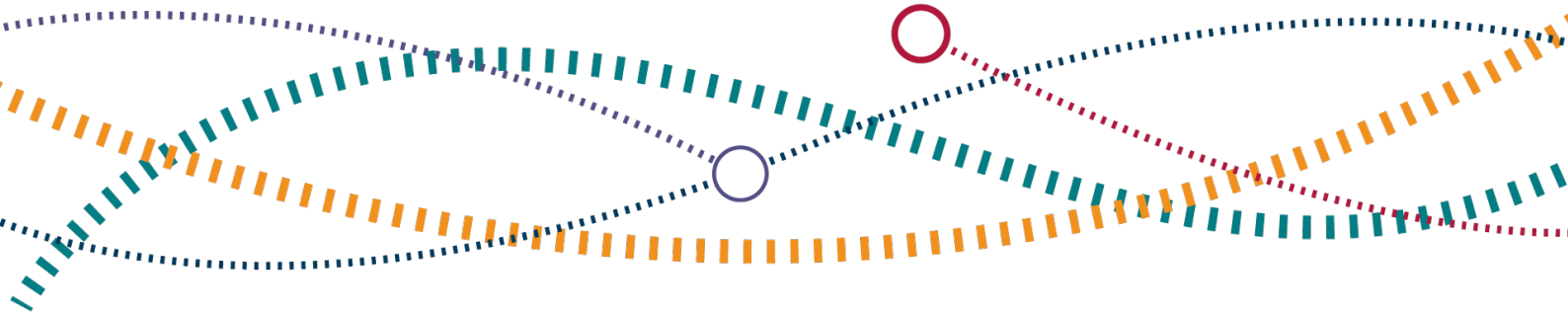
OFFICE OF RAIL AND ROAD

Traction Power Modelling & Capability

Targeted Assurance Review

19 August 2022



Contents

Abbreviations and Acronyms 2

Definitions 4

1. Executive Summary 5

Background 5

Conclusions & Recommendations 6

Next Steps 7

2. Introduction 8

Background 8

Purpose 10

Scope 10

Methodology 11

3. Findings 13

Defining Infrastructure Project Scope 13

Traction Power Modelling and Decision-making 17

Network Rail's changing approach to Traction Power Supply capability 21

Long-term planning 24

Improved governance and change control for Traction Power 26

4. Conclusions and Recommendations 28

Conclusions 28

Recommendations 29

Abbreviations and Acronyms

Abbreviation or Acronym	Full name
AT	Auto-Transformer
BEMU	Battery Electric Multiple Unit
CAPEX	Capital Expenditure
CP6	Control Period 6
CP7	Control Period 7
DfT	Department for Transport
DMU	Diesel Multiple Unit
DNO	Distribution Network Operator
ECML	East Coast Mainline
E&P	Electrification and Plant
FBC	Full Business Case
FOC	Freight Operating Company
GWML	Great Western Mainline
NR	Network Rail
OBC	Outline Business Case
OLE	Over-head Line Equipment
ORR	Office of Rail and Road
PR18	Periodic Review 2018
PR23	Periodic Review 2023
RFI	Request for Information
SOBC	Strategic Outline Business Case
STP	Short-Term Planning

Abbreviation or Acronym	Full name
SRO	Senior Responsible Owner
TAR	Targeted Assurance Review
TOC	Train Operating Company
TS	Transport Scotland
VSTP	Very Short-Term Planning
WCML	West Coast Mainline

Definitions

Control Period – Network Rail Control Periods are the five-year timespans in which Network Rail works to deliver the determined objectives as set in ORR's periodic review.

Periodic Review – Periodic Reviews are one of the principal mechanisms by which ORR holds Network Rail to account and secures value for money for users and funders of the railway. The PR18 final determination was published on 31st October 2018, covering the period April 2019 to March 2024.

Targeted Assurance Review (TAR) – TARs are ORR-led reviews which supplement the high-level information ORR receives regularly from Network Rail, by looking at specific issues in a more granular level of detail. TARs help ORR to develop an independent, evidence based opinion on important issues in advance of the next Periodic Review and they are a key element of assurance work within the Enhancements, Engineering and Asset Management team in ORR.

1. Executive Summary

Background

1.1 As part of our role in holding Network Rail to account, we initiated a Targeted Assurance Review (TAR) to assess whether Network Rail can produce timely, accurate and proportionate traction power modelling and capacity information to industry stakeholders.

1.2 Evidence from stakeholders suggested that traction power capability information and the required infrastructure interventions were not identified and adequately addressed as part of the enhancements process.

1.3 Not accounting for the lead times and costs required to change traction power supply had contributed to delays, overspend and reduced benefit realisation for these enhancements.

1.4 With this in mind, we wanted to gain an understanding of Network Rail's approach to delivering traction power capability for network changes (timetable uplifts, enhanced infrastructure or introduction of new rolling stock), including how it manages stakeholder expectations. In particular we looked to:

- investigate the reasons behind the power supply issues that were impacting enhancement projects and timetable changes (where additional electric traction is being introduced) across the network and whether Network Rail was able to provide timely, relevant and proportionate information;
- understand Network Rail's capability and strategy, and whether this was conducted consistently and to an appropriate level of detail for industry stakeholder needs across the five Network Rail operating regions.

1.5 In addition to this, we also investigated:

- whether Network Rail had a consistent approach to providing power capacity information to industry stakeholders who are involved in delivering enhancements and timetable uplifts where electric traction usage changes;
- how Network Rail provided information to these stakeholders, and whether stakeholders in turn gave Network Rail sufficient notice of proposed enhancements and timetable changes so that it could produce and provide the information;

- whether Network Rail was provided with sufficient information from stakeholders to enable it to produce the appropriate power modelling data and information.

Conclusions & Recommendations

1.6 This review found that Network Rail had the capability to produce power modelling information when required to inform stakeholders and feed into project requirements. We found no evidence that suggested that any of Network Rail's regions were failing to carry out the modelling or produce information in a timely manner with reasonable detail and accuracy.

