hybrid technology to a main line train in this country and the first application of a stage 3a emissions compliant diesel engine. In the near future Porterbrook will be making available a class 153 diesel multiple unit as a test bed for further research on these issues.

ii) Angel Trains

2.24 Angel is working with operators to identify improved maintenance regimes in order to reduce life-cycle costs, exploring component replacements so that components costs could be reduced and looking for ways in which train operations could be improved.

2.25 Working closely with operators, research work is underway to improve reliability and using risk assessment techniques to qualify and justify changes in maintenance regimes reducing safety and business risk.

2.26 Angel is continually looking at lessons learned from their past procurements to ensure that mistakes are not repeated in the future procurement.

⁸ ERS, Annex 4

- 2.27 Angel is taking a lead on research work for engine replacement for HST, carrying out trials on class 442 for alternative air conditioning systems using air-cycle technology). This type of research is very much dependent upon good cooperation with the TOCs.
- 2.28 Angel is providing active contribution to European policies (TSI drafting groups, UIC (engine efficiency-NRMM), ensuring products are EU policy compliant).
- 2.29 Angel is proactively carrying out research into recommendations arising from inquiries and development of solutions to mitigate identified risks.
- 2.30 Angel is working with operators and engine suppliers to improve engine fuel efficiency.
- 2.31 Angel is developing technology platforms to remotely monitor poor performing systems on older rolling stock.

iii) HSBC Rail

- 2.32 Some of the research activities HSBC Rail is currently involved in include:
- Energy reporting via GPRS from a fleet of modern DMUS to enable better driver management and encourage fuel efficient operation.
 - Introduction of selective engine isolation of fleet of modern DMUS to reduce energy use.
 - Leading wheel set research to lead to standardised wheel set components on the pre 1994 rolling stock and reduce the cost of wheel sets to the industry.
 - Continually looking at ways of reducing costs of maintenance and improving reliability of rolling stock.
 - Research into corrosion and its repair and prevention on vehicles and devising a business led corrosion strategy for all of its fleets.
 - Active contributions to European policy especially in the persons with reduced mobility (PRM), wheel set, bearing and bearing grease area.

- Identify the ways in which the culture of a contracting company affects the success of the product.
- Leading work identifying GPS / GNSS applications that could potentially be used for railways.

ASSOCIATION OF TRAIN OPERATING COMPANIES (ATOC) AND PASSENGER DEMAND FORECASTING COUNCIL (PDFC)⁹

ATOC/TOC Community

- 2.33 The TOCS, either individually or through ATOC, are often part of client groups for research being carried out primarily through RSSB, but are also direct sponsors of research. ATOC helps identify and prioritise research needs and shape and steer projects across the RSSB research programme and in the SICS and their sub-groups. ATOC also manages a continuous programme of research to maintain and develop the PDFH (see below).
- 2.34 That said, ATOC and the TOCS together do sometimes fund small projects or start-up activities e.g. to support or encourage SIC work (such as taking the lead on environmental issues such as sulphur free diesel) and initiate applications and design work on engineering developments.
- 2.35 ATOCS/TOCS collaboratively and individually, do also undertake commercial research, including in the course of bidding for franchises, and market research work (for example, a programme of market research into railcards).
- 2.36 TOCS also initiate and deliver a significant volume of applications and design work on engineering developments. Examples include: re-designing the pantograph carbons on class 91 enabled Alstom to offer the same improved equipment on Pendolino; exploiting existing hall effect technology enabled THALES and NRS to be able to offer solid state AWS receivers, which have radically improved UK train reliability.
- 2.37 ATOC/TOCs also contribute to European research. For example, ATOC engineering council is a paid-up member of the UIC technology and research forum (FTR); and are active partners in bidding for and contributing expertise to various EU research projects e.g. MODTRAIN, INTEGRAIL.
- 2.38 Current areas of research in which ATOC/TOCs are involved include:

⁹ ERS, ANNEX 4

- Market research on ITSO compliant applications.
- Contribution to cross-industry research efforts, including
- Leading a project on bio-diesel jointly funded by RSSB and TOCS.
- Leading environmental and sustainability initiatives – intelligent driving practices, exploring energy efficient measurements and techniques.
- Regenerative braking work.
- Contribution to European research, including Dynamic stability of lightweight trains project.
- Hyrail project with Network Rail.
- Supporting work on delivering ERTMS compliant interlocking systems.

