Eurofins Electrical & Electronic UK Ltd
York Office
Unit 1, Arabesque House
Monks Cross Drive, Huntington
York, YO32 9GW
United Kingdom
+44 (0) 330 430 3456
EEinfoUK@cpt.eurofinseu.com
eurofins.co.uk/ee

EMC Control Plan for C2 The Birtles, Wythenshawe, Manchester

(Electronic Uncontrolled Copy)

for

Caddick

EY Document Nº: Y6696CR1
EY Project Nº: Y4298

Author: [redacted]
T Konefal BSc, DPhil
Senior EMC Engineer

Checked: [redacted]
R Armstrong, BSc (Hons), MSc (Research), PhD, MIET
Expert Services Manager

Approved: [redacted]
R Armstrong, BSc (Hons), MSc (Research), PhD, MIET
Expert Services Manager

Issue	Description	Issued by	Date
1	**First issue**	**TK**	**14th July 2026**

Disclaimers:
This report contains commercially confidential information and shall not be reproduced, except in full, without the prior written approval of Eurofins E&E UK.
Users should satisfy themselves that they are in possession of the most up to date version of this report by calling +44 (0) 330 430 3456 or emailing: [redacted]

LRQA CERTIFIED ISO 9001-2015
UKAS MANAGEMENT SYSTEMS 0001
Instrumentation, Expert Services and Training

Registered Address
Eurofins Electrical and Electronic UK Ltd
i54 Business Park, Valiant Way
Wolverhampton, WV9 5GB, UK

Registered in England and Wales
Company Reg. No. 6048589
VAT Reg. No. GB 887 1276 83

CHANGE HISTORY SHEET

Date	Issue	Section	Description
14.07.2026	1	-	First issue

EXECUTIVE SUMMARY

This document is the EMC Control Plan for the construction of the C2 Birtles building, Wythenshawe, Manchester. It sets out the activities and documentation required to ensure electromagnetic compatibility (EMC) for the project, within the scope of Caddick and its subcontractors.

The activities required are listed in Section 2.3 and the documentation required is listed in Section 7.1. Should the activities or documentation required change (either due to a change in the project requirements, or due to emergent issues), these will be reflected in an update to this document and in the relevant documentation listed in Section 7.1.

CONTENTS

Change History Sheet 2
Executive Summary 3
List of Terms and Abbreviations 5
Abbreviations: 5
Terms: 7
1 Introduction 8
1.1 The Birtles (C2) project background 8
1.2 EMC background 8
1.3 Relevant EMC Phenomena 11
1.4 Relevant EMF phenomena 13
2 Project Overview 15
2.1 List of Contractors/Suppliers and Apparatus 16
2.2 List of existing and third party apparatus to be considered 17
2.3 EMC activities to be undertaken 18
3 EMC Management and Organisation 20
4 Management of EMC interfaces 21
4.1 EMC Environments - General 21
4.2 EMC Environment for this project 21
4.3 EMC Interfaces 24
5 Legislation and Standards 25
5.1 EMC Regulations applied to this project 25
5.2 London Underground EMC standards 27
5.3 Network Rail EMC standards 28
5.4 Overall EMC requirements for Apparatus 29
5.5 CEMFAW Regulations 31
5.6 UK Radio Equipment Regulations 34
5.7 EREC G5/5 35
6 EMC testing and commissioning arrangements 36
6.1 EMC surveys 36
6.2 EMF surveys 38
7 Deliverables schedule 39
7.1 Documentation 39
7.2 Dates for Deliverables 42
Appendix 1 – Third party interfacing apparatus and systems 43
Appendix 2 - Cable separation distances, signal and power cabling 44
References 48

LIST OF TERMS AND ABBREVIATIONS

Abbreviations:

AC	Alternating Current
ACE	Axle Counter Evaluator
AFIL	Audio Frequency Induction Loop
AHU	Air Handling Unit
AIMD	Active Implanted Medical Device
ALARP	As Low As Reasonably Practicable
ASHP	Air Source Heat Pump
BS	British Standard
CCTV	Closed-Circuit Television
CEMFAW	Control of Electromagnetic Fields at Work
CFA	Continuous Flight Auger
CMS	Cable Management System
COMMS	Communications
CRT	Cathode Ray Tube
DBT	Department for Business and Trade
DC	Direct Current
DNO	Distribution Network Operator
DoC	Declaration of Conformity
DR	Design Review
E&B	Earthing and Bonding
E&E	Electrical and Electronic
EIRP	Effective Isotropic Radiated Power
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMF	Electromagnetic Fields
EMI	Electromagnetic Interference
EN	Euronorm
EREC	Engineering Recommendation
EV	Electric Vehicle
EVC	Emergency Voice Communication
EY	Eurofins E&E UK
FM	Frequency Modulation
FO	Fibre Optic
3G, 4G, 5G	Third, Fourth, Fifth Generation
GI	Generic Industrial
GP	General Public
GSM	Global System for Mobile Communications

GSM-R	Global System for Mobile Communications – Railway
HAZID	Hazard Identification
HV	High Voltage
HVAC	Heating, Ventilation, & Air Conditioning
IAP	Intelligent Access Point
ICNIRP	International Commission on Non-Ionising Radiation Protection
IEC	International Electrotechnical Commission
IRS	Integrated Reception System
IT	Information Technology
LAN	Local Area Network
LU	London Underground
LV	Low Voltage
MCC	Manchester City Council
MESH	Type of decentralised radio topology
MVHR	Mechanical Ventilation with Heat Recovery
MWR	Mesh Wireless Router
NR	Network Rail
OLE	Overhead Line Electrification
O&M	Operation and Maintenance
OPSS	Office for Product Safety and Standards
PCC	Point of Common Coupling
PMR	Private Mobile Radio
PV	Photovoltaic
RADAR	Radio Detection and Ranging
RCD	Residual Current Detector
RCLI	Residential Commercial and Light Industrial
RF	Radio Frequency
RFI	Radio Frequency Interference
SI	Statutory Instrument
SPAS	Signal Passed At Stop
TBC	To Be Confirmed
TD	Technical Documentation
TETRA	Terrestrial Trunked Radio
TfGM	Transport for Greater Manchester
THD	Total Harmonic Distortion
TJ	Technical Justification
TV	Television
UK	United Kingdom
UMTS	Universal Mobile Telecommunications System (3G)
UPS	Uninterruptible Power Supply