1.7 Power modelling was not the sole method of effectively determining traction power capability, and that there had been a general over-reliance in the industry on modelling to inform decision making. Decision making on traction power capability requires a wide, holistic set of data, and Network Rail must work to ensure stakeholders understand this and have sight of it.

1.8 Network Rail regions are cognisant of this issue, and that steps are being taken to aggregate and simplify traction power capability information to make it accessible and relevant to stakeholders.

1.9 With regard to stakeholder engagement, a key reason for the traction power issues that have affected enhancement schemes and timetable changes had been due to communication breakdowns and a lack of clarity over how and when information on proposed changes to the electrified network should be communicated between Network Rail and rail industry stakeholders (and vice versa).

1.10 There is evidence that Network Rail had begun to take steps to address the issue of information flow with the introduction of improved governance. The maturity of this governance varied between regions, as did the maturity of the traction power strategies that each region now produces.

1.11 ORR would encourage Network Rail to ensure that best practice is shared between regions. Network Rail should also proactively engage with industry stakeholders (particularly the DfT and operators) to understand their future requirements and to get their input into the development of traction power strategies and long-term plans.

1.12 This review therefore makes the following recommendations:

- Recommendation 1: Each region should develop and maintain a robust traction power supply strategy. These strategies should promote decision making based on a holistic set of information, not solely on modelling. Each strategy should cover the short-term, medium-term, long-term developments to traction power capability in the region.
- Recommendation 2: Annual Statements should be produced by Network Rail to accompany regional strategies.
- Recommendation 3: Each region should embed effective change management, governance and control processes for traction power capability.

Next Steps

1.13 Regular engagement between ORR and Network Rail will continue throughout CP6 and future control periods. This will enable ORR to monitor Network Rail's progress with implementing the recommendations given in this TAR. It will also allow Network Rail to highlight any risks or issues that affect the implementation of the recommendations.

1.14 Engagement with industry stakeholders will also continue, to monitor traction power supply risks and issues and their impact on the rail network. Feedback will also be sought from stakeholders on the effectiveness of Network Rail's implementation of the recommendations in this TAR.

2. Introduction

Background

2.1 Traction power supply issues have affected a number of key enhancement projects across the rail network. A particular issue had been a lack of electrical capacity to enable the introduction of additional electric traction at timetable changes.

2.2 The following, current schemes were identified as either carrying a significant risk relating to traction power supply and capacity, or are already affected by traction power supply issues:

- **Midland Mainline Enhancement Programme –** concern over whether there was sufficient power supply for new electric fleet introduction and 125mph electric running.
- **East Coast Mainline Enhancement Programme –** scope and timescales of power supply works are an on-going issue for the programme, and are contributing to the delay of implementing a significant timetable change.
- **North West & Central Timetable Change –** insufficient power supply to enable the 2022 timetable change between Acton and Bushey.

2.3 Through our business as usual monitoring, ORR identified this as a recurring issue across the enhancements portfolio, over the last two control periods.

2.4 Network Rail's role in the power supply planning process includes:

- gathering supply and demand data from stakeholders;
- performing traction power supply modelling;
- conducting option selection and developing designs based on the modelling and power supply requirements; and
- developing business cases and presenting them to funders, for projects to enhance traction power supply infrastructure.

2.5 The roles of other stakeholders include:

- TOCs/FOCs: providing forecast usage and electric traction requirements, and information on future fleet strategy and procurement.
- Power suppliers: explaining options to increase supply, providing support to develop programmes to enhance supply infrastructure, and delivering grid connections and non-contestable works.
- Funders: selecting options based on affordability, strategic objectives, and political considerations.

2.6 Network Rail's Network Licence requires it to:

- secure the improvement, enhancement and development of the network in accordance with best practice and in a timely, efficient and economical manner;
- treat stakeholders in ways appropriate to their reasonable requirements and ensuring their views are duly taken into account.

2.7 As the regulator of this Network Licence, ORR needs to understand Network Rail's power modelling capability, and whether power modelling was conducted consistently and to an appropriate level of detail for industry stakeholder needs across the five Network Rail operating regions. There are several reasons why this is currently urgent, including:

- funders announcing enhancement pipelines;
- further decarbonisation proposals, which may result in higher volumes of electric traction usage, are in development;
- operators increasing their usage of electric and bi-mode traction and replacing diesel traction; and
- ORR is commencing its PR23 periodic review, where there will be interfaces between Network Rail's planned power supply upgrades and other elements of its business plan, including operational resilience and asset renewals.

2.8 In addition to looking into Network Rail's power modelling capability, ORR also needed to investigate how communications and stakeholder engagement issues affect Network Rail's ability to share timely, proportionate and accurate information

to other rail industry stakeholders (such as the Department for Transport, Transport Scotland, TOCs and FOCs). This includes how Network Rail provides information to these parties, and whether these parties in turn gave Network Rail sufficient notice of proposed enhancements and timetable changes so that they can produce and provide the information.

Purpose

2.9 Evidence from ORR's business-as-usual monitoring suggests instances where this had caused projects to incur delays, increased delivery costs or impacted the delivery of timetable changes. The purpose of this TAR was to go beyond ORR's business-as-usual monitoring and gather detailed evidence to understand:

- the reasons behind why these issues are so prevalent;
- Network Rail's capability (resources, competence, training etc) and the effectiveness of its stakeholder engagement;
- whether Network Rail can mitigate or prevent the occurrence of these issues by improving power modelling capability and stakeholder engagement; and
- to demonstrate that Network Rail was achieving its relevant obligations under the Network Licence, as noted in 2.6 above.

Scope

2.10 This Targeted Assurance Review covered the following specific questions:

2.11 **Capability:**

- Does Network Rail have the capability to provide timely and accurate information on power modelling, to advise stakeholders on:
  - the network's electrical capacity and whether their proposals are feasible;
  - indicative timescales and requirements to enable the introduction of additional electric traction and timetable uplifts; and
  - whether there are consistent processes and methodologies for power modelling across Network Rail's regions.