Passenger Demand Forecasting Council (PDFC)

2.39 PDFC's current research priorities are set out below. However, the content of the list and relative priorities are reviewed by members twice a year to reflect changing industry needs so the list should not be regarded as a firm plan. The PDFC aims to carry out three or four new projects per year as funding and project management sources permit.

2.40 The PDFC research priorities for 2007/08 and beyond are:

- **Capacity and crowding** – a complete overhaul of current crowding advice, reflecting design of rolling stock interiors, how crowding impacts on individual customer segments and their travel experience and ideal use of time. Reviewing the link between fare and crowding as a modelling approach and considering whether a simpler non-interactive approach can be used.
- **Flexibility, price & crowding** – to look at how customers value flexibility, price and avoidance of busy services when selecting restricted, non-restricted and advance purchase tickets, and how this would relate to yield management strategies.
- **Evolution of rail demand drivers** – to look at how the relationship with external demand drivers is changing, including changing lifestyle and working practices, demographic factors and awareness of environmental issues, and how these changes will impact on future rail demand.

- **Regional studies of elasticities and relationships with demand drivers** – to undertake a series of case studies in towns and cities around the country and develop an understanding of how factors driving demand differ geographically.
- **New services/stations** – to review advice on modelling potential demand for new stations and train services and services that have received major upgrades.
- **Demand profiles** – research current demand profiles and journey factors to provide alternatives to the outdated profiles used by Orcats and for season ticket suspense.

FREIGHT SECTOR

- 2.41 Research activity by rail freight operators, such as EWS and Freightliner, tends to focus on tactical research on areas that affect rail freight operations in the short to medium term. Current areas of interest include biofuel testing, the operation of longer trains and rail emissions. Freight operators also contribute to research programmes through organisations including RSSB and ATOC.
- 2.42 Suppliers to the rail freight industry also undertake research. Rolling stock suppliers such as EMD (who provides the Class 66 locomotive), and wagon suppliers such as WH Davis and Axiom carry out research into locomotive and wagon design. Research on forecasting future demand for rail freight is carried out by consultancies such as MDS Transmodal. Wider research carried out by the logistics industry often has indirect application and impacts on the rail freight sector.

PASSENGER FOCUS

- 2.43 Tables 2.8 to 2.10 summarises all current, recently completed and planned research projects at Passenger Focus.

Table 2.8 - National Passenger Survey

Issue	Next action	Date
Spring 2007 report	Summary publication available on passenger focus website and public detailed ad hoc queries available on request	05/06/2007

Table 2.9 - Continuous Research Projects

Issue	Next action	Date
T – 12 monitoring compliance by TOCs of ability to book seats in advance of travel Carried out in-house at PF	No issues, all TOCs compliant for booking during Easter 2007 period. Check Christmas 2007 availability	November 2007

Table 2.10 - Research Projects to Support Understanding of Passenger Issues

Project	Next action	Date
Ticket retail - mystery shop Station, telephone sales and on train shops carried out by continental research for PF. Data reliable at a national level, Not at a TOC level. Internet shops carried out in-house	Reports and summary published March 2007	Available
Passenger awareness / levels of crowding following First Capital Connect ticket restrictions being introduced	Data tables / press summary produced for research carried out in October 2006.	Available
Fares qualitative research – focus group	Full report produced on research carried out in February 2006	Report available
Fares quantitative research – national survey	Full report produced on research carried out in May 2006	Report available
Mystery shop of complete passenger experience to better understand NPS data. To be carried out in partnership with southern TOC. Quantitative, structured survey.	Fieldwork Draft report due	Feb / Mar 2007 August 2007
Accessing stations with a	Published	Report