VECOM	Vehicle Communication
VMM	Vehicle Mounted Modem
VOIP	Voice Over Internet Protocol
VSD	Variable Speed Drive
Wi-Fi	IEEE 802.11 family of wireless network protocols

Terms:

Apparatus	Any finished appliance or combination thereof made commercially available as a single functional unit, intended for the end user and liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance.
Approved Body	A body accredited by DBT for the assessment of Technical Documentation.
Designated standard	A standard recognised as such by the OPSS (published in formal notices at https://www.gov.uk/guidance/designated-standards), with respect to UKCA-marking regulations. This provides a presumption of conformity for Apparatus within the scope of the standard.
EMC Documentation	Documentation to demonstrate the compliance of a Fixed Installation with the EMC Regulations.
Equipment	Any Apparatus or Fixed Installation.
Fixed Installation	A particular combination of several types of Apparatus and, where applicable, other devices, which are assembled, installed and intended to be used permanently at a predefined location.
Inherently benign equipment	Equipment which inherently meets the protection requirements of the EMC Regulations and is thus excluded from its scope. Examples include HV transformers, cables and circuit breakers (without active electronic components).
Presumption of Conformity	Apparatus meeting the requirements of a designated standard is presumed to meet the essential requirements of the Regulations (covered by the scope of the standard).
Technical Documentation	Documentation to demonstrate the compliance of Apparatus with the EMC Regulations.
Persons at particular risk	Persons at particular risk from electromagnetic fields. This includes: Wearers of active implanted medical devices (AIMD), e.g. pacemakers, cardiac defibrillators, cochlear implants, inner ear prostheses, neurostimulators, retinal encoders; Wearers of passive devices, e.g. artificial joints, pins, plates, screws, clips, stents, valves; Pregnant workers. Wearers of body-worn medical devices, e.g. infusion pumps,

1 INTRODUCTION

This document is the EMC Control Plan for the C2 Birtles building, a new apartment block planned to be constructed in Wythenshawe, Manchester. It forms part of a suite of EMC documentation designed to demonstrate that the C2 Birtles building is compliant with the EMC Regulations SI 2016 Nº 1091.

1.1 The Birtles (C2) project background

The C2 Birtles project is a planned new building in Wythenshawe, Manchester. The new building will be over 5 levels/storeys and will be primarily used as residential apartments, with some retail/commercial areas on the ground floor. Further details are provided in Section 2.

1.2 EMC background

1.2.1 EMC Regulations

Statutory Instrument 2016 Nº 1091 "The EMC Regulations" [1], requires that EMC Documentation be prepared as part of the works for a Fixed Installation. The completed Birtles (C2) building will be a Fixed Installation.

The Documentation should demonstrate *"that good engineering practice has been used and the information on the intended use of its components has been respected"*. Essentially the EMC Regulations require that the Birtles (C2) building should not be a source of EMI nor should it be susceptible to electromagnetic disturbances expected in the installation environment. As far as practicable the Documentation will demonstrate that this is the case.

1.2.2 Railway standards – TfGM requirements

Under the pre-commencement planning condition 7a for Plot C2 at Wythenshawe, Manchester City Council (MCC) have requested an electromagnetic compatibility plan:

- *Condition 7a - Prior to the commencement of development, an electromagnetic compatibility plan shall be submitted to and agreed in writing, by the City Council, as Local Planning. This plan shall demonstrate compliance with BS50121-3-2, BS50121-4, and BS50121-5, together with Network Rail EMC assurance process NR/L2/RSE/30041 and shall include for pre-development testing.*

It is noted here that BS EN 50121-3-2 applies only to apparatus that is to be installed on a train, whilst BS EN 50121-4 and BS EN 50121-5 respectively apply only to railway signalling apparatus and railway traction (or related) supply apparatus. Since the construction of the C2 Birtles building will not involve installation of any of these types of apparatus, none of these three standards are directly relevant or applicable. However, since the new C2 Birtles building will be constructed close to the railway/tramway, there is a requirement both to control emissions from the building (to the extent that the railway will not be adversely affected) and similarly to ensure that apparatus within the building will not be adversely affected by the nearby tramway. This document specifies the activities to be undertaken to ensure that such electromagnetic compatibility between the two entities will be achieved, and is considered (along with the spawned documentation indicated in Section 7.1) to fulfil the requirements of MCC Condition 7a outlined in the bulleted paragraph above.

It is noted that Caddick and its subcontractors have no influence over the compliance or otherwise of TfGM trams, signalling apparatus, and power supply apparatus with the three EN 50121-X standards mentioned in the previous paragraph. In analysing the interactions between the building apparatus and the railway therefore, it is necessary to *assume* that TfGM apparatus is compliant with the relevant standards. However, even where this assumption is correct, it does not automatically guarantee EMC in all cases. Instead, it is intended that an EMC hazard identification and analysis (HAZID) (see Section 7.1.2) will be carried out; any identified EMC hazards that have a viable means of causing issues will be considered in detail in an EMC design review (DR) document (see Section 7.1.3). In particular, the Manchester tramway makes use of the following systems, which will all be considered in the HAZID document (and analysed in the DR document where necessary) :

- VECOM (ground induction loop) system;
- Axle counters, including heads, associated lineside apparatus, transmission lines and axle counter evaluators (ACEs);
- Voice trunked radio system, including on-board tram radios and handheld units;
- MESH radio system, including Vehicle Mounted Modems (VMMs) and pole mounted trackside Mesh Wireless Routers (MWRs) and Intelligent Access Points (IAPs);

- Fibre Optic (FO) network;
- Conflict monitors;
- Points heating;
- Points machines;
- SPAS indicators.