2.12 **Stakeholder management:**

- Does Network Rail effectively engage with its stakeholders, in particular the DfT, TS, TOCs and FOCs, to actively identify and advise on:
  - proposed timetable changes that result in operating additional electric traction;
  - introduction of new electric rolling stock; and
  - increases in electric freight usage.

2.13 The following areas are excluded from scope:

- we have not assessed the competence of other industry partners (DfT, TS, TOCs, etc) or made recommendations on how they could improve engagement with Network Rail regarding power modelling, because ORR does not regulate these parties in this area. However, we have highlighted any issues these parties may want to consider, especially as part of wider industry reform;
- we have focussed only on power supply issues relating to traction. Power supply issues affecting other aspects of the railway (e.g. station operation, signalling) are not be considered under this TAR because we had not identified these as a systemic issue.

Methodology

2.14 The timeline of the TAR was as follows:

- The TAR was initially discussed with Network Rail's Electrification Engineering Expert, who was also the key contact for the review.
- We then arranged an initial engagement meeting with stakeholders within Network Rail to introduce the TAR process and set-out the objectives of the review. This included Regional Asset Managers and Asset Engineers from each of the five regions, as well as the Chief Mechanical & Electrical Engineer. At this engagement meeting we agreed the deliverables, timescales and key contacts for the review.
- Following the meeting, a Request for Information (RFI) was issued that formally requested specific information from the five Network Rail regions.

- Network Rail then submitted evidence to ORR, which included:
  - formal Network Rail standards, policies and guidance notes;
  - explanatory slides and papers detailing how each region manages traction power supply capability;
  - processes and examples of how each of the regions communicates traction power supply information to stakeholders; and
  - case study examples of where Network Rail have produced traction power supply data to support project decision making.

- The information was reviewed and analysed and queries were resolved in correspondence. We then interviewed a cross-section of industry stakeholders. Interviewees included representatives from:
  - Department for Transport;
  - freight operators;
  - train operating companies; and
  - Network Rail project sponsors.

- This report was shared with Network Rail, to provide an opportunity to comment before it was finalised and issued.
- Throughout this process Network Rail has engaged and worked collaboratively to assist in our review. We would like to thank all those involved for their work and contributions to this TAR.

3. Findings

Defining Infrastructure Project Scope

Traction Power Capability should be a critical project requirement

3.1 Through our business-as-usual monitoring, stakeholders commonly reported that traction power supply information was not being communicated from Network Rail in a timely, clear or concise format to stakeholders. This resulted in the associated infrastructure requirements being missed from the scope of projects. This contributed to project delays, increased costs and delays to benefit realisation.

3.2 In this review, we interviewed stakeholders from Network Rail and from the wider rail industry. There was consensus from these interviews that traction power capability was often not prioritised effectively as a critical requirement. This was the case when planning enhancement projects and also when developing proposals to increase the volume of electric traction on the network (through new rolling stock or the uplifting of timetabled services).

3.3 By not prioritising traction power capability as a requirement for enhancements and timetable uplifts, this had led to several distinct risks and issues including:

- insufficient electrical capacity to run proposed services;
- changes to project scopes, which can cause rework and inefficiencies;
- loss of resilience in the electrified network, so it is possible to run additional services, but the network loses its resilience against unexpected asset failures or operational disruption.

3.4 As well as timetable changes and new rolling stock, it is important to consider other reasons that power capability can be exceeded, or resilience reduced including substitution of freight for passenger services, or changes to the wider network.

Case Studies and Systemic Issues

3.5 As noted in 2.4, Network Rail provided a sample of case studies. We requested that this sample should include:

- projects where traction power supply formed a critical requirement for the successful delivery; and

- projects where power supply upgrades and related works were delivered successfully, as well as projects which encountered issues that threatened delivery.

3.6 We found there was a common set of risks and issues that affected many of the case studies, and we also found many examples of good practices across the sample. Table 1 below summarises the issues identified across the five examples:

Table 1 – common issues affecting projects

Project	Late engagement with the proposer of change	Scope change	Over-reliance on power modelling to inform decision making	Ineffective internal communication between NR functions	Changing priorities affecting funding	Power supply requirements not being communicated to stakeholders
Class 385 introduction	Yes	Yes				
Reading Independent Feeder		Yes			Yes	
South London High Voltage		Yes			Yes	
WCML electric freight	Yes		Yes		Yes	
Acton-Bushey				Yes		Yes

3.7 Many of the issues are fundamentally the result of poor communication, both from Network Rail to industry stakeholders and vice versa. We found this was partly due to the roles and responsibilities for managing traction power supply being unclear and inconsistent between Network Rail regions (where traction power supply is a devolved matter) and with stakeholder organisations. This made it