Project	Next action	Date
particular emphasis on parking in relation to the Greater Anglia RUS. Station surveys and transport planning.	March 2007	available
Encouraging edge of morning peak travel for passengers using waterloo station in the peak. Qualitative research, focus groups.	Full report produced on research carried out in April 2006 Policy implications paper produced	Report available Paper available
Passenger priorities (all fieldwork carried out in 2006) Quantitative surveys at a line of route level. Central trains, Greater Anglia and Scotland - 13 routes Virgin Cross Country - Whole network Scottish routes - 5 routes North West routes - 4 routes	Full reports produced Data sets produced Full reports produced Data sets produced Full reports produced Data sets produced Full reports produced Data sets produced	Reports available Data sets available
Research on passenger evaluation of new Desiro trains on TPE Quantitative survey		Report available
Passenger information needs in relation to train service disruption whilst Colchester to Clacton line is re-signalled sponsored by Network Rail. Focus group research.	Groups held Published April 2007	Jan / Feb. 07 Available
Disabled mystery shop working with disabilities rights commission to address issues identified in their research. Pilot mystery shop.	Fieldwork Report	2007 February / March 2007 Estimated August 2007
National priorities for improvement survey has been commissioned.	Publication	24/07/2007
Focus group research on environmental impact of rail and passenger issues	Publication	24/07/2007
Focus group research on DfT priorities for rail strategy	Publication	24/07/2007
Table of seas on ticket benefits by TOC	Desk research May 2007	Report available

Project	Next action	Date
Audit / mystery shop of different rail information sources	Scoping document produced Desk research	Summer 2007

2.45 In addition Passenger Focus is conducting the following research in the 2007/08 financial year:

- Survey of employer requirements from rail – different sized companies, focused on organisations that make high volumes of longer distance journeys.
- Survey of route based passenger priorities in response to RUS's in Wales, Lancs, Merseyside and Yorkshire and Humber.
- Passenger evaluation of station enhancements – small / medium sized stations.
- Ticket queue lengths – SWT and possibly extended.
- The issue of TOCs handling of unplanned service disruption.

LONDON TRAVEL WATCH

2.46 London TraveWatch represents the interests of transport users in and around the capital. It is involved in research relating to the improvement of passenger experience. Research projects carried out in recent years are summarised in Table 2.11.

Table 2.11 – London TravelWatch Research

Title	Date
Easing the trip - Meeting the needs of disabled rail users	March 2001
Fare Deals for London?	July 2004
Getting To The Station	April 2006
Good Riddance to Bad Rubbish	December 2002
How fair are the fares memorandum	October 2005
Light at the end of the tunnel - Chiltern report	June 2006
London for the continent	January 2003
London on the Move	March 2002

Title	Date
Major Rail Construction Schemes in London - Results of a public consultation (March 1998)	March 1998
Reaching the Skies	February 2002
There's more to Chiltern than the Chilterns - The Case for a Chiltern Metro	
Times tables - Making sense of when and where trains run	March 2002
Times tables - Making sense of when and where trains run Full Version	March 2002
Transport for all? - Dial a Ride and Taxicard users speaking	June 2003
When is a train not a train? A study of rail replacement bus services	April 2004
Where is this? An audit of station name signing	March 2004
Which Street for Southend - choice of terminus for c2c late evening trains	December 2001
Whose station are you - A survey of joint Underground National Rail stations in London	
Signage audit of stations on the North London Line	Current

2.47 In addition to this research London TravelWatch is involved in producing National Rail Performance Reports, and responds to consultations on rail franchise replacement, RUS's, Community Rail, Crossrail, Government White Papers and Strategies, timetabling etc, all in the interests of the travelling public.

TRANSPORT FOR LONDON

2.48 Transport for London carries out research mainly in areas focusing on strategic service planning, demand and capacity analysis, passenger volumes and fares. It is currently involved in four areas of rail research:

- Impact of fares changes on revenue, demand and possible switches in types of ticket used (Overground);
- Revenue and demand forecasting – Overground;
- Gross cost contracts - costs and benefits compared to net cost contracts;
- Demand management/peak spreading - research on impact of fares differentials (joint with DfT and Network Rail).