It is further noted that TfGM will require assurance that there will be no adverse EMC interactions with tramway signalling systems during the construction phase of the Birtles C2 building. Whilst Caddick will generally have very little control over the EMC standards that contractors' apparatus meets, it is proposed that any EMC certification that contractors' apparatus possesses should be requested to be provided before engaging with the contractor, possibly as an additional contractual condition. In particular, contractors should supply details of any intentional site radio transmitters (such as walkie talkies) that are to be used (for example, frequencies and EIRP). In general, it should be verified that contractors' apparatus is compliant with the generic industrial standard EN 61000-6-4:2007, or that it generates EM emissions which are no higher than those specified in EN 61000-6-4. See Sections 2.1, 5.4 and 5.4.1.

1.2.3 Railway standards - London Underground

The Birtles (C2) building will be located adjacent to the Manchester Tram system, at a closest distance of approach of approximately 16.5m. At this distance it is credible that the high levels of DC current present on the tramway may be the source of EMC issues, where there is apparatus present in the Birtles (C2) building which is sensitive to magnetic fields (e.g. containing Hall probes or making use of Cathode Ray Tubes [CRTs]). Whilst less likely, it is also possible that magnetic fields at harmonic frequencies of 50Hz (emanating for example from transformers powering the building or from LV/HV cabling that runs in close proximity to the tramway) may cause issues for track circuits associated with the tramway.

Although London Underground (LU) standards are not directly relevant, they have been developed over many years to ensure EMC of new infrastructure with a DC railway (albeit with a slightly different [4th rail] electrification scheme) operating at a similar DC voltage of 750V. Some useful guidance can therefore be taken from LU standards. The main LU EMC standards to be considered are S1222 A4 (2023) "Electromagnetic Compatibility" [2], together with its accompanying guide, G222 A3 (2016) "EMC best practice" [3]. The

purpose of these documents is to ensure that EMC is sufficiently considered for any significant addition or alteration to the railway. These documents are considered further in Section 5.2.

1.2.4 Railway standards - Network Rail

The Birtles (C2) building will be located more than 1.5km from the nearest main line railway line, which is on the approach into Manchester Airport and electrified at 25kV AC (the Styal line). At this distance it is not credible that there will be any adverse EMC interactions with railway equipment (which will be being subjected to the much harsher local railway EMC environment). The two principal Network Rail EMC standards

1) NR/L1/RSE/30040 "Electromagnetic Compatibility" [4].
2) NR/L2/RSE/30041, "Electromagnetic Compatibility (EMC) assurance process" [5].

are therefore not directly relevant. Nevertheless, these standards reference a number of other standards which are helpful (for example with respect to separation of HV power cables from sensitive telecommunications cabling) and provide an EMC zoning scheme that can be used. Guidance is therefore taken from these EMC standards in this document, where relevant.

1.3 Relevant EMC Phenomena

1.3.1 DC Stray Current

The traction power supply for the Manchester tramway is provided by overhead line electrification (OLE) equipment, operating at 750V DC. Current returns from trams to the powering 750V DC substations via the running rails. During this process, a portion of the return current (typically 5% -10%) will flow through the ground, depending on the detailed design of the tram system. For example, a dual tram system (4 rails in total) just compliant with EN 50122-2: 2022, powering trains at a distance of 1km from the substation, will provide $2.5\times10^{-3}\times1000\times4 = 10$A of DC stray current flowing through the mass of earth. Such DC stray currents have the potential to adversely affect newly installed equipment in the C2 Birtles building, through common impedance coupling or through corrosion effects on buried structures. The fact that the new building will be on an internal bend of the tram rail system does exacerbate the issue slightly.

However, since the new C2 Birtles building will be on a site where there has been an existing building (to be demolished) for many years, it is highly likely that any such issues (where present) have already been discovered and mitigated. Any such issues will be evident through the presence of an existing cathodic protection scheme for the present building (to be demolished) and/or other surrounding buildings. It should be confirmed that there is (are) in fact no such historical cathodic protection scheme(s) present, which will effectively confirm that there are no issues with DC stray currents. If there *is* in fact a cathodic protection scheme in place for existing buildings, this scheme should be reassessed for other buildings as appropriate and maintained, and a new cathodic protection scheme should be devised for the C2 Birtles building.

With regard to the C2 Birtles building acting as a source of DC stray currents, the most likely culprit will be the photovoltaic (PV) cells that are planned to be installed on the roof of the building. There does not seem to be a general consensus in the literature (e.g. [6, 7]) on the necessity to earth systems of photovoltaic (PV) cells on the DC (input) side of the inverter to which they are connected. Where there is no connection (both DC wires insulated from earth), DC stray currents will not be an issue. For PV systems which are earthed (e.g. cathode of PV cell array connected to earth at a single point of entry into the inverter), stray DC earth currents may arise where a fault condition arises e.g. if there is an inadvertent earth connection to the anode of the PV cell array, or if there is a direct route for DC current to flow between the anode connection at the inverter input and one of the three phase outputs (or indeed the Neutral or Earth conductor on the inverter output). It is expected that RCD devices will detect such faults and result in the operation of circuit breakers. As a result, problems associated with DC immunity and stray current (including corrosion issues), due to PV cells as a source of DC stray current, are not anticipated.

1.3.2 Induced voltages

Assuming defined cable separations (e.g. IEC 61000-5-2 [8], EN 50174-2 [9], EN 50174-3 [10], BS 7671 [11]) are respected, it is generally expected that any stretches of parallel running cable will not be long enough to induce excessive voltage onto neighbouring cables. Cabling requirements are considered in Section 5.1.1.1. However, where the recommended cable separations cannot be maintained, analyses should be performed on

the expected levels of crosstalk in the Design Review document, as indicated in Section 7.1.3.

It is possible that medical or scientific research facilities based in the C2 Birtles building may be disturbed by the change in quasi-static magnetic fields caused by slowly varying traction currents on the nearby Manchester tram (such effects may occur at several hundred metres separation from the track). However, no such magnetically sensitive apparatus appears to be planned for installation at the C2 Birtles building (see Section 2.1).

1.3.3 RF and transient disturbances

Electronic equipment installed as part of this project must be appropriately immune to RF and transient disturbances. Similarly, it must not be a source of RF disturbances above prescribed levels. The actions needed to appropriately control these phenomena are described in Section 2.3.

