Environmental Impact Assessment of Electromagnetic Fields for Major Rail Schemes

Dr Ian Flintoft, Martin Grant & Leslie McCormack

Atkins, a member of the SNC Lavalin Group

An early stage of the Transpennine Route Upgrade (TRU) project was to assess the environmental impact of the proposed scheme, as is required for construction schemes in the UK. A crucial part of that assessment was to consider Electromagnetic Fields (EMFs) which are generated wherever electricity is produced, distributed, and consumed including by railway electric traction systems, power lines, electrical and electronic equipment, and intentionally by radiocommunication systems. These EMFs can have a short-term impact on human health and can also affect the correct operation of vulnerable equipment and systems (electromagnetic compatibility, EMC). The assessment investigated baseline conditions and characterised the current Electromagnetic Environment (EME) of the study area with respect to EMC and Human Exposure to EMFs. The impact of the Scheme on the EME in the study area was evaluated with mitigation measures identified where necessary and the outcomes of the assessment will inform the EMC management and assurance activities as the project progresses.

1. INTRODUCTION

In the UK, construction schemes are required to consider their impact on the local environment, taking into account for example noise, pollution, impact on local water courses, vegetation, wildlife and human health.

Electromagnetic Fields (EMFs) are generated wherever electricity is produced, distributed, and consumed including by railway electric traction systems, power lines and electrical and electronic equipment. EMFs may also be generated intentionally by radiocommunication systems. Strong EMFs can have a short-term impact on human health. The effects of EMFs are highly localised and have the most potential to affect people in buildings and locations that are immediately adjacent to high voltage traction power distribution equipment, electricity sub-stations and transformers. EMFs can also affect the correct operation of vulnerable equipment and systems and managing these types of occurrences is the discipline of electromagnetic compatibility (EMC).

The Transpennine Route Upgrade (TRU) is a multi-billion-pound, transformative, long-term railway infrastructure programme that will improve connectivity in the North of the UK. Stretching across the North of England between York and Manchester, via Leeds and Huddersfield, the 76-mile Transpennine railway serves 23 stations, crosses over and dips under 285 bridges and viaducts, passes through six miles of tunnels, and crosses over 29 level crossings. TRU will transform this line into a high-performing, reliable railway for passengers with greater punctuality, more trains and improved journey times. To achieve this, the route will be electrified, potentially causing significant change to the local electromagnetic environment (EME).

An early stage of the TRU project was to assess the environmental impact of the proposed scheme and a crucial part of that assessment was to consider EMFs. Focus was initially on route section W3, Huddersfield to Westtown, as shown in red below. The assessment investigated baseline conditions and characterised the current EME of the study area with respect to EMC and Human Exposure to EMFs. The impact of the Scheme on the EME in the study area was evaluated with mitigation measures identified where necessary.

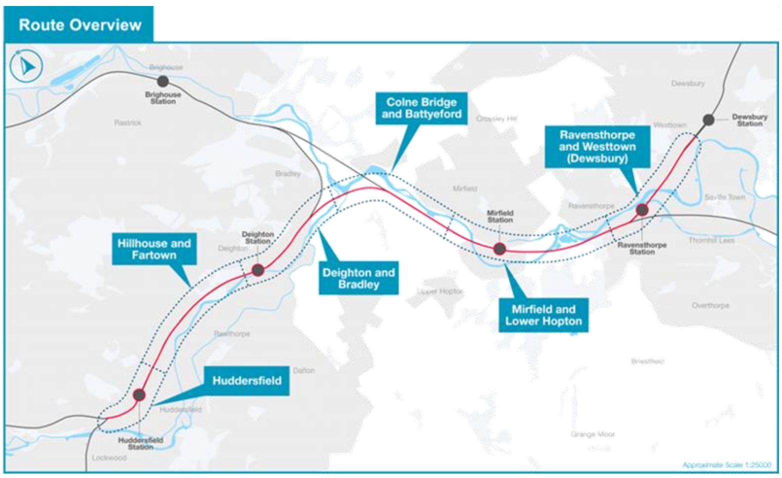

Figure 1 – Transpennine Route Upgrade (TRU) W3 – Overview

2. ASSESSMENT METHODOLOGY

The study area for Electromagnetic Interference (EMI) and Human Exposure to EMFs was defined by a corridor along the railway alignment with the extent of the corridor defined using a zoning concept which extended perpendicularly from the centreline of the nearest Scheme track alignment to a distance prescribed by Table 1. This distance was dependent on the type of property or installation under consideration.

