TRANSPORT AND WORKS ACT 1992

TRANSPORT AND WORKS (INQUIRIES PROCEDURES) RULES 2004

NETWORK RAIL (CAMBRIDGE SOUTH INFRASTRUCTURE ENHANCEMENTS) ORDER

SUMMRAY PROOF OF EVIDENCE
ON MATTERS OF ELECTROMAGNETIC INTERFERENCE

JOHN MCAULEY ON BEHALF OF
THE UNIVERSITY OF CAMBRIDGE

Inquiry Document Reference	**[TBC] /OBJ 8**
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1 INTRODUCTION

1.1 My qualifications and experience are set out in section 1 of my main Proof of Evidence.

1.2 I specialise in the subjects of electromagnetic fields ("**EMF**") and radiofrequency ("**RF**") engineering and have been a designer and consultant in these subjects for more than thirty years.

2 SCOPE OF EVIDENCE

2.1 The scope of my evidence is set out at section 2 of m main Proof of Evidence and concerns the effects on the Anne McLaren Building ("**AMB**") from electromagnetic interference ("**EMI**") of the construction of the works and from the operation of the proposed Scheme.

2.2 I have been instructed by the University of Cambridge ("**University**") to consider, in particular, the effects on specialist equipment used in the AMB that is sensitive to EMI. The specialist equipment includes MRI, confocal microscopes and CT scanners.

2.3 The University also has an interest in the nearby area of land known as "Plot 9" and I briefly consider the potential effects of the Scheme on the development and use of Plot 9.

3 THE WORKS PROPOSED AND THE UNIVERSITY'S INTEREST

3.1 The Network Rail (Cambridge South Infrastructure Enhancements) Order seeks powers to construct and operate a new station on the existing main line serving Cambridge. The works involved include, as well as a four platform station and associated structures, the slewing of the existing main line and the installation of two new loop lines connected via new switches and crossings. These works are proposed in the vicinity of the Cambridge Biomedical Campus ("**CBC**"), on which are located a number of buildings sensitive to EMI.

3.2 The Environmental Statement ("**ES**") for The Network Rail (Cambridge South Infrastructure Enhancements) Order ("**Order**") reports that there is a risk of significant effects due to EMI on facilities in premises on the CBC owned and operated by the University, namely the AMB.

3.3 The AMB houses research facilities which are sensitive to EMI. These include sensitive scientific instruments, including a Magnetic Resonance Instrument ("**MRI**").

4 THE NATURE OF EMI

4.1 EMI effects potentially arise from the operating phase of the Scheme when electromagnetic interference from the railway as received at the AMB could potentially increase by virtue of the increased current drawn by the new trains, both passenger and freight, and the closer proximity of the nearest track.

4.2 EMI impacts many electrical and electronic products. Research centres such as the AMB use instruments that are particularly susceptible to EMI. These instruments use magnetic techniques as part of their process or use devices that are affected by EMI. The AMB uses a research MRI which has a defined environmental specification. In addition, the institute uses CT scanners and confocal microscopes. A full audit of the instruments in use has not been carried out.

4.3 The AMB was designed and constructed taking account of the existing EMI environment caused by existing sources, including the railway line, road vehicles and other external sources in the baseline environment to ensure that acceptability limits would not be exceeded and that there were no adverse effects of this kind.

4.4 Existing sources of EMI and the receptors in the AMB sensitive to EMI are set out in section 6 of my main Proof of Evidence.

4.5 Were acceptable limits for EMI to be exceeded the operation of sensitive research equipment could be affected

5 REVIEW OF ENVIRONMENTAL STATEMENT

5.1 My review of Network Rail's ES is contained in section 7 of my main Proof of Evidence.

5.2 The ES did not consider all of the potential effects of EMI caused by the proposed Scheme on sensitive receptors in the AMB. Mitigation such as to remove significant effects was not proposed.

5.3 The EMI information in the ES lacks sufficient information to enable a detailed assessment to be made.

6 ELECTROMAGNETIC FIELDS AND UNITS

6.1 The EMI levels I refer to in my evidence are measured in units of volts/metre (V/m) for electric fields and microtesla (μT) for magnetic fields.