1.4 Relevant EMF phenomena

1.4.1 Magnetic fields surrounding current carrying cables

According to EN 50499: 2019 [12], cables carrying more than 100A per phase at 50 Hz will require assessment to ensure that the magnetic fields arising from the current will not affect workers or members of the general public at particular risk (particularly personnel with implanted or body-worn medical devices, and pregnant workers). Desktop assessments should be made as part of the Design Review, with possible EMF measurements being made to ensure the ICNIRP 1998 guidelines [13] are met. In addition, it is likely that the transformers that source the currents will themselves be significant sources of magnetic fields. Manufacturers' recommendations should be followed with regard to safe distances for personnel (especially persons who are at particular risk, see List of Terms and Abbreviations). Where such recommendations are non-existent and it is known that the transformer can source currents higher than 100A (which will be the case for the majority of transformers), it is recommended that a site survey is undertaken to establish protection distances. This is particularly important for maintenance personnel who also happen to be persons at particular risk (e.g. by virtue of the fact that they wear a cardiac pacemaker) and who will have access to the transformer environment. See Section 5.5.1 for more details.

1.4.2 Electromagnetic fields surrounding antennas

Each apartment will have facility for a Wi-Fi router, which will operate on one or both of the 2.4GHz and 5GHz bands. Depending on the transmitted EIRP from the antennas of each of these systems, there will exist a region surrounding the antennas where it will be possible for the electric field to exceed the maximum levels permitted for human exposure, as defined in the UK CEMFAW Regulations [14] and the ICNIRP 1998 guidelines [13]. Calculations of appropriate protection distances to be maintained between the antennas and personnel should be undertaken as part of the Design Review document. See Section 5.5.2 for more details. Note that Wi-Fi routers are generally limited in power to 100mW [15] when designed for use by the general public, in which case they are deemed not to pose a threat to personnel who are not persons at particular risk (see [12]).

2 PROJECT OVERVIEW

The C2 Birtles project is a planned new 5 storey apartment building in Wythenshawe, Manchester. The new building will also have some retail/commercial areas on the ground floor. There will be a number of electrical and electronic systems and apparatus installed as part of the building (see Section 2.1), for which the majority of power will originate from an existing substation. Power will be supplemented by multiple photovoltaic modules installed on the roof of the building. These modules will provide approximately 110 kWh/yr/m^2 for the building. A plan view of the proposed site for the building is provided in Figure 1, which also shows the location of the existing substation and the nearby Manchester tramway.



Figure 1. Location of proposed C2 Birtles building, Wythenshawe, Manchester. Top: General works boundary. Bottom: Ground floor Plan.

The new building will have a total power consumption 426kW (equivalent to a 3-phase supply current of 615A per phase for a standard 400V 3P supply), and will be accompanied by 38 car parking spaces. There will be EV charging facilities for vehicles, each charger serving two vehicles at a power level of 7kW per vehicle.

The building will make use of a communal integrated reception system (IRS) [16]. Distribution of radio, satellite and TV data/signals throughout the building will be effected by fibre optic (FO) cabling, which is immune to RF interference at all practical frequencies of interest for EMC purposes (i.e. generally, less than 6GHz). Copper cabling of Category 6A and of length not exceeding 90m will be used to form the basis of a LAN that will support broadband data services and voice services via VOIP.

2.1 List of Contractors/Suppliers and Apparatus

The principal items of electrical and electronic apparatus that will be newly installed as part of the C2 Birtles building Fixed Installation are indicated in Table 1.

Apparatus	Supplier
Generator (Life Safety)	Perkins, Cummins or Caterpillar
Switchgear	By DNO
Photovoltaic Inverters	TBC
Meters	By BNO
Lighting and Controls	TBC
Emergency Lighting	TBC
UPS for lighting	TBC
Security/Door entry Systems	KMS, Technology Solutions
AFIL for Door entry	TBC
Fire Alarm System	TBC
CCTV	TBC
Emergency systems (radio)	Dualcom or Redcare
EVC (wired)	TBC
Wi-Fi routers	TBC
MVHR systems	Dimplex, Vent Axia
AHUs, Fans	TBC
VSDs for HVAC systems	TBC
ASHPs	TBC
Electric vehicle charging	TBC
Disabled Refuge	TBC
Lifts	TBC
IRS	Openreach, Virgin Media
Cabling (LV, COMMS, Coax, Ethernet, Cat 6, Fire)	Various
RCLI apparatus	Various, unknown
GI apparatus	Various, unknown

Table 1. Major new components of C2 Birtles project.

Other items of apparatus may be installed by tenants once the building is occupied. Although the details and extent of such apparatus cannot reasonably be anticipated, it is expected that it will be mostly Residential, Commercial and Light Industrial (RCLI) in nature, or occasionally Generic Industrial (GI). Such items are covered by the final two entries of Table 1.

In addition to the apparatus to be installed in Table 1, there will be a number of items of apparatus that will be temporarily brought onto site during the construction phase. These are summarised in Table 2.

Apparatus	Supplier
Telehandlers	Unknown
Luffing tower crane	Unknown
Site hoists	Unknown
CFA piling rigs	Unknown
Silos	Unknown
Hiabs	Hiab or similar

Table 2. Temporary apparatus to be used during construction (list is not exhaustive).

2.2 List of existing and third party apparatus to be considered

A desktop survey has been performed, with the aim of identifying potential sources or victims of EM interference that could adversely interact with newly installed apparatus within the C2 Birtles building. This survey appears in Appendix 1. The survey is summarised in Table 3, which additionally shows third party apparatus that may reasonably be expected to interface with the installations in C2 Birtles. The items are generally either intentional transmitters or receivers. These may provide radio transmission levels that are above those prescribed by the GI emission standards, or operate at sensitive levels, potentially below the levels at which radio emissions are still permitted by the GI or RCLI standards.