Existing sources of EMI and EMF, and property usage in the study area, including those within the existing railway infrastructure, were identified by a desktop study to establish a baseline EME.

The significance of potential effects of EMI and EMF was assessed using a risk-based approach and recorded in a Risk Assessment according to an EMC zoning principle which was developed to help classify risk to equipment (EMC) and to humans (EMF). The zones were defined based on national and international standards as well as industry specific standards and guidelines.

Following the identification of receptors through the desktop study, each receptor is assessed for the impact of EMF exposure and EMC effects. The assessment has classified these impacts by considering factors such as:

- The distance of the receptor from the track;
- The receptors electromagnetic characteristics and EMC standards compliance; and
- The likelihood of it being affected.

Categories	Distance (m)
Hospitals, Clinics, Other Medical Establishments	100
Educational Premises	50
Airports	1000
Recording, Film Studios	100
Military Establishments	1000
Research Laboratories	1000
Intentional Radio Transmitters	50
Other Commercial Premises (Retail Unit, Light & Heavy Industrial, etc.)	50
Radio Telescopes	5000
High Voltage Transmission and Distribution Lines/Cables	500
Interfacing Railways	50
Railway Depots and Signal Control Centres	50
Other sites not listed above	20

Table 1 – Distance of Outer Zone Boundary for Receptors

For EMI, this enabled sensitivity and magnitude of impact to be assigned to each receptor as follows:

- Low sensitivity: A receptor whose failure when subjected to EMI is non-critical – i.e. has no impact with regard to safety or to operational integrity of a system or service;
- Medium sensitivity: Any receptor whose failure to perform as intended, may disrupt the normal operation of a system, the effect of which is to cause a delay to the production of a service or an annoyance;
- High sensitivity: A receptor that has safety-critical applications; and
- Very high sensitivity: A receptor that contains sensitive apparatus e.g. laboratories, military establishments.

Therefore, sensitivity to EMI is dependent on the type of receptor and the likelihood that it would be affected as detailed in Table 2. For EMF exposure, sensitivity was determined based on the location of the property with respect to the railway boundary and was classified either as high or low as detailed in Table 3.

The magnitude of impact for the EMI and EMF assessment was categorised as detailed in Table 4. In determining the impact, the separation distance of the property from the railway was considered.

The significance of an effect was categorised using the combination of sensitivity and magnitude of impact. The significance was classified as shown in Table 5.

Sensitivity of receptor (EMI)	Type of Property
Very High	Sensitive sites which may include: Research laboratories (including within universities); Radiocommunication facilities;
High	Heavy industrial sites
Medium	Light industrial and commercial premises
Low	Residential properties

Table 2 – Sensitivity of receptors with regards to EMI

Sensitivity of receptor (EMF)	Property Location
High	Property located inside the railway boundary
Low	Property located outside the railway boundary

Table 3 – Sensitivity of receptors with regards to EMF

Magnitude of impact	Impact of EMI	Impact of EMF
High	Any EMI effects lead to degradation of performance of equipment or systems in such a way that injury or worse may be incurred by the operator, third party or member of the public or which leads to unrecoverable operation of equipment or system itself.	EMF exposure levels may approach or exceed the applicable limits at localised areas.
Medium	Any EMI effects lead to degradation of equipment or system performance leading to maloperation or delay which requires intervention to recover following the removal of the disturbance.	EMF exposure levels are increased but remain within the applicable limits.
Low	Any EMI effects lead to some degradation of equipment or system performance leading to annoyance or delay which is fully recoverable following the removal of the disturbance.	EMF exposure levels may be increased but remain well within the applicable limits.
Very Low	Any EMI effects are negligible with regard to operation of equipment or systems which continue to operate as normal.	There is negligible effect on EMF exposure to people.

Table 4 – Magnitude of impact

Magnitude of Impact	Sensitivity of Receptor			
	Very High	**High**	**Medium**	**Low**
High	Significant	Significant	Significant	Significant
Medium	Significant	Significant	Significant	Not significant
Low	Significant	Significant	Not significant	Not significant
Very Low	Significant	Not significant	Not significant	Not significant

Table 5 – Significance of Receptor

For the purposes of EMI and EMF, the following mitigations were assumed to be applied (known as "embedded mitigations") and form part of the initial significance classification of receptors in the risk assessment process:

- A robust EMC Assurance Process is in place throughout the project lifecycle to ensure that EMC/EMI and EMF is correctly managed;
- Application of applicable EMC standards and good practices by the designers and installers;
- Product acceptance and required levels of EMC compliance are achieved for apparatus to be procured as part of the Scheme;
- Where bridges were to be retained, the design of the Scheme incorporates raising of parapet heights to railway standards (minimum 1.8 m) to allow overhead line equipment to pass safely underneath;
- Where construction of new or replacement bridges are proposed, the design of the Scheme will incorporate parapet heights to railway standards (minimum 1.8m) to allow overhead line equipment to pass safely underneath; and,
- The findings of the risk assessments would be further developed and taken forward by the Scheme for management throughout the remainder of the project lifecycle to ensure the EMC/EMI and EMF risks to railway neighbours is addressed and managed.

3. ASSUMPTIONS AND LIMITATIONS

During the assessment, all properties or buildings which lie within the 50 m zone of influence whose functionality or type could not be identified were classified as residential.

Where the available mapping data did not provide additional information (including building purpose or type of industrial use), Google Maps and Bing Maps were consulted to attempt to determine the necessary data (so far as reasonably practicable).

The rolling stock and infrastructure introduced by the Scheme are expected to be compliant with the relevant Regulations, national and international standards.

It is anticipated that the Scheme will be categorised as a "Standard" installation by the Network Rail Designated Project Engineer (DPE) to satisfy the requirements of Network Rail's EMC Assurance Process NR/L2/RSE/30041. For standard installations, compliance with the British Standards (BS), railway National Technical Rules (NTR), Railway Industry Standards (RIS), and NR standards coupled with application of industry best practice with respect to EMC is sufficient to mitigate risks posed by the installation as a whole to the environment. Therefore, these standards have been used as the primary source of mitigation against EMI for all receptors identified as part of this study.

The Stakeholder Advisory Group on EMFs (SAGE) for the UK government and ICNIRP have carried out assessments to determine safe EMF exposure limits for people at particular risk, such as pregnant women, persons with active implanted medical devices (AIMDs) and body worn medical devices (BWMDs). Studies conducted by ICNIRP recognise a limit as low as 0.5 mT for static magnetic field exposure. It is not anticipated that this limit will be exceeded at and beyond the operational railway boundary.

A detailed review of buried services records was not been carried out as the dataset was accompanied with a disclaimer regarding its validity and was not to be used for design purposes. A high-level review was undertaken of the available buried services data. As part of the design development process, it was assumed that a detailed review of the instructed buried service information would be undertaken at detailed design.

The Scheme is based on conventional lineside signalling systems. No consideration was given to any new GSM-R (Global System for Mobile Communications – Railway) sites or any works required to support future introduction of ETCS (European Train Control System).

4. LESSONS LEARNT

4.1. Tools

Work on this project developed over a two-year period and so many lessons were learnt along the way. Principal amongst them was the appreciation for tool sets which enabled easy overlay of multiple data sets. A project specific tool was used which allowed map and aerial photography to be overlaid with an array of datasets, including:

- Scheme red line boundary;
- Project chainage;
- Buried services model; and,
- Project design information (including links to an "iModel Hub", the project's 3D model rendering environment).

This tool was not available during the early stages of the work and so manual correlation was required between map data and copied of designs. However, once it was available with access to the relevant datasets it was invaluable in undertaking updates to the EIA as the base map, design and consents information was consolidated in one place. Where amendments were made to a dataset, this was highlighted on accessing the tool and, in some instances, it was also possible to overlay multiple versions of a single dataset. For example, the red-line boundary so that attention was only given to areas where this had changed.

4.2. Target Audience

In authoring any document, as engineers we should be mindful of the target audience and adjust the language used accordingly to ensure readability and accessibility of our documentation. Whilst those formally reviewing the document may well be industry professionals, the end user may not. In the case of an Environmental Impact Assessment, the target audience is the general public as these documents are provided in the public domain as part of consultation processes. This is something that should be reinforced as part authoring and quality assessment, particularly where the end user may be the general public.

5. CONCLUSIONS

Environmental impact assessment forms an integral early stage in developing a construction scheme and consideration of the electromagnetic impacts is essential. However, such assessments can take several years and require multiple iterations as design intent and detail evolve. It is therefore essential to establish a robust and consistent methodology at an early stage and to consult widely and receive stakeholder buy-in. The amount of data to be consider and the extent of change can be considerable over the lifetime of the assessment and therefore adoption of tools which help manage this data and enable ease of comparison will have a significant impact on the consistency and success of the exercise.