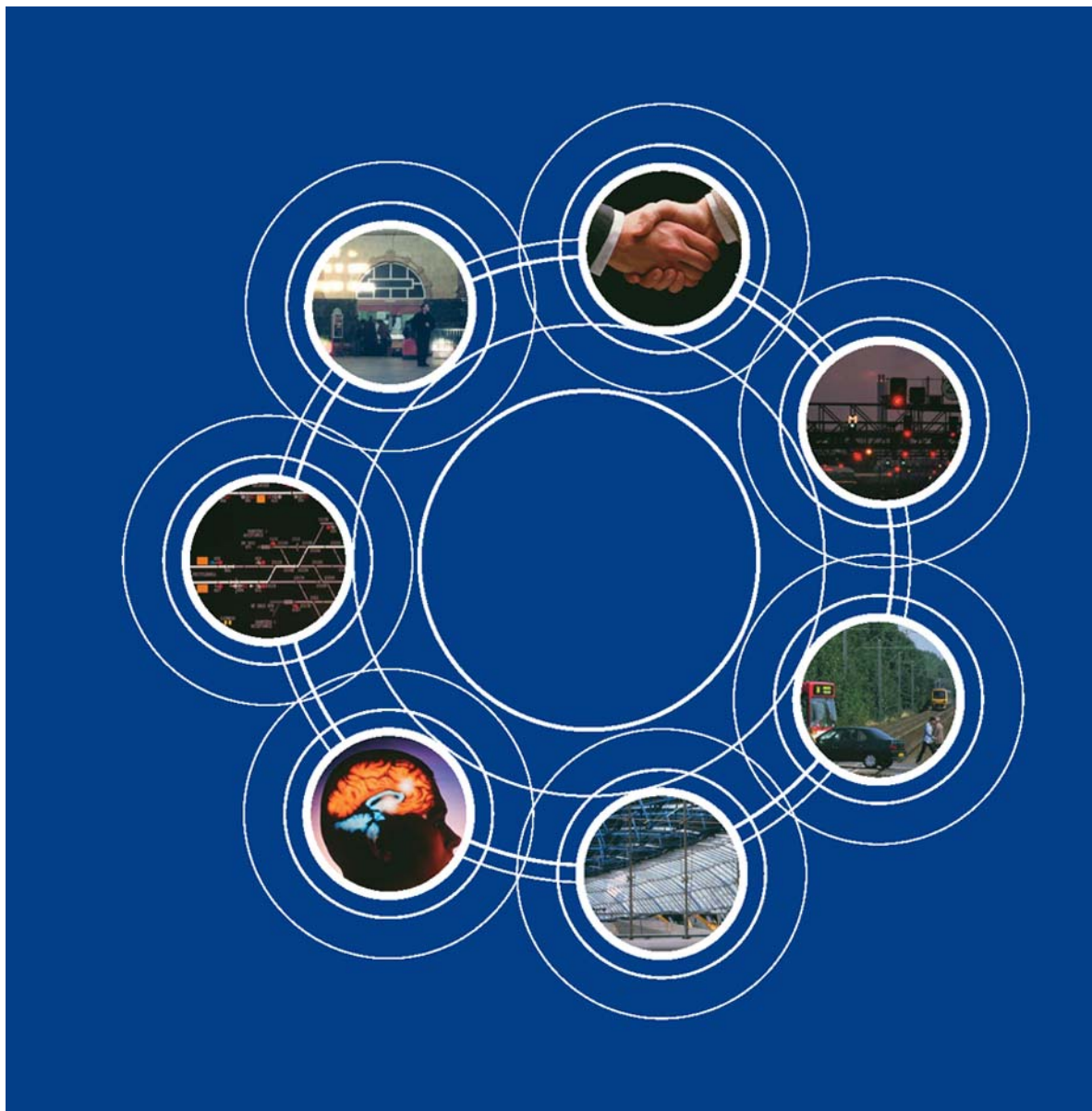


TSAG



Research Programme Strategy Support

Tomorrow's railway and climate change adaptation
Phase 1 report



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Published: August 2010

Written by:

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Adapting to extreme climate change

Phase 1 report

Background

This report covers the technical outputs from Phase 1 of the research project T925 *Tomorrow's Railway and Climate Change Adaptation* (TRaCCA). Network Rail has managed the work within the agreed timescale, with inputs from the Met Office and the Association of Train Operating Companies (ATOC) and Phase 1 is now complete.