Existing 3rd Party Apparatus
Mobile phones (GSM) (~900MHz and ~1800MHz)
Mobile phone Base stations (GSM, non-railway) (~900MHz and 1800MHz)
UMTS (3G) (~2100MHz)
4G (~800MHz, ~1400MHz, ~1800MHz, ~2100MHz, ~2300MHz, ~2600MHz)
5G (~3400MHz, ~3600MHz to 4000MHz)
TETRA (~400MHz)
Global System for Mobile Communications (GSM-R, railway) (~900MHz)
Residential broadcast receivers (Poundswick Lane, see Appendix 1)

Existing 3rd Party Apparatus
Wythenshawe FM radio station (see Appendix 1)
Peel Hall Medical Practice (see Appendix 1)
Tramway Rolling stock (see Appendix 1)
Tramway OLE (see Appendix 1)
Tramway signalling systems (see Section 1.2.2)
Broadcast transmitters
3rd Party radio transmitters/receivers (e.g. PMR such as taxi services ~450MHz)
Manchester Airport (RADAR and radio systems e.g. on aircraft)
Humans
Existing Buried services (e.g. telephone cabling)
Distribution Network Operator (DNO)

Table 3. Interfacing existing and 3rd Party apparatus and assets.

It is noted that Manchester Airport is located 1.6km away from the C2 Birtles site. Apart from the OLE associated with the neighbouring tramway itself, from satellite and photographic images [17] there do not appear to be any other overhead pylons (carrying high voltages and/or currents) in the vicinity of the C2 Birtles site.

2.3 EMC activities to be undertaken

The following activities are to be undertaken to demonstrate compliance of the installation with the UK EMC Regulations, SI 2016 No. 1091 [1], Control of Electromagnetic Fields at Work (CEMFAW) Regulations, SI 2016 No. 588 [14] and UK Radio Equipment Regulations, SI 2017 No. 1206 [18].

- EMC Hazard Identification (HAZID) and Risk Analysis/Register (see Section 7.1.2);
- Design Review, including induction effects into parallel running cables, expected EMF exposure levels and impact of installation on existing Manchester tramway systems (e.g. signalling), and vice versa (see Section 7.1.3);
- A staged EREC G5/5 assessment of the impact of the new installation on the power quality of the DNO supply;
- Verification that apparatus EMC evidence is in line with project requirements with respect to adequate levels of immunity and acceptable levels of emissions (Procurement Review, see Section 7.1.4);
- EMF testing where deemed necessary by the HAZID;

- Pre- and Post-installation EMC Site Surveys, where deemed necessary by the HAZID.
- Earthing and Bonding (E&B) Strategy/Plan (note that this item is outside the scope of Eurofins E&E. However, it is a requirement of this EMC Strategy that such an E&B Plan should be produced and implemented).

3 EMC MANAGEMENT AND ORGANISATION

The client for the fixed installation is Muse. Eurofins E&E UK (EY) are contracted to Caddick to provide appropriate EMC documentation for the fixed installation. The documentation that EY provides will be issued for review, comment and acceptance by Caddick and Muse, as part of the contract works.

- Muse will appoint a 'Responsible Person,' who by virtue of their control of the fixed installation will be able to ensure its continued compliance with the EMC Regulations.

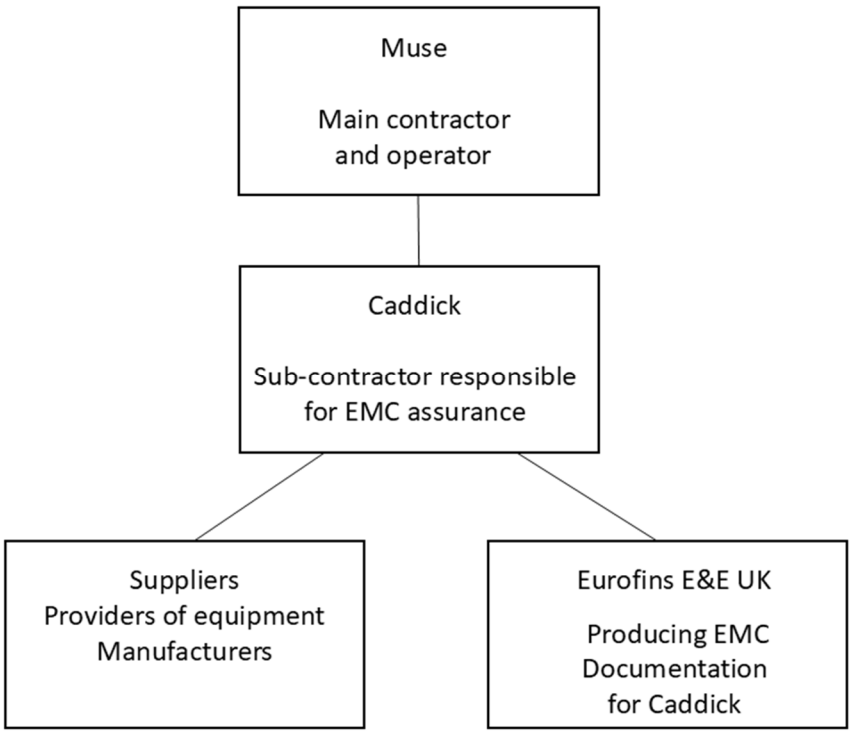


Figure 2. EMC Contract responsibilities.

The principal engineering staff dealing with EMC in the project are:

- Caddick – TBC – responsible for providing the EMC Documentation to the operator (Muse).
- Eurofins E&E UK – Tadeusz Konefal – responsible for providing the EMC Documentation to Caddick.

4 MANAGEMENT OF EMC INTERFACES

4.1 EMC Environments - General

EMC standards are normally written for specified EMC environments. Some examples of common EMC environments are shown in Table 4. As the table shows, the emission and immunity requirements vary depending on the expected EMC environment.

EMC environment	Emission requirement	Immunity requirements
Residential, Commercial and Light Industrial	Most Stringent	Least Stringent
Industrial	Medium	Medium
Railway	Medium/Least Stringent	Most Stringent
Professional Healthcare Facility	Medium	Medium/Less stringent
Home healthcare	Medium	Medium/Less stringent
Special	Usually stringent	Usually stringent

Table 4. Some common EMC environments.

Product specific and generic EMC standards have many tests in common but depending on the intended EMC environment the test levels differ from standard to standard, with more onerous immunity requirements imposed for harsher environments. For example, the railway environment is considered to be particularly harsh, in view of the relatively high levels of EM disturbance generated by traction and power distribution systems. Consequently, the immunity requirements for the railway environment are generally the most stringent, as can be seen in Table 4.