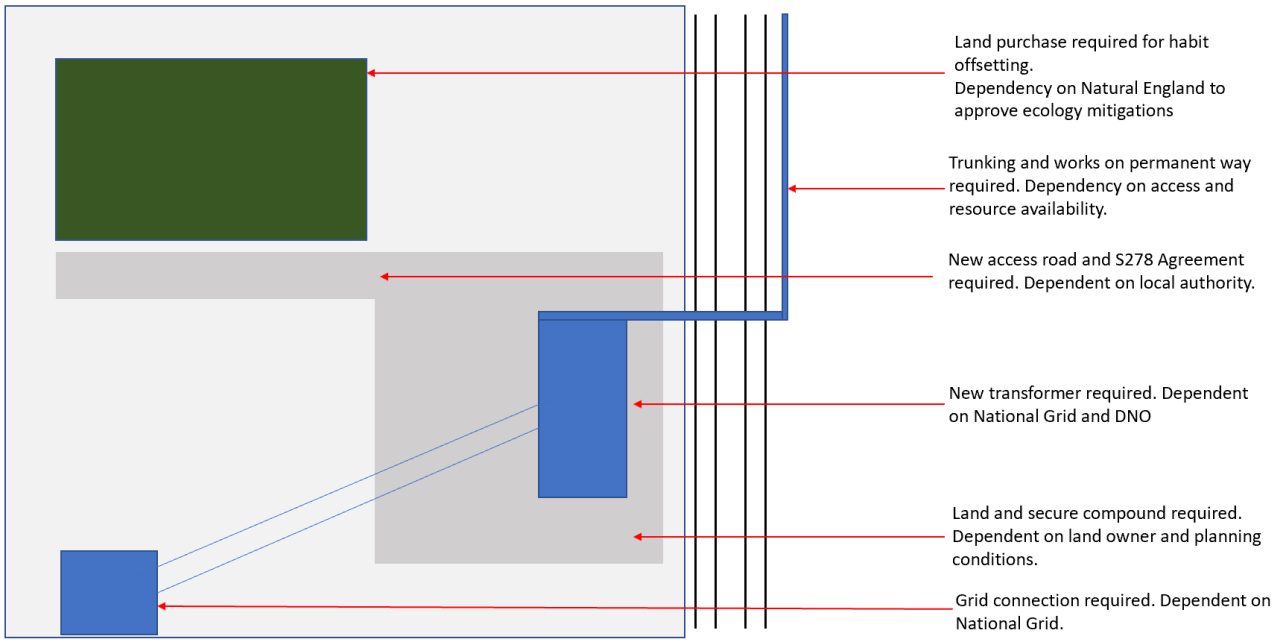
difficult to ensure the right parties have access to the right information at the right time.

3.8 For example, an industry stakeholder we interviewed noted that there was no lead or point of contact for traction power capability in their organisation, despite them managing a major portfolio of enhancements. They acknowledged that this had resulted in a risk that traction power capability may not be consistently addressed as a critical requirement for their projects.

3.9 A further example of where communication issues affected traction power capability was the introduction of the class 385s in Scotland. The electric units were originally planned for deployment on the Edinburgh-Glasgow route. However, the scope of the fleet introduction was increased to run 385s on various other routes in Scotland. There was late engagement between Network Rail and the proposer of the change. The late change of scope meant that the fleet introduction was rolled out without thorough traction power analysis being conducted by Network Rail. This resulted in a power feeder station being run near capacity, significantly reducing the resilience of the electrified network.

3.10 In each case study we reviewed, it was clear that upgrading power supplies and associated infrastructure can become a complex and expensive undertaking, with long lead times and dependencies on outside parties (such as the National Grid and Distribution Network Operators). Figure 1 below highlights the range of infrastructure components required to deliver a power supply upgrade. This is based on the Reading Independent Feeder project, a scheme that will take upwards of five years to bring into service at an anticipated final cost in excess of £50m. Delivery of the scheme is also dependent on external parties including National Grid, who are required to deliver non-contestable services.

Figure 1 – Top-down diagram of the Reading Independent Feeder project

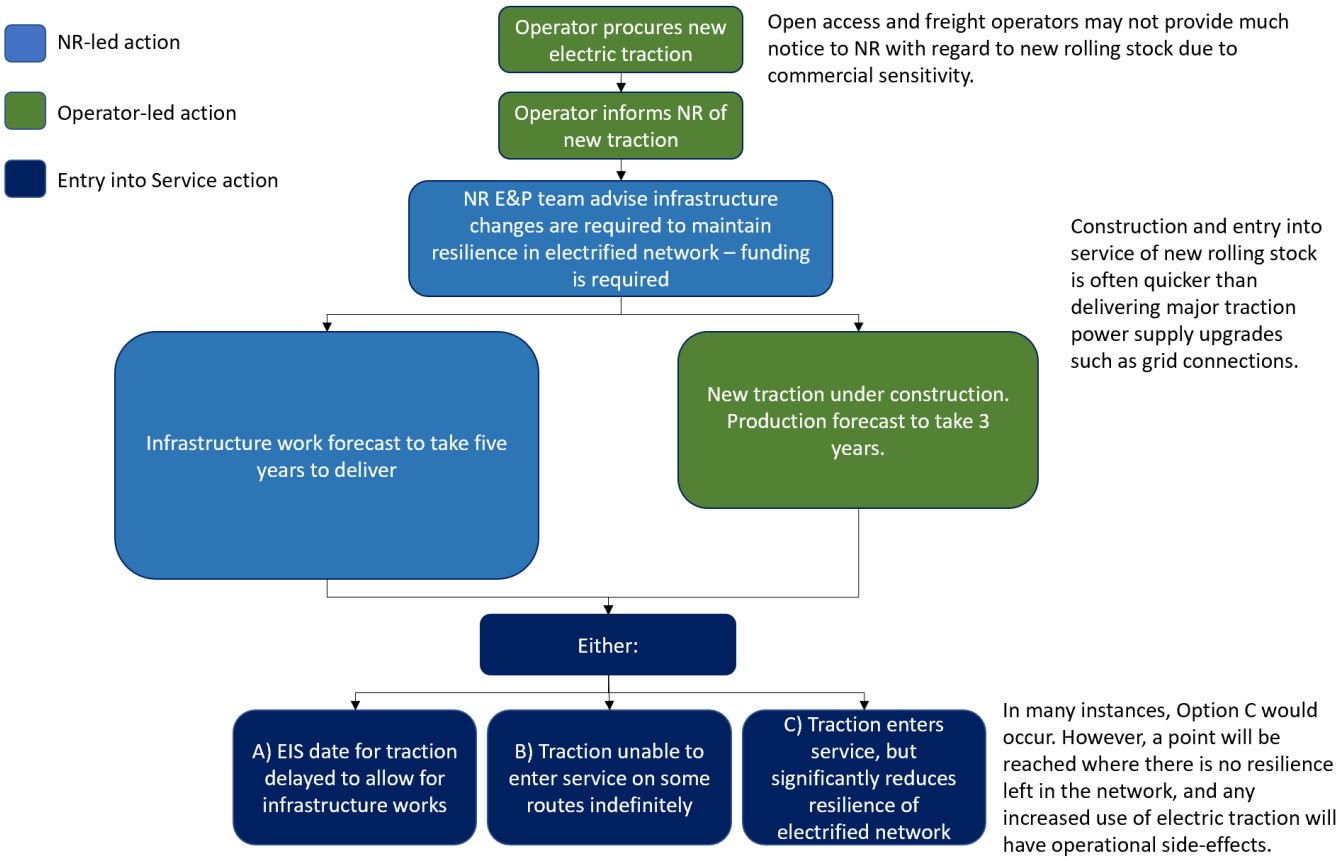


3.11 The time, cost and complexity of enhancing traction power supply can be exacerbated if the associated infrastructure requirements are not adequately understood at the design stage of the enhancement. We have seen evidence of this in several major enhancement schemes, including in the North West & Central (Acton-Bushey) and Eastern (East Coast Mainline) regions.