The Technical Strategy Advisory Group (TSAG) held a meeting in October 2009; a proposal was submitted from the Route Mapping Steering Group, on adapting to extreme climate, this summarised the need for funding of a research project, to facilitate the development of an adaptation strategy, and to permit the provision of improved reliability for the railway network, taking into account the impact of climate change.

Business drivers

Extreme weather events in the last few years have shown that we have insufficient understanding of weather effects on our infrastructure and rolling stock, passengers and staff to permit informed judgements to be made concerning adaptation policy to deliver a reliable railway into the future.

The rail industry needs to know how the current and future climate will affect the ability to achieve and deliver:

- A safe railway
- A highly reliable railway
- Increased capacity
- Value for money
- A 'predict and prevent' ethos

Studies by Network Rail, RSSB, and the Environment Agency to consider the impacts of climate change on coastal defences and flood-susceptible structures, have highlighted the importance of the need of prediction, to necessitate the long-term management decisions required, to ensure reliable operation of the railway through the maintenance, and modification or replacement of potentially vulnerable assets. The requirement for this is all the more important given the future demands and needs for a highly reliable railway, increased capacity and value for money.

The philosophy of embracing climate change needs to be extended to the reliability of the railway system as a means of transport into the future, and as such, needs to consider the information required that is necessary to support the planning and provision of infrastructure and rolling stock, that may be adapted to cope with the impacts of climate change at a reasonable cost.

The resistance and resilience of railway assets to current extreme weather events and to future climatic conditions, needs to give way to a priority to the assessment of the railway as a whole system. The development of a generic method for assessment of the future impact of climate change, will permit the development of options for managing railway assets in the longer term, and will suit the timing of discussions between the Office of Rail Regulation (ORR) and Network Rail regarding the provision of information for future infrastructure investment in the High Level Output Statement and Control Period 5.

The Climate Change Act 2008 will require the compliance of Network Rail (and the ORR) to assess and report on the risks of climate change to rail operations, and to formulate plans to manage these risks. TOCs are not directly involved according to current proposals for assessment, and reporting, but receive and provide extreme weather related information.

Acceptance, Conditions, and Funding

The proposal was well received by TSAG, which is the industry group established to support the development, challenge, communication and delivery of the Rail Technical Strategy. TSAG offered support of up to £150k for Phase 1, on the understanding that the deliverables should be clearly defined, and requested that the outputs are in a form suitable for dissemination to scientific advisors across Whitehall, not only confined to the transport area.

When the research for phases 1 to 3 is completed, this should provide benefits across the rail industry, although the major factors that will influence improved reliability of operational performance are associated with adaptation of the infrastructure. Network Rail was identified as the preferred supplier to undertake the research, with input from ATOC, through the project Steering Group.

The work has been cited in DfT's Adaptation Plan, as a means of supporting the objectives of RSSB, in identifying long-term planning tools and techniques for the rail industry, to determine

potential strategies for sustainable development, furthermore, the DfT's plan recognises this work, as an opportunity to '*Fund research via RSSB to quantify the costs and benefits of climate change, and identify appropriate adaptation measures for the rail network*'.

Phase 1 Deliverables

The deliverables for Phase 1 were established to support the definition of the specific project requirements in Phases 2 and 3.

The key deliverables for Phase 1 were:

- 1 Confirmation of priorities with infrastructure, TOC, maintenance and operations specialists.
- 2 Confirmation of data availability: performance, safety data, rolling stock, systems, operations.
- 3 Determine requirements for the Government Climate Change Act Adaptation Reporting Power.

Method

The Phase 1 method involved seven workshops with the participation of railway asset management specialists from Network Rail (Engineering, Operations and Maintenance) and ATOC. From these workshops potential risks to the railway, taking in to account the effects of projected climate change, were identified. The list of topic areas established from the workshops is summarised in Appendix A.

An expert review and moderation exercise took place to 'sense check' and prioritise the workshop findings. This will help to ensure the outputs will be focussed and deliverable - the project recognises that if we assessed all possible climate risks the project would become unmanageable.

The outputs for Phases 2 and 3 are being based on the assumption that traffic levels and asset management policies remain as at 2009/10.