OFFICE OF RAIL REGULATION (ORR)

- 2.49 The ORR has a statutory duty relating to research (The Railway Act 2005), in connection with railway safety purposes. The key driver of the research that ORR commissions is the organisation's immediate needs as a regulator, such as in support of inspector intervention of the safety side or developing policy on the economic side. However strategic research is also important to ORR, although much of this is funnelled into the RSSB research programme.
- 2.50 The ORR's own research spend is approximately £200k per annum. Recent projects include research into derailment of trains and the integrity of aluminium welded structures.

TECHNICAL NOTE: CROSS-CHECK AGAINST RAIL WHITE PAPER AND RAIL TECHNICAL STRATEGY

NOVEMBER 2007

3. INTRODUCTION

3.1 This technical note provides a cross-check of the Rail Industry Research Strategy (RIRS) against the Rail White Paper (RWP) and Rail Technical Strategy (RTS). This is to ensure that all relevant issues highlighted in the RWP and RTS are reflected appropriately in the RIRS.

4. RAIL WHITE PAPER

4.1 The Rail White Paper, Delivering a Sustainable Railway, was published in July 2007 and set out short, medium and long-term plans for the railway. Table 1 below highlights all references to research in the RWP and explains how these are reflected in the RIRS.

Table 1 – Rail White Paper

Rail White Paper – Delivering a Sustainable Railway	How RIRS addresses the issue
Ch 1 -The Government will encourage progress by funding research and writing environmental objectives into passenger franchises.	Strategic research theme 4 addresses environmental objectives.
2.24 – Notes the potential for increased patronage (particularly at off-peak times) if passengers' personal security concerns are addressed.	Strategic research theme 5 addresses customer security concerns.
2.29 - The reduction of non-accident risks (crime and security) should be a key focus of the Industry Research Strategy to be published later this year.	Safety research stands alongside all the proposed strategic research themes (3.14)
4.6- Research by Passenger Focus confirms that capacity is now high on the list of rail-user concerns.	Strategic research theme 1 addresses capacity.
6.3- The Eddington Study stressed the critical importance of good inter-urban links to the competitiveness of the UK economy. Consultation carried out with the CBI and research provided by the British Chambers of Commerce in developing this White Paper highlighted the influence that a reliable and frequent rail service has on business-location decisions.	Strategic research themes 1 and 5 address capacity, reliable and quality of service.

Rail White Paper – Delivering a Sustainable Railway	How RIRS addresses the issue
10.13 -Research by Passenger Focus confirms that reliability and capacity are amongst the top passenger priorities.	Strategic research theme 1 addresses capacity and reliability.
Ch 11 Summary - supports research on environmental impacts and the technological solutions.	Strategic research theme 4 addresses environmental impacts.
11.13- Department for Transport research shows that currently there is a relatively weak link between awareness of climate change and people’s actual travel behaviour. Passenger Focus research found that rail’s environmental performance is not a priority for passengers. However, over a 30-year time horizon, this can be expected to change. Achieving the Government’s carbon-reduction target implies that people in 2037 will have around half of today’s carbon footprint. It is plausible therefore that they will be much more sensitive to the carbon cost of transport and will factor it into their choices about whether and how to travel.	Strategic research theme 4 addresses the environment and energy and theme 5 address passenger behaviour issues.
11.34- The Government will support research into alternative, less intrusive train horns.	Strategic research theme 4 addresses noise.
11.40- The Government will also support and encourage research to demonstrate the potential of new technologies, such as fuel-cell trains and battery-diesel hybrid vehicles, which could offer significant climate change and other environmental benefits in the longer term.	Strategic research theme 4 addresses new technologies with environmental or energy benefits.
11.42- Recent industry research has identified a range of energy-saving measures that deliver a relatively quick commercial payback through lower energy bills. The Government expects the industry to implement these measures.	Strategic research theme 4 addresses energy saving measures.
13.43- As improvements in technology are essential to future delivery, so those improvements depend upon research. The Government will continue to provide funding for industry research aimed at improving the safety and cost-effectiveness of the railway. In the past, this has primarily been executed through the Rail Safety and Standards Board, and this arrangement is expected to continue.	Safety cuts across all the strategic research themes. Cost-effectiveness is dealt with in strategic research theme 2. RSSB funding for safety research is not proposed to be changed in RIRS.
13.44- Following the publication of this White Paper, the Government intends to lead a wide-ranging review of railway industry research, ensuring that priorities are agreed, funding is appropriately directed and maximum value is obtained through collaboration within the industry and with European bodies. The results will be published in the <i>Rail Industry Research Strategy</i> later this year.	RIRS objectives and scope as set out in chapter 1 are consistent with this.