3.12 From our interviews with Network Rail, it was clear that providing more electrical power via supply points alone cannot always allow for more intensive use of electric traction. There are numerous additional and holistic factors that must be considered in order to increase the capability to run more electric trains – such as whether upgraded cables are needed over part of the network, to distribute the electrical power to trains and at a compliant voltage. As a result, power supply upgrades cannot be effectively planned and executed in isolation, as their implementation will have many impacts across the wider electrified network.

3.13 Through our interviews with industry stakeholders, many advised that they were not fully aware of the scope of requirements that need to be considered when planning upgrades to traction power capability. For example, one operator advised that they had plans to run more electric traction using bi-mode locomotives, but that they had not been informed by Network Rail as to what infrastructure enhancements would be required to achieve this. Figure 2 below shows a typical example of how failure to adequately address the infrastructure requirements could impact the network:

Figure 2 – traction power infrastructure requirements for new rolling stock



Traction Power Modelling and Decision-making

Over-reliance on Power Modelling

3.14 Traction power modelling generally adopts a process similar to the one shown below in figure 3.

Figure 3 – Power Modelling Process Flow

3.15 Evidence gathered through interviews suggested that Network Rail may have (in some instances) failed to provide timely and proportionate power modelling information to internal and external stakeholders, to inform the scoping of some enhancement projects, traction changes and timetable uplifts across the network.

3.16 Some stakeholders indicated that power modelling information they reviewed showed that their proposals were feasible. However, when they were ready to introduce their new stock and/or service changes, Network Rail then advised that there was insufficient capability to accommodate this, resulting in late changes to project scope. For example, this occurred with Avanti's proposals to run additional class 390 and 80x units from Euston in 2022. In these scenarios, this contributed to project delays, cost increases and delays to benefit realisation.

3.17 Network Rail advised us that this issue had been worsened by an over-reliance on power modelling to inform decision-making. While it was a useful input to inform decision-making, modelling alone was limited in determining how much capability there was to run increased volumes of electric traction, as well as identifying infrastructure interventions to increase capacity.

3.18 For example, we understand from the Wales and Western E&P Team that while models can assist decision-making, they cannot be relied upon for an accurate

view of the resultant resilience of the system. It can only provide an indicative snap-shot of whether a proposal to run additional electric traction is feasible or an indication of the infrastructure interventions that are required. It can also lead to the development of many small-scale, incremental traction power supply upgrades, which are less cost effective than a single, sustainable solution.

3.19 From our interviews with industry stakeholders, there was evidence of over-reliance on headline outputs from power modelling information to aid project decision-making. This had contributed to the decision to descope traction power supply upgrades from larger programmes of work to reduce costs, as it would have shown that upgrades were not critical to deliver the programme and maintain service levels. It did not adequately account for the reduced operational resilience, or future proposals to uplift service levels. Examples of this include the descoping of power supply upgrade works from the West Coast Power Supply Upgrade Programme and the Great Western Electrification Programme. In both instances, the power supply upgrades are now being delivered following further reviews of traction power supply capability.

Monitoring and Managing Risks to Operational Resilience

3.20 We also found evidence that where traction power supply capability works have been deferred or descoped from larger programmes, the residual risks to operational resilience resulting from this decision were not effectively recorded, monitored and communicated between Network Rail and the wider industry. For example, power supply upgrades on the West Coast Mainline have a history of being scoped and then descoped from various programmes over at least the last fifteen years. As the work was descoped each time, the demand for electric traction continued to increase incrementally through timetable changes and phasing out diesel rolling stock, so any resilience in the existing power supply was gradually eroding. This continued until the recent plans to remove the class 221 Super Voyager fleet and utilise bi-mode class 80x in their place (combined with more intensive use of the existing Avanti electric fleet) showed that this could not be accommodated under the existing traction power supply without significant side-effects to operational performance. Additional decarbonisation schemes and the push to utilise more electric freight traction (often run at short notice on VSTP paths) further exacerbated the issue.

3.21 We found additional evidence that there was insufficient communication between Network Rail's E&P Team, the Strategic Planning Team and industry stakeholders (train operators). In particular, a business case to deliver power supply enhancement works between Acton-Bushey was in development as of 2019.

However, the introduction of new electric Avanti class 80x rolling stock was not taken into account until 2021, when planning for the December 2022 timetable change commenced. Whilst discussions would have taken place before this between Avanti and the Strategic Planning Team, the E&P team had not been part of the conversation until timetable planning commenced. Given the age of the class 221 fleet, the fact that they run on diesel when most of their service route was under OLE and the widespread introduction of bi-mode 80x fleets, this development should have been anticipated by a reasonable horizon-scanning process and planned for.

Stakeholder engagement during design and delivery

3.22 We spoke to several TOCs as part of this TAR. The feedback we received from them was fairly mixed. There was a general consensus that engagement with Network Rail in this area had been poor at times (with one TOC noting that this contributed to issues that affected a timetable change), but also that it had started to improve in recent years.