Findings

The review and moderation exercise produced a summary list of priorities which was then proposed to, modified and confirmed by the workshop attendees. This resulted in Table 1 which lists the risks that are likely to pose the greatest threat to the performance and safety of the railway, taking into account the impact of climate change. These topic areas may be considered to be 'priority topic areas' in respect of the impact of climate change on performance and safety. They are summarised in Table 1.

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Table 1 - Confirmed priority topic areas

Climate Impact Group	Cluster	Consequence
Heat	Track	Management of track buckle risk
Heat	Track	Reduced window of opportunity to carry out maintenance/ renewals work due to heat
Heat	People	Passenger health and impact on freight from train failure in extreme temperatures, including heat and cold
Heat	People	Staff working conditions, eg use of heat watchmen
Heat	Power/ Telecoms/ Signalling	Floating electrical earth leading to stray earth currents caused by dry ground/ low groundwater; heat (solar gain) affecting lineside equipment; sag in tethered overhead line systems at terminal stations
Rainfall	Fluvial flood	Track and lineside equipment failure
Rainfall	Groundwater flood	Track and lineside equipment failure
Rainfall	Pluvial flood	Track and lineside equipment failure
Rainfall	Fluvial flood	Scour and water effects at bridges
Rainfall	Fluvial flood	Scour at embankments due to high river levels and culvert washout
Rainfall	Fluvial flood	Safety of workforce carrying out inspections during an extreme flood event
Rainfall	Pluvial flood	Landslips
Rainfall	Fluvial flood	Accessibility of fleet and of maintenance depots
Insolation/ heat/ rainfall/wind	Vegetation	Change in type, falling trees causing obstructions, poor adhesion, and track-circuit non-activation
Sea level rise and storms	Coastal and estuarine defences	Wave overtopping and flooding at defended coastal and estuarine railways

Phase 1 required confirmation of data availability, and the principal datasets identified are shown in Table 2.

Table 2 - Principal data systems

Network Rail Data systems	
PALADIN	A user interface, for requesting data from various data systems
TOPS	Records of train schedules, details of locomotives, coach pools, vehicle maintenance regimes
TRUST	Records trains running and delays attributed to incidents
PEARS	Commercial data system for financial data
PAT	Performance Action Tracking, records for investment projects
NatTrends	Performance data
FMS	Fault Management System for reporting and managing faults on infrastructure
CARRS	Civils Asset Register and Reporting System, for asset management of Civil Engineering assets
CIV28	Civil Engineering safety related information
TABS	Track Access Billing System, rolling stock (train movement) data
GEOGIS	Geography and Infrastructure System, a database of railway infrastructure assets
ELLIPSE	A maintenance work management system
ISC	Investment Support Centre, monitors track renewals work carried out across the rail network
NROL	Information on shifts for haulage and on-track machine shifts
Train/vehicle data systems	
BUGLE	Data used for recording rolling stock failure - data is 95% NR
NFRIP	National Fleet Reliability Improvement Programme, shows train failures per mile for individual fleets
Other external data systems	
SMIS	Records safety performance and analyses risk across the rail industry

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A summary of the government requirements for Network Rail can be seen in Box 1. Appendix B contains more detail from the Defra document *Adapting to Climate Change: helping key sectors to adapt to climate change*' Statutory Guidance to Reporting Authorities 2009.

Box 1 - Summary of Government Requirements

Network Rail is required to report to Government [Defra] under a statutory direction the impacts of climate change on rail operations. Network Rail 'must prepare and send to the Secretary of State [of the Environment] a report' containing:

- (a) an assessment of the current and predicted impact of climate change in relation to the reporting authority's functions;
- (b) a statement of the reporting authority's proposals and policies for adapting to climate change in the exercise of its functions and the time-scales for introducing those proposals and policies.

The assessment of impact referred to [above] must include:

- (a) a summary of the statutory and other functions of the reporting authority;
- (b) the methodology used to assess the current and predicted impacts of climate change in relation to those functions; and
- (c) the findings of the assessment of the current and predicted impact of climate change in relation to those functions.

This report must be prepared by 30 April 2011.

Network Rail has been identified as an organisation recognised for its expertise in climate change adaptation, engineering and risk management. Because of this Defra wish to 'encourage Network Rail to submit the risk assessment part of its report by 30 September 2010'.

Furthermore, the Climate Change (Scotland) Act 2009 places a duty on specific bodies relating to climate change and this duty comes into force on 1 Jan 2011. Network Rail and Transport Scotland will need to support each other in meeting statutory requirements.