5. RAIL TECHNICAL STRATEGY

5.1 The Rail Technical Strategy was published alongside the Rail White Paper and sets out a long-term vision for the future railway. Table 2 below highlights all references to research in the RTS and explains how these are reflected in the RIRS.

Table 2 – Rail Technical Strategy

Rail Technical Strategy	How RIRS addresses the issue
<p>1.6 Research has already started to influence change to train and track characteristics through the Vehicle–Track Interaction Strategic Model (VTISM) sponsored by the Vehicle–Track System Interface Committee.</p>	<p>Strategic research themes 3 and 7 deal with the interactions between track and train.</p>
<p>1.6 European research (such as INNOTRACK projects) supported by all UK industry parties will further inform future specifications for both track and train from about 2009 onwards.</p>	<p>These projects are relevant under strategic research themes 2 and 3.</p>
<p>1.9 Research into hydrogen technology is best pursued at European level, with the UK continuing as an active partner in collaborative European research.</p>	<p>Strategic research theme 4 addresses alternative fuel sources.</p>
<p>1.11 Initiatives in passenger and train flow data need to be better co-ordinated. DfT and ATOC are taking forward smart ticketing, Train operating companies are working individually on passenger loading and information systems, and Network Rail is developing a new train location system in an initiative supported by ORR. This area will change very rapidly over the next 10 years, and the need is for agreement of common requirements and structures rather than technological research, as the technology already exists.</p>	<p>Strategic research theme 5 addresses passenger information needs and theme 7 addresses the interaction between operational and passenger data systems.</p>
<p>1.13 The DfT will continue to engage with all industry partners and stakeholders to encourage and support research, encourage alignment of incentives through the ORR and facilitate cross-industry programmes and projects that move the industry in the direction of minimised whole-life, whole system cost. The RTS is intended to be a living document, owned and updated by the industry in response to future technology development and the results of ongoing research.</p>	<p>The RIRS supports this process.</p>
<p>2.6 Ownership of development and delivery resides with the owners and operators of the railway. The Technical Strategy Advisory Group (TSAG) of senior industry executive staff with appropriate expertise and experience will develop and champion the implementation of the RTS, advising and supporting further communication, overseeing strategic research, identifying opportunities and barriers and advising its member organisations on actions needed to achieve an optimum outcome.</p>	<p>The RIRS sets out the role of TSAG in overseeing strategic research in chapter 4.</p>