4.2 EMC Environment for this project

There is a variety of apparatus to be supplied to the project, with the principal apparatus being listed in the table in Section 2.1. The vast majority of the locations in the C2 Birtles building can be considered as RCLI environments. The only possible exceptions are:

- areas of the building that are less than 20m from the tramway (see Figure 3, where the distance of closest approach will be 16.5m [19]);
- areas near the substation (generally, within 13m of the substation walls, see Figure 3);
- areas near the PV inverters, particularly where the inverters are close to each other.

With regard to the first bulleted point above, there are 10 apartments at the northern end of the building which are potentially impacted. However, see later in this section. The zoning scheme is such that the emissions from the tramway will be ~15dB below the levels emitted from a 25kV AC railway, where the tramway is compliant with UK Designated standard EN 50121-2:2006. Since the permitted levels of emissions in EN 50121-2:2006 are set with the explicit intention of protecting radio services, the impact on radio receivers in these apartments is expected to be minimal. It is further noted that there will be a communal IRS installed (see Section 2). In most cases it is expected that the receiving antennas for the IRS services will be located sufficiently distant from the tramway that RFI levels will be acceptably low. Where unacceptable interference is experienced on a radio receiver in one of these 10 apartments therefore, it will generally be possible for the user to make use of the alternative and RFI free IRS service.

With regard to the second bulleted point, there will generally be only 5 apartments potentially affected. In the event of unacceptable levels of RFI from the substation, reliance can be placed upon the IRS installation. However, in order to address concerns regarding emissions from the substation, it is recommended that any EMC survey carried out (see Section 6) should include a position near the substation.

With regard to the third bulleted point, the number and locations of the inverters are unknown. Assuming that there are multiple (5+) inverters and that they will be located near the top floor, there is a perceived issue with radio interference due to the fact that each inverter is permitted to emit EM radiation at a level that is generally 13dB above even GI levels, if it has an output current capacity of more than 16A. In this case the relevant product specific UK designated standard EN 62040-2:2006 requires the inverter to include the following warning in the instructions for use: "*Warning: This is a product for commercial and industrial application in the second environment. Installation restrictions or additional measures may be needed to prevent disturbances.*" Even where the current capacity is less than 16A, if the inverter is of Category C2 (an industrial device), EN 62040-2:2006 requires the inverter to include the following warning in the instructions for use: "*Warning: This is a category C2 UPS product. In a residential environment, this product may cause radio interference, in which case the user may be required to take additional measures.*" In order to mitigate the risks of RFI from inverters

therefore, the standards specified in Section 5.4 stipulate that inverters should be of Category C1, which are suitable for use without restriction in a residential environment.

With regard to the interfaces with the Manchester tramway, guidance on EMC environments and zoning can be taken from [20], which is referenced in [5]. The zoning of the electromagnetic environment provided in [20] is set out in Figure 3, where zones are specified on the basis of distance from the centre line of the nearest track, and from traction substations. As can be seen in Figure 3, since the vast majority of locations in the C2 Birtles building are located at least 20m from the nearest tracks, it is generally considered acceptable (at least to Network Rail) that apparatus should be certified to RCLI standards, with regard to immunity to EM emissions from the railway (generally, a 25kV system is implied here).

There are no such equivalent guidelines provided in LU standards S1222 A4 [2] or G222 A3 [3] for a 750V DC or 630V DC railway. However, it can be generally assumed that shoe arcing on a 750V DC system does not produce levels of electromagnetic emissions which are as high as they are for a 25kV AC pantograph system. This viewpoint is supported by the fact that the UK designated railway standard EN 50121-2:2006 (which applies to both AC and DC railways) contains emission limits that are considerably lower for a 750V DC railway than for a 25kV AC railway (by a factor of 15dB). With regard to EM emissions from the Manchester tram system therefore, adoption of the zoning scheme illustrated in Figure 3 is a conservative approach, in keeping with a worst-case philosophy. The only exception will be with regard to low frequency quasi-static magnetic fields, which are expected to be higher for a 750V DC system than for a 25kV system.

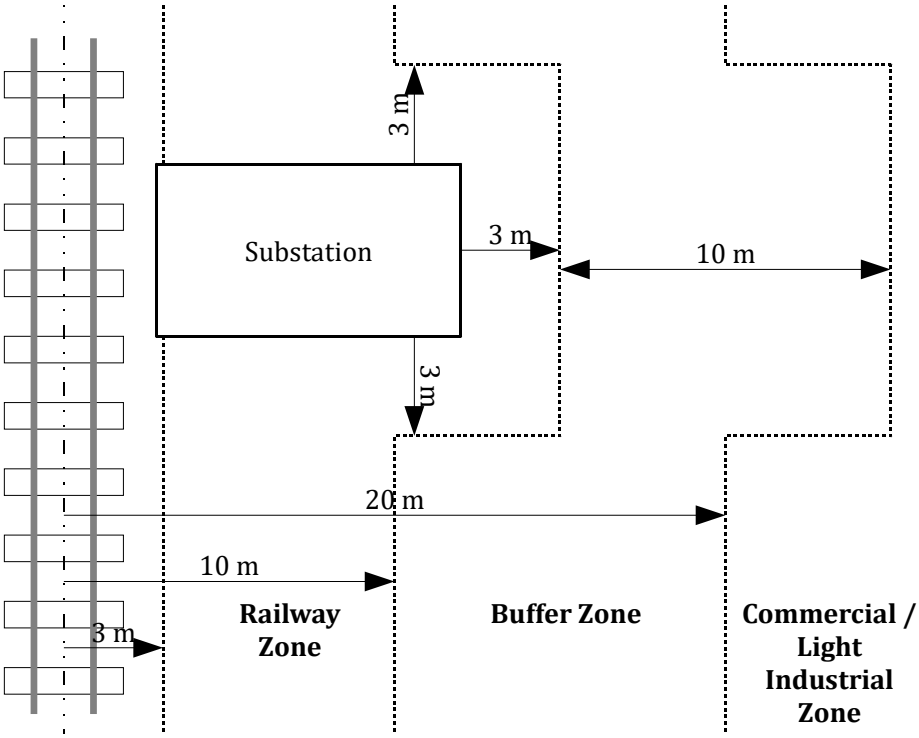


Figure 3. EMC zoning principle from NR/L2/RSE/30041/01 Issue 1 (taken with slight adaptation from [20]).