There is an opportunity to extend the research beyond the minimum statutory obligation of Network Rail, to report the impacts of climate change on rail operations on behalf of the railway industry.

Further work is necessary to understand and quantify the magnitude of the risks posed by the 15 'priority topic areas' across the network.

This work should be based on the assumption that traffic levels and asset management policies remain as at 2009/10.

The work necessary to achieve the outputs above are specified in Phases 2 and 3. A summary of the proposed outputs in Phases 2 and 3 is set out in Table 3.

Table 3 - Phase 2 and Phase 3 Deliverables

Phase 2 and Phase 3 Deliverables
Phase 2
Mathematical models for the priority topic areas for the Detailed specifications and costings for Phase 3
A high-level impact assessment as required by Government for 30th September 2010
Recommendations for potential 'quick wins' in terms of adaptation and procedural options for dealing with the impacts of current weather patterns
Preliminary recommendations for asset management policy and planning for Control Periods CP5 - CP8
Decades 2010s, 2020s, 2030s, 2040s
A specification for a tool to enable the rail industry to evaluate policy options (Adaptation Policy Evaluation Tool) for adaptation and weather resilience for priority and other topic areas
A climate change adaptation seminar to raise awareness and to inform the rail industry of likely climate change issues
A report summarising the above

Phase 1 report

Table 3 - Phase 2 and Phase 3 Deliverables

Phase 2 and Phase 3 Deliverables
Phase 3
Route-based climate change vulnerability maps
An interactive mapping visualisation tool
Adaptation policy evaluation tools for the priority and other topic areas for use by the rail industry
Material for the Government reporting in detail
Recommendations for geographically - based Standards development and further research requirements to support this
Priority climate change impacts for the whole GB rail industry for the four decades 2010s, 2020s, 2030s, 2040s
A seminar to cover the findings of the research
Guidance to inform the rail industry of likely climate change issues and how they will be dealt with
A report summarising the above

Appendix A

List of topic areas established from the climate change workshops

Climate Impact Group	Risk ¹	Safety Impact	Performance impact	Impact from Climate Change?
Heat	Air conditioning failure in carriages	Low	Medium	High
Heat	Track buckling	High	High	High
Heat	Speed restrictions due to buckle risk	Low	High	High
Heat	Use of heat watchmen for buckle risk	Medium	High	High
Heat	Floating electrical earth caused by a low water level	High	High	High
Heat	Reduced window of opportunity for work – renewal and maintenance - due to heat restrictions on track	Low	Medium	High
Heat	Reduction in track quality due to less maintenance	Low	Medium	High
Heat	Staff working conditions in hot weather	High	High	High
Heat	Earthworks desiccation	Low	Medium	High
Heat	Effect of heat on swing bridges	Low	Low	High
Heat	Contact wire sagging at terminal stations	Low	High	High
Heat	Solar gain affecting lineside equipment: Signalling, Power, Telecoms	Med	High	High
Heat	Reduced transformer life	Low	Low	High
Increased rainfall	Increased flooding generally	Low	High	High
Increased rainfall	Flooding at stations	Low	Medium	High
Increased rainfall	Flooding at depots	Low	Medium	High
Increased rainfall	Flooding affecting plant and equipment rooms	High	High	High
Increased rainfall	Flooding caused by poor drainage and high water levels	Low	High	High
Increased rainfall	Flooding at bridges – scour/ pressure/ obstruction damage	high	High	High
Increased rainfall	Flooding in tunnels	Low	Medium	High
Increased rainfall	Flooding - Track Circuitry/ Automatic Warning Systems/ Lineside cabinets and equipment	Low	High	High
Increased rainfall	Pluvial (surface water) flooding	Low	High	High
Increased rainfall	Increased rainfall causing high surface run off	High	High	High