3.23 For example, one TOC advised that they were in the early stages of developing a business case to utilise Battery Electric Multiple Units (BEMUs) in place of their existing Diesel Multiple Unit (DMU) fleet. The units will draw from the OLE to charge their batteries, before running on batteries away from the wires. The TOC advised that despite this work being at an early stage, the region's E&P team have engaged with them and provided relevant information to help inform their business case. They advised that they had not received this level of engagement from Network Rail on previous projects that they had developed, and welcomed this change.

3.24 The TOC representative did note that they, as the proposer of a change to the network and their fleet, approached Network Rail at an early stage to request their input into the development of the programme. It was noted that not all operators are in a position to approach Network Rail at such an early stage for various reasons, including commercial sensitivity around fleet procurement (an issue that was far more prevalent with open access operators and freight operators). Our review found that Network Rail faced fewer issues when they were not be reliant on operators giving them advance notice of changes to their electric traction utilisation and were proactive in their engagement.

3.25 Another TOC did note that there had been failings by Network Rail in the past to communicate slippage of power supply upgrade projects, including a major programme that was a critical enabler for a timetable change in 2018. However,

they advised that lessons were learnt from this failing, and that communication had started to improve since then.

3.26 Another TOC representative was cognisant that projects can become over-reliant on power modelling information to inform decision making. They suggested that Network Rail could be more transparent with how the modelling was produced (i.e. what inputs and assumptions have been used to inform the modelling, and what the limitations of the model were). They suggested that this would help mitigate against headline modelling information being used as the primary basis for decision making.

3.27 As part of the review, we also spoke to representatives from FOCs about their experience of working with Network Rail, with regard to traction power supply. Feedback from the FOCs was generally negative about engagement, and one operator described Network Rail's consideration of traction power capability for freight services as limited. The operator noted several power supply schemes currently being delivered by Network Rail which are at an advanced stage of delivery, where Network Rail had not yet engaged with the FOC to ascertain electric freight requirements – either for services that are currently running or proposed future services.

3.28 It was acknowledged that there were compatibility issues between electric freight locomotives and newly electrified lines (for example Bedford-Corby on the Midland Mainline), but it was evident that Network Rail had not effectively engaged with freight operators on their future plans to understand how additional electric freight services could be part of the outputs of infrastructure enhancements. The FOC also advised that they had ambitions to run and procure more electric locomotives, and that Network Rail had failed to engage with them on their future fleet strategy.

Network Rail's changing approach to Traction Power Supply capability

3.29 In 2019, Network Rail underwent a significant organisational transformation as part of the Putting Passengers First (PPF) initiative. PPF has resulted in the devolution of accountability for traction power capability from the centre to the five Network Rail regions. Each region had taken a bespoke approach to this, as there are various factors that determine how best to manage traction power capability in each region. These factors include:

- The type of electrical supplies available for traction (AC OLE or DC third rail, and also bespoke elements such as the fixed conductor beam in the Severn Tunnel);
- The extent of electrification across the region;
- The nature of the electric traction using the electrified routes and how this may change over time (for example, the makeup of local services, intercity and freight);
- The capacity of the electrical supply; and
- The proposed enhancements in the region that will impact the level of electric traction in use, including proposed decarbonisation schemes that could change the electrified network.

3.30 Network Rail recognised that devolution created a risk that concise and proportionate information on traction power capability may not be consistently fed through to stakeholders. Each region taking a bespoke approach to managing traction power capability may have exacerbated the pre-existing issue of inconsistent stakeholder management and communication.

3.31 As a mitigation for this issue, we found evidence of a drive to consolidate information and provide traction power capability information to stakeholders in a more transparent, concise and proactive way. Each of the regions are working to develop traction power supply strategies that provide detailed overviews of the capacity, capability and constraints of their routes. ORR is supportive of this, as it should enable a more thorough and earlier understanding of the effect of running higher volumes of electric traction and help identify where infrastructure interventions might be required.

3.32 The strategies are also used in some regions to forecast future infrastructure/service developments on each route, which may result in increased volumes of electric traction. For example, some of the strategies show how switching all freight to electric locomotive haulage could affect capability. The strategy then provides RAG-rated points along the route where modelling shows that capacity/capability would be limited. This provides an early warning where future schemes may incur additional costs to provide suitable traction power supply. Some strategies even go as far as to include very high-level illustrative costs for the associated works to increase traction power capacity. This may help industry stakeholders plan future schemes.

3.33 Feedback from Network Rail sponsors showed that these strategies have already proved useful in some regions. For example in the Wales and Western region, the work to install a new grid supply point near Reading was descoped from the main Great Western Electrification Programme due to financial and programme constraints. The region's traction power supply strategy, along with the support and expertise of the region's E&P team, played a crucial role in helping the Capital Investment team develop a robust business case to deliver the new supply point as a separate project. As a result, the project team were able to secure funding, which will lead to greatly improved traction power resilience in the region. This could have easily been deemed a low priority or non-essential, had the relevant information on the benefits of increasing power resilience not been fed through from the strategy and E&P team and into the business case.

3.34 Whilst we found evidence of the benefit of producing robust traction power supply strategies, the maturity and consistency of the strategies varies between regions. Some regions have only recently produced strategies, whereas some regions have had theirs in place for a number of years, as summarised in Table 2. Because operators, power supply companies and some programmes span across regions, there would be a clear benefit if the strategies adopted a consistent format and level of detail across all regions.

Table 2 – Initial publication dates of route/regional power supply strategies

Region	Wales & Western	Southern	Scotland	Eastern	North-West & Central
Initial publication date	November 2012	January 2022	June 2021	February 2022	TBC

3.35 In addition to producing a strategy, we found that some regions have also produced an accompanying traction power supply annual statement, which are then shared with rail industry stakeholders. The rationale behind this was that the overarching strategy documents will be published at the start of each Control Period, going forward. These will provide the strategic information on capability, capacity, constraints, risks, network developments, fleet changes, etc for the duration of the Control Period. Some of this information was very likely to change within a Control Period. The annual statement will reflect these changes and detail whether the strategy is being delivered, or if the strategy needs to change. For example, the strategy may have been written on the assumption that a project in

development would be delivering a power supply upgrade within the Control Period. If this is subsequently descoped, it will impact the content of the strategy and likely have a negative impact on the resilience of the traction power supply.