4.3 EMC Interfaces

Fixed Installations comprise a number of different apparatus and systems. It is necessary to consider the interface between each apparatus and its neighbours. This is sub-divided into various classes of interface:

- Intra-system EMC, between apparatus supplied within the scope of this project.
- Inter-system EMC, between existing customer assets and the apparatus supplied as part of this project.
- Extra-system EMC, between third-party systems and the apparatus supplied as part of this project.

Inter-system and extra-system interfaces are often grouped together, for example as has been done in Section 2.2.

5 LEGISLATION AND STANDARDS

It is the primary purpose of this plan to ensure that this project meets the requirements of the EMC Regulations 2016 [1]. The essential requirements of the EMC Regulations are quoted below:

> Equipment shall be so designed and manufactured, having regard to the state of the art, as to ensure that:
>
> *a) the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended;*
>
> *b) 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.*

Meeting these essential requirements will satisfy all other EMC requirements for the project. This Plan sets out how the essential requirements are to be met.

In order to meet the requirements of the EMC Regulations, it is necessary to consider the additional EMC requirements of the neighbouring tramway. Whilst London Underground and Network Rail (NR) standards are not directly relevant (see Sections 1.2.3 and 1.2.4), these standards include signalling safety requirements in addition to the EMC Regulations' essential requirements. There are also TfGM specific requirements which are discussed in Section 1.2.2. This EMC Control plan, the activities mandated in Section 2.3 and the standards prescribed in Section 5.4 are designed to fulfil the TfGM specific requirements. The application of the EMC Regulations, London Underground and NR standards to this project is considered in the following sub-sections.

5.1 EMC Regulations applied to this project

The EMC Regulations apply to both *Apparatus* and *Fixed Installations*. The requirements differ but both are relevant to this project so are considered below in Sections 5.1.1 and 5.1.2.

5.1.1 The Birtles (C2) as a Fixed Installation

The Birtles C2 building as supplied to Muse will be a Fixed Installation. As such Caddick are responsible [21] for ensuring the installation:

- Is in conformity with the relevant essential requirements;
- Has documentation available to the relevant national authorities demonstrating the good engineering practices used to ensure conformity of the installation.

Muse require that the documentation be supplied to them. The documentation will include this EMC Control Plan and the further EMC documentation listed in Section 7. The EMC Documentation will demonstrate with respect to EMC that:

1) Good engineering practices have been used in the construction of the installation (see Table 7, Section 7).
2) The information on the intended use of 'apparatus' has been respected (see Table 7, Section 7).

In this manner the EMC Documentation will demonstrate that the Birtles C2 building meets the essential requirements of the EMC Regulations.

5.1.1.1 Cabling standards for this project

Cabling, particularly (but not exclusively) the HV cabling and high current LV cabling shall meet the requirements of

- IEC 61000-5-2 [8]
- EN 50174-2 [9]
- EN 50174-3 [10]
- BS 7671[1] [11]
- NR/SP/ELP/27224 [22]

regarding separation from other cables and use of cable trays. A summary of these requirements is provided in Appendix 2.

5.1.2 Apparatus for The Birtles (C2)

It is important for the project to verify that the items procured to form the Fixed Installation meet the appropriate EMC emission and immunity requirements. Appropriate certification is described in Section 5.1.2.1 and the method of recording the certification for the project is described in Section 7.1.4.

[1] Although primarily concerned with electrical safety, the 18th edition includes cable separation requirements to address EMC concerns.

5.1.2.1 Expected EMC evidence for supplied apparatus

Apparatus has a presumption of conformity with the EMC Regulations if the correct application of designated standards is made. Expected designated EMC standards are set out in Section 5.4. Where designated standards have not been used, or do not match the zoning principles of Section 4.2, further evidence will be required, and further actions may need to be undertaken.

Electrical equipment containing no electronics (e.g. transformers or passive filters) will be classed as *inherently benign*. A statement from the supplier confirming the benign status should be obtained.

5.2 London Underground EMC standards

Whilst these standards are not directly relevant, London Underground require that all their new assets meet the requirements of the EMC Regulations. To assist suppliers of both Apparatus and Fixed Installations in achieving this objective LU have produced their own EMC standards. These requirements are designed to provide guidance in known EMC problem areas specific to the LU infrastructure, which are not covered by the standards in the designated list. The most relevant LU standards are as follows:

- S1222 A4, “Electromagnetic Compatibility”, 2023, mandatory [2]
- G222 A3, “Manual of EMC Best Practice”, 2016, for guidance [3]
- S1193 A4, “EMC with LU Signalling System Assets”, 2017, mandatory [23]

It is expected that the apparatus to be procured for the Birtles C2 building will be commercially available equipment already certified (using generic or product-specific standards) for an RCLI or GI environment.

The LU standard S1222 sets the following limits:

1) Signalling compatibility – maximum levels of interference to LU track circuits are specified in S1193, which must not be exceeded. Although such specific LU track circuits will not be present on the Manchester tramway, there will be other TfGM signalling assets (see Section 1.2.2) which will need to be initially risk assessed for EMC issues. Where viable EMC hazards are identified, these will need to be analysed further in the Design Review document (see Section 7.1.3). For example, transformer rooms and some associated high current carrying cabling are located at a similar level to the tramway (ground level), and it is known that

high levels (above the limits specified by the CEMFAW Regulations, see Section 5.5.1) of magnetic fields can be present at 2m – 3m from transformers. A signalling compatibility study shall therefore be undertaken to assess the levels of disturbance to identified TfGM assets in the vicinity of the Birtles C2 building.