Rail Technical Strategy	How RIRS addresses the issue
<p>2.8 TSAG will also own the agenda for strategic research. Many research initiatives are already in hand, driven through RSSB, Network Rail and ATOC. The benefits of academic involvement should continue to be exploited, principally through Rail Research UK, and maximum value extracted from European research co-operation. Professional bodies can also help. The engineering institutions are already facilitating a number of seminars on key aspects of the RTS and the work of the System Interface Committees.</p>	<p>The roles of key players are set out in chapter 4 of RIRS and are consistent with this.</p>
<p>4.50 The development of standard solutions at modular level (for example body shells, traction packages) is being addressed through European research.</p>	<p>Strategic research theme 6 addresses standardised solutions for rolling stock.</p>
<p>4.72 Research can provide evidence about the risks for the railway of changing climate and has the potential to evaluate options for mitigating these risks where they are shown to be significant. However, the impacts are not yet sufficiently well quantified to be able to define specific actions at specific locations, except in the most obvious cases such as Dawlish, where a fully-quantified study has been carried out by RSSB.</p>	<p>Strategic research theme 4 addresses this.</p>
<p>4.73 Rail research should increasingly include specific projects to provide quantitative evidence of the effect of climate change on the railways and options for adaptation to these changes. Design standards can then be updated where needed and opportunities for upgrading to meet changes in weather patterns and temperatures exploited.</p>	<p>Strategic research theme 4 addresses this.</p>
<p>4.107 Further research needs to be done by Network Rail to demonstrate the relationship between occasional use by heavier trains and infrastructure cost, where lines are normally used by lightweight passenger trains.</p>	<p>Strategic research theme 3 addresses the impact of trains on infrastructure.</p>
<p>5.38 The need for a differentiated railway system is recognised in the current approach to interoperability, and European research, influenced to no small extent by UK industry, is enhancing the clarity of this approach in a way that closely parallels our thinking.</p>	<p>Strategic research theme 2 addresses the differentiated railway concept.</p>
<p>5.44 Enhancing reliable capacity - Research initiatives in this area include:</p> <ul style="list-style-type: none"> • High-reliability infrastructure; • High-reliability trains; • Effect of ERTMS on capacity; • Advisory speeds; • Effect of cab signalling on route knowledge requirements; • Line-of-sight working; • Freight and other train planning; and • Comparison of relative costs/benefits of train lengthening versus double-deck trains 	<p>Strategic research theme 1 addresses the enhancement of reliable capacity.</p>

Rail Technical Strategy	How RIRS addresses the issue
<p>5.45 Reducing specific cost of reliable infrastructure. Research initiatives in this area include:</p> <ul style="list-style-type: none"> • Intelligent condition monitoring; and • Detection of broken rails in the absence of track circuits. 	<p>Strategic research theme 2 addresses the reduction in the cost of reliable infrastructure.</p>
<p>5.46 Encouraging reduction in vehicle mass. Research initiatives in this area include:</p> <ul style="list-style-type: none"> • Lightweight rolling stock; • European 'LITE'; and • Reductions in mass of equipment. 	<p>Strategic research theme 3 addresses the reduction in vehicle impacts upon infrastructure.</p>
<p>5.47 The environmental case for rail. Research initiatives in this area include:</p> <ul style="list-style-type: none"> • Baselining current environmental performance and setting targets for improvement • Hybrid traction packages; • Biofuels; • Air quality; • Energy metering; • New forms of energy, e.g. fuel cell; • Noise; and • Impact of climate change on the railway. 	<p>Strategic research theme 4 addresses the environment, energy and the railway.</p>
<p>5.48 Improving the passenger experience. Research initiatives in this area include:</p> <ul style="list-style-type: none"> • Communication with passengers by personal media; and • Integration of passenger data and information systems. 	<p>Strategic research theme 5 addresses the customer experience.</p>
<p>5.49 T&RS – reducing cost and improving availability. Research initiatives in this area include:</p> <ul style="list-style-type: none"> • Rational family of trains; • The European MODTRAIN project is aimed at reduced life-cycle cost and improving availability; and • Community rail. 	<p>Strategic research theme 6 addresses the cost and availability of rolling stock.</p>
<p>5.52 Current research should be pursued, including initiatives by professional bodies investigating the concepts of lightweight, high-performance, low life-cycle cost rolling stock, and energy/capacity-optimised control systems.</p>	<p>Strategic research themes 3 and 6 address rolling stock improvements and themes 1 and 4 address the optimisation of control systems for capacity or energy.</p>
<p>5.53 A major item of research associated with the RTS will be a financial and benefit analysis of applying appropriate differentiated standards to the identified network segments. Working with the rest of the industry, Network Rail is preparing to take the industry lead on this work.</p>	<p>Strategic research theme 2 addresses the differentiated railway concept.</p>

Rail Technical Strategy	How RIRS addresses the issue
<p>6.4 The DfT will continue to engage with all industry partners and stakeholders to encourage and support research, encourage alignment of incentives through the ORR and facilitate cross-industry programmes and projects that will deliver long-term change.</p>	<p>This is consistent with the approach to rail industry research set out in chapter 4.</p>