3.36 There are several benefits to producing an annual statement:

- It formally records changes that affect the Traction Power Supply Strategy, or impact the assumptions that were made when the strategy was written.
- It provides clarity to stakeholders on the current status of traction power capability in the region.
- It provides an audit trail for risks/dependencies/issues/constraints that arise from changes to the scope (for example, reduced resilience if a power supply project is cancelled).
- It assists in developing the next iteration of the overarching strategy for the next Control Period.

Long-term planning

3.37 A key challenge for increasing traction power supply capability was the long-lead times and often considerable investment required. As highlighted in Figure 1 above, a project to install a new grid supply point to the network can take in excess of five years - longer than the full duration of a Control Period. A new fleet of electric trains can be procured and brought into service in a shorter timeframe. A five-year forward plan (only considering one Control Period) is therefore insufficient to understand multiple interventions, or even a single intervention if it gets delayed or descoped.

3.38 The review found that Network Rail typically split the inputs for traction power supply development into three categories, each with increasing levels of risk and uncertainty:

- **Short-term planning (within the next 5 years):** This will primarily focus on the impact of new or cascaded rolling stock, timetable changes and new electric services. Option selection and capacity assessments are also produced to inform traction power capacity schemes.
- **Medium-term planning (5-10 years):** The evaluation of proposed enhancements, renewals or new assets as part of schemes in development

or delivery. Such schemes are typically more than a control period in planning.

- **Long-term planning (>10 years):** The evaluation of growth and expansion of the electrified network.

3.39 It is important that the strategies consider short, medium and long-term developments in each region, as it would show how the electrified network may change over time, giving stakeholders more time to plan for enhancements/timetable uplifts/fleet procurement etc. Traction power modelling should be done against a range of future scenarios that reflect how the network could change, and how this could affect traction power capability.

3.40 Some regions are already incorporating long-term planning into their strategies, although the practicality of doing this varies greatly between regions due to various factors. For example, the Eastern region was developing a 2050 Traction Power Strategy. This strategy identifies how new sections of the electrified network could be supplied and also identifies what upgrades would be required on existing electrified routes. This long-term strategy will help inform all future infrastructure upgrades so that decisions can be made with the full knowledge of how the change will fit with the longer-term requirements.

3.41 The review found that there are various reasons why power supply and demand forecasts, particularly longer-term forecasts and plans, prove to be wrong or inaccurate. For example:

- **Unforeseen external factors, notably the COVID-19 pandemic**
  - We found evidence that the impact of the pandemic removed (at least temporarily) demand for increased service levels. This had a subsequent impact on the business case for enhancements schemes.
- **Government Spending Reviews**
  - We have seen evidence of how spending reviews have had a direct impact on which schemes go forward, or change scope. This can affect schemes that include traction power supply upgrades.
- **Changing priorities**
  - There are various factors (both internal and external to the railway) which may have a significant impact on the funding of traction power supply schemes. For example, there may be additional funding to

deliver decarbonisation schemes, as well as political pressure to prioritise these schemes.

- **Technological advances and innovation**
  - Long-term plans are particularly at risk from being impacted by changing and emerging technology, for example large scale use of battery or hydrogen traction are possible, but uncertain at this time.
  - We have also seen evidence of recent innovations that could affect even short-term planning. For example, bi-mode and tri-mode traction becoming common across the network.
  - Another short-term example was a recent trial to install moveable conductor beams in freight facilities, which could potentially enable electric locomotives to be used more widely across the network.

Improved governance and change control for Traction Power

3.42 To further mitigate the risk of traction power supply requirements not being fed through to industry stakeholders, some regions have developed improved change management and control processes.

3.43 As a case study example, the Wales and Western region had adopted the following approach:

- "For new services, the process is that a request to enhance the service will be considered by the regional Head of Engineering & Asset Management covering Electrification & Plant (HEAM (E&P)), and a response given within ten working days on the capability of the network to meet the service.
- The HEAM(E&P) may call upon several types of analysis and assessment, including measurement, to assist with the decision-making process, but it should be stressed that the purpose is to provide the customer with a robust, informed decision, rather than make any requirement that a particular form of analysis is required, such that power modelling is not a necessary requirement. In fact, if system capacity is constantly managed, power modelling should not be required for any service change decision. This was certainly the position for Wales & Western Region, where it is very improbable that a service enhancement would require modelling.

- At the same time, other issues, such as management of ENA ER G5/5 harmonic compliance, may require a level of specialised analysis, but in all cases a response would be given within ten working days, and the analysis undertaken within twenty working days."

3.44 A similar approach had been adopted in the Eastern Region, where traction power capability must now be assessed as part of the development process for all major enhancement schemes. This requires sponsors and project teams to engage with Network Rail's E&P teams at an early stage to ensure that any traction power issues are identified and factored into the development of the enhancement.

3.45 As a case study to illustrate this in practice, Eastern provided the following:

- "Network Rail sponsors will work with the stakeholders to understand the timetable specification and modelling shall be undertaken to support the SOBC - this would typically be 5 - 15 years before entry into service. The modelling at this stage will be a time table specification (typically just a number, and type, of trains per hour). This type of modelling would include a number of assumptions and the proposed interventions/designs will reflect a level of risk associate with this high-level specification.

- As the project develops there will be a requirement to undertake more detailed modelling against and expected timetable to agree the exact detail of the proposed interventions/design. As this could be typically 3 - 8 years out and again the Sponsors would lead the involvement of the stakeholders. Note that major interventions, such new supply points, can typically take 5 years to contract, design, build, and commission, so these are often committed early in the process."

3.46 We also found evidence that some regions are improving governance of traction power capability and proposals that will impact capability. For example, in Eastern there was a Traction Power Management Steering Group that maintains oversight of all proposed enhancements and changes in the region, enabling a more thorough review of capacity constraints and risks to the resilience of the network. This again helps to prevent breakdowns in the communication of critical information to stakeholders.