2) Psophometric noise – a maximum induction of $1mV_P$ into lineside cables is specified. Although it is not anticipated that there will be any significant (e.g. greater than 200m) lengths of HV or LV cabling running parallel with TfGM telecommunications lines, this will be confirmed in the Design Review (see Section 7.1.3). Where there *is* in fact significant parallelism at low separation distance (e.g. less than 0.5m), a cable study shall be undertaken to assess the levels of induced psophometric disturbance onto lineside analogue telecommunications circuits.
3) DC and low frequency magnetic fields – static and 50 Hz limits are specified for train saloons, primarily to protect passengers with cardiac pacemakers.
   This limit is not in scope for the Birtles C2 project. However, the limits set by the CEMFAW Regulations are appropriate; see Section 5.5.
4) Operation of radio – station and train radios must be able to operate, and use of Wi-Fi routers must not adversely affect this operation. Emissions from the Birtles C2 building will be controlled by the apparatus meeting appropriate designated standards.
5) Touch voltage – a maximum normal-running induction of $60V_{rms}/25V_{rms}$ into lineside cables is allowed. Due to the Lack of parallelism of the installation with the tracks, such induction from the Birtles C2 building is not considered credible, unless the Design Review identifies significant parallelism of new HV or LV cabling with tramway lineside cables. In the latter case, a cable study shall be carried out to assess the normal-running and short-circuit induction levels into lineside cables.

5.3 Network Rail EMC standards

Although Network Rail standards are not directly relevant to this project, the zoning principles of Section 4.2 (taken from NR standard NR/L2/RSE/30041/01 Issue 1 [20]) have been adopted by this EMC Control Plan, in the absence of any equivalent LU or TfGM guidance. Furthermore, the separation distances between HV cabling and

telecommunications cabling outlined in NR standard NR/SP/ELP/27224 [22] have been included in this EMC Control Plan. Apparatus compliant with relevant, designated EMC emissions and immunity standards as indicated in Section 5.4 shall be regarded as having acceptable levels of emissions and immunity for the project.

The installer shall note that:

- apparatus shall be procured to meet the EMC requirements (see Section 5.4), and that
- EMC documentation for all electrical equipment shall be provided by the sub-contractor (see Section 5.4.1).

The correct procurement of apparatus will be verified in a standards gap analysis to be performed in the EMC Procurement Review (see Section 7.1.4).

5.4 Overall EMC requirements for Apparatus

Given the EMC environment, along with the additional requirements and guidance provided by LU and NR documents, the overall EMC requirements are listed in Table 5. The standards are listed undated: any current version of a designated standard that is listed on the relevant UK government web site [24] will provide a presumption of conformity.

Item	Emission	Immunity
Generator (Life Safety)	EN 61000-6-4 [25] EN 55012 [26]	EN 61000-6-2 [27]
Switchgear	EN 61439-1 [28] + relevant part of EN 61439	
Photovoltaic Inverters	EN 62040-2 [29] (Category C1)	
Meters	EN 50470-1 [30]	
Lighting and Controls	EN 55015 [31]	EN 61547 [32]
Emergency Lighting	EN 55015	EN 61547
UPS for lighting	EN 62040-2 (Category C1)	
Security/Door entry Systems	EN 61000-6-3 [33]	EN 50130-4 [34]

Item	Emission	Immunity
AFIL for Door entry	EN 61000-6-3 EN 62489-2 [35] PD IEC/TR 63079 [36]	EN 61000-6-1 [37] EN 62489-1 [38] PD IEC/TR 63079
Fire Alarm System	EN 61000-6-3	EN 50130-4
CCTV		
Emergency systems (radio)	EN 301 489-1 + relevant parts of EN 301 489	EN 301 489-1 + relevant parts of EN 301 489
EVC (wired)	EN 61000-6-3	EN 50130-4
Wi-Fi routers	EN 301 489-1 [39] EN 301 489-17 [40]	EN 301 489-1 EN 301 489-17
MVHR systems	EN 61000-6-3	EN 61000-6-1
AHUs, Fans	EN 61000-6-3	EN 61000-6-1
VSDs for HVAC systems	EN 61800-3 [41] (Category C1)	
ASHPs	EN 61000-6-3	EN 61000-6-1
Electric vehicle charging	EN IEC 61851-1 [42] EN IEC 61851-21-2 [43]	
Disabled Refuge	EN 61000-6-3	EN 50130-4
Lifts	EN 12015 [44]	EN 12016 [45]
IRS	EN 50083-2 [46]	
Cabling (LV, COMMS, Coax, Ethernet, Cat 6, Fire)	n/a (see Section 5.1.1.1 and Appendix 2 for separations)	
RCLI apparatus	EN 61000-6-3	EN 61000-6-1
GI apparatus	EN 61000-6-4	EN 61000-6-2
Contractors' construction apparatus (e.g. hoists etc.)	EN 61000-6-4	EN 61000-6-2

Table 5: Expected standards for apparatus supplied to the project, within Caddick's scope.

5.4.1 Overall EMC requirements for suppliers

Apparatus supplied to the project shall be accompanied by documentation demonstrating its EMC with the defined project environment. Expected documentation is listed in Table 6.

Item	Notes
Declaration of Conformity	For benign apparatus, a statement from the supplier of this exclusion is expected.
Installation, use and maintenance instructions	If required to ensure EMC in the defined environment
Technical Justification	If the designated standards listed above have not been applied.
Conducted 50Hz harmonic current emissions profile	High current (e.g. greater than 16A) items only. This would typically include Lifts, UPS, Heaters/AHU and other GI heavy duty plant apparatus.
Available EMC certification	Details of DoCs, any EMC specific instructions for use, Test Reports, radio system frequencies and powers (e.g. walkie talkies) or other EMC relevant technical documentation accompanying construction contractors' equipment should be requested when engaging a contractor.

Table 6: Expected documentation for apparatus supplied to the project.

5.5 CEMFAW Regulations

In July 2016, the CEMFAW Regulations 2016 [14] came into force, requiring employers to ensure their employees workplace(s) meet the exposure limits set out in the regulations; these limits are largely based on the International Commission on Non-Ionising Radiation Protection (ICNIRP) guidance [13, 47, 48, 49].

5.5.1 Magnetic fields

The ICNIRP 1998 General Public limits shown in Figure 4 are applicable.