6.2 Electric trains generate several types of electromagnetic fields. The traction system is fed from substations at frequent intervals along the rail producing AC (50Hz) electric and magnetic fields. The location of the substations determines the path of current flow to the trains and therefore the local magnetic field strengths. The electric fields are not of concern as they are absorbed by building materials. Conversely the magnetic fields pass readily through common building materials. The power source for the trains is a 25kV feeder system which is fed via an over head line (OLE) equipment and returned via the rails. The steel rails are bonded at frequent intervals using additional conductive cables. The train generates a number of interference types including AC fields from the 25kV traction system, quasi DC fields from the moving ferromagnetic metal mass of the train and radiofrequency fields. The radiofrequency fields can include transitory disturbances caused by arcing at discontinuities between the overhead line and the pantograph.

6.3 The limits of acceptability for the different types of sensitive receptor in the AMB are expressed in terms of nanotesla for magnetic fields and volts/metre for radiofrequency fields.

7 LEGISLATION, POLICY AND GUIDANCE FOR EMI

7.1 All products placed on the UK market must comply with the UK Electromagnetic Compatibility Regulations 2016, S.I. 2016/1091, as amended in 2019 (the "**Regulations**"), which provide a basic level of protection for products.

7.2 The Regulations refer to standards as a means to demonstrate compliance with the legislation which confers the "presumption of conformity". The following are the essential requirements:

7.2.1 Equipment shall be designed and manufactured, having regard to the state of the art, as to ensure that:

(i) the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended

(ii) it has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use.

EMI Standards

7.3 The references to standards for electromagnetic compatibility in support of the Regulations provide a limited set of requirements that cover the most common interference types. In the respect of railways the relevant standard is "EN 50121-2:2006 Railway applications: Emission of the whole railway system to the outside world". This standard only specifies limits for radio frequencies above 9 kHz to protect radio and TV transmissions. As the range of equipment that is susceptible to emissions below 9 kHz is limited the standard does not specify limits.

7.4 The Regulations do not specify an upper or lower frequency range for EMI disturbances. Whilst the published standards for railways provide a presumption of conformity to the legislation they do not cover the particular EMI scenario that pertains with the highly sensitive equipment located in the AMB.

7.5 I have been provided with EMI survey results contained within a wider report prepared by Ramboll that was itself prepared in 2014 in connection with the design of the AMB. It was reported that magnetic field values found at the site could be incompatible with sensitive laboratory equipment, such as MRI scanners. Following installation of the relevant equipment within the AMB, I understand that initial operations did not indicate any concerns relating to the performance of that equipment (however further work is in my view required to be undertaken by Network Rail to understand EMI impacts on the AMB, as I explain below).

8 CONCLUSIONS

8.1 My conclusion is that the Order application documents, including the ES and Statement of Case which have been submitted by Network Rail are inadequate for the purpose of considering the potential impacts of EMI on the operations within the AMB.

8.2 The University have requested further information, some of which has been received, and some of which is awaited. Any recent information received from Network Rail at the time of preparing my evidence is not covered in this Proof of Evidence and I will comment further, as necessary, in Rebuttal evidence.

8.3 Outstanding information includes a prediction of quasi static and AC magnetic field levels and their effects on the existing equipment in the AMB.

8.4 A detailed modelling exercise is required that is based on the new track configurations, substation locations and resultant current flows. The timetable for the new services and types of trains is required to determine the maximum current flows.

8.5 This information is necessary to ensure that the following key objectives can be achieved in relation to the EMI issue in this case:

8.5.1 there must be measures which avoid any potential for increased EMI within the AMB (including interference to sensitive research equipment and AMB electrical services);

8.5.2 there must be mitigation to avoid any exceedance of the environmental limits of sensitive research equipment within the AMB.

8.6 It will also be necessary to ensure that adequate surveys and modelling take place to ensure that these fundamental requirements are complied with.

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