3.47 We have seen evidence of similar work in the other regions, but as with the strategy documents, the maturity of the processes and governance varies. There are also some differences in approach due to the devolved nature of traction power capability and the bespoke requirements of each region.

4. Conclusions and Recommendations

Conclusions

4.1 The scope of this TAR was to answer the following questions:

- **capability -** does Network Rail have the capability to provide timely and accurate information on power modelling?
- **stakeholder engagement -** does Network Rail effectively engage with third parties, in particular the DfT, TS, train operating companies and freight operators, to actively identify and advise on proposed timetable changes, introduction of new electric rolling stock and increases in electric freight traction?

4.2 With regard to capability, the evidence gathered during this TAR has shown that Network Rail has the capability to produce power modelling information when required to inform stakeholders and feed into project requirements. We found no evidence that suggested that any of Network Rail's regions could not produce this information in a timely manner and proportionate quantum.

4.3 The review concluded that there had been a general over-reliance in the industry on modelling to inform decision making, but power modelling was not the sole method of effectively determining traction power capability. Decision making on traction power capability requires a wide, holistic set of data, and there is a need for Network Rail and stakeholders to understand this and have sight of it.

4.4 We concluded that all Network Rail regions are cognisant of this issue, and that steps are being taken to aggregate and tailor traction power capability information to make it accessible and relevant to stakeholders. The development of traction power strategies and supporting annual statements is positive progress. Some regions are further along this process than others. We saw evidence that best practice was being shared between regions in aid of this. We concluded that Network Rail's regional strategies were beneficial, as was long-term planning with stakeholders to help ensure transparency, accuracy and shared understanding of risks, dependencies and assumptions.

4.5 With regard to stakeholder engagement, we concluded that a key reason for traction power issues impacting enhancement schemes and timetable changes had been poor communication. This included a lack of clarity over how and when information on proposed changes to the electrified network are communicated between Network Rail and stakeholders (and vice versa).

4.6 We have outlined examples where stakeholders advised Network Rail of its proposals to run additional electric traction, but the E&P team in the region were not informed, leading to the traction power requirements not being given adequate consideration as part of the project. We have also outlined examples where operators had proceeded with plans to procure additional electric traction, but did not inform Network Rail until contracts were signed due to commercial sensitivity. This resulted in Network Rail being unable to assess the impact of running additional electric traction and advising the operator of any infrastructure requirements. In both instances, the critical information was not received by the relevant parties until it was too late.

4.7 We concluded that Network Rail has begun to take steps to address this issue, with the introduction of improved governance and control over traction power supply capability through the introduction of steering groups and change management and assessment processes. As with the strategies, the maturity of this varies between regions.

4.8 We concluded that there is some sharing of best practice between regions, but there may be benefits to greater consistency between regions. Network Rail would also benefit from more proactive engagement with industry stakeholders (particularly the DfT, TS and operators) to understand their future requirements and to get their input into the development of traction power strategies and long-term plans.

Recommendations

4.9 Recommendation 1: Each region should develop and maintain a robust traction power supply strategy.

- All regions should ensure that they develop and maintain an overarching traction power strategy that brings together all key datasets to provide a robust and holistic overview of traction power capacity in the region.
- This should include power capacity modelling, risks, constraints, capacity pinch points and demand forecasts.

- Strategies should include modelling and assumptions based on upcoming developments in the region (for example, new services, new fleets, increased electric freight, etc). However strategies should not be over-reliant solely on modelling as the basis for decision making.
- The strategies should be published at the start of each Control Period as a minimum interval. ORR will expect to see draft regional strategies as part of Network Rails submission for the PR23 periodic review, ahead of the start of CP7
- ORR will review progress to develop these strategies on an annual basis.
- To maximise effectiveness, strategies should attempt to provide as much information as possible about a long-term pipeline of developments, so that regions can deliver corresponding modelling and analysis – ideally allowing Network Rail to be able to plan and model for medium and long-term developments on the network.
- Strategies should account, so far as is reasonably practicable, for long-term developments, to enable planning of infrastructure projects to increase traction power supply (such as construction and installation of new grid connections), as these have lead times that can easily span two whole control periods.
- Network Rail should lead on planning activity, with input from industry stakeholders (in particular the DfT, TS and operators).
- Network Rail must ensure that there is transparency around any assumptions, dependencies, margins of error and uncertainty in their plans – particularly with long-term plans which may be subject to significant uncertainty. This must be communicated effectively to stakeholders.
- ORR will review progress with integrating short, medium and long-term plans into the strategies, upon receipt of the draft CP7 strategies, then on an annual basis.

4.11 Recommendation 2: Annual Statements should be produced to accompany regional strategies.

- An annual statement which provides an update on traction power capability should be produced and shared with stakeholders.

- This should note any changes resulting from projects or enhancements, emerging constraints, risks or issues that will affect the information presented in the regional strategy.
- This is intended to help monitor emerging issues and assist in planning mitigations for them.
- It also provides an audit trail of where key assumptions or dependencies on projects/enhancements which underpin the strategies change significantly and sometimes suddenly, resulting in residual risks to traction power capability.
- ORR will review Network Rail's progress to publish these statement documents on an annual basis.

4.12 Recommendation 3: Change controls and governance around traction power capability should be improved.

- Each region should embed effective change management, governance and control processes for traction power capability.
- This is intended to ensure that there is clarity across the wider Network Rail organisation and with stakeholders over the limitations, dependencies, issues, constraints and associated costs regarding traction power supply.
- This is intended to help ensure that traction power capability is consistently considered when changes or developments to the network are proposed.
- It is also intended to ensure that the relevant teams at Network Rail are consulted at an early stage (and throughout the change), and that information and feedback is promptly provided to the proposer of the change. This mitigates the risk of traction power supply from being underestimated and misunderstood, as well as communication breakdowns from occurring.

This publication is available at orr.gov.uk

Any enquiries regarding this publication should be sent to us at orr.gov.uk/contact-us