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Increased rainfall	Rising ground water level	High	High	Medium
Increased rainfall	Scour due to high river levels	Medium	High	High
Increased rainfall	Cabinets	High	High	Low
Increased rainfall	Safety of workforce in extreme flood conditions – watchmen at flood sites ⁴	Medium	Low	High
Cold	Heave caused by freeze thaw	Low	Low	Low
Cold	Rockfall caused by freeze thaw	High	High	Low
Cold	Freeze thaw action on bridges	Medium	Low	Low
Cold	Ice in tunnels	Low	Medium	Low
Cold	Broken Rails	Medium	High	Low
Cold	3rd rail ice and snow	Low	High	Low
Cold	Snow and ice on the track	Low	High	Low
Cold	Slips, trips and falls, ice & snow	Medium	High	Low
Wind ²	Effect of wind on bridges and traffic on bridges	Low	Low	Low
Wind ²	Effect on equipment (OLE, signal, telecomms) structures, station canopies etc	Low	Low	Low
Wind ²	Effect of wind on freight trains	High	Medium	Low
Wind ²	Lifting with crane in wind	Low	Medium	Low
Wind ²	Change in direction and speed affecting trees	Medium	Medium	Low
Wind ²	Contact wire/ pantograph	Low	Medium	Low
Sea level rise and increased storminess	Sea defences ⁴	Low	Medium	High
Insolation/ heat/ rainfall/ wind	Increase and change in vegetation type	High	High	Medium
Insolation/ heat/ rainfall/ wind	Floral Adhesion ⁴	High	High	Low
Insolation/ heat/ rainfall/ wind	Vegetation – Showing Clear When Occupied track circuitry from leaves ⁴	Medium	High	Low

Insolation/ heat/ rainfall/ wind	Vegetation - Signal sighting ⁴	Medium	High	Low
Wind	Trees growing on the lineside – obstruction risk	High	High	High
Insolation/ heat/ rainfall/ wind	Loss of a safe Cess from vegetation encroaching	Medium	Low	Medium
Insolation/ heat/ rainfall/ wind	Vermin - signalling	High	High	Low
Increased humidity	Corrosion of rails	Medium	Low	Low
Increased humidity	Corrosion of bridges	Low	Low	Medium
Various	Incident Response	Low	Medium	High
Various	Failed trains and impact on passengers	Medium	High	High

Table notes:

- 1 Duplication is apparent because the same or similar issues were raised in different workshop sessions.
- 2 Climate change projections for changes in wind are uncertain to a degree where it is not reliable to make any judgement on change in wind velocity.
- 3 Groupings shown shaded were taken forward as priority topic areas.
- 4 This risk was taken forward as a priority topic area subsequent to the 'moderation' exercise.

Appendix B

Extracts from Defra document

'Adapting to Climate Change: helping key sectors to adapt to climate change Statutory Guidance to Reporting Authorities 2009'

Available via <http://www.defra.gov.uk/environment/climate/documents/statutory-guidance.pdf>)

Outline of Defra Adaptation Reporting Requirements Process

Stage 1: Assessing risks, identifying threats and opportunities

A reporting authority should have an appreciation of the potential climate impacts on its operations and/or functions for specified periods into the future, given the current best evidence. This assessment should include identifying the threats and opportunities to an organisation that may arise from future climate change. From an understanding of current vulnerability and projected impacts, it will be possible to identify threats and opportunities, and their consequences.

The risk assessment should generate priority areas for action based on the organisation's vulnerability to these risks. These priorities should be established and evidenced using a rigorous risk-based approach in order to ensure that impacts are dealt with in a prioritised and proportionate fashion, and so to reduce risks to the organisation over time to a residual level (the residual risk).

The approach adopted should be flexible given that our knowledge of future climate risks will undoubtedly change over time as knowledge and understanding improves, and given that there will always be inherent uncertainties when dealing with future unknowns.

Stage 2: Developing adaptation plans

The risk assessment should generate a priority list of risks for which a range of possible adaptation responses can be developed. The uncertainties and interdependencies that are an inevitable feature of the risk assessment mean that organisations

will need to be flexible as they generate their adaptation responses.

Some issues will require immediate practical adaptation responses, or changes to existing regulatory frameworks; while others will require more extended periods of investigation. These might include research, cost - benefit appraisal and other types of capacity building initiatives.

The resulting programme of adaptation responses should be assessed against sustainability principles (economic, social and environmental) and whether they would be viable in a low carbon economy.

Stage 3: Implementing the adaptation plan, embedding adaptation into existing structures and monitoring the effects

Having prepared a programme for adaptation responses, the next step is delivering adaptation actions, as well as an ongoing evaluation of their effectiveness in reducing the residual risk to the organisation. This process, which could include further risk assessment and analysis of other adaptation options, should assess, avoid and minimise any adverse impacts.

It is important that adaptation becomes part of the way that reporting authorities carry out their functions. Adapting to climate change is not a single, one-off exercise. It is ongoing and needs to be embedded into the core of each authority's business, not undertaken as a standalone activity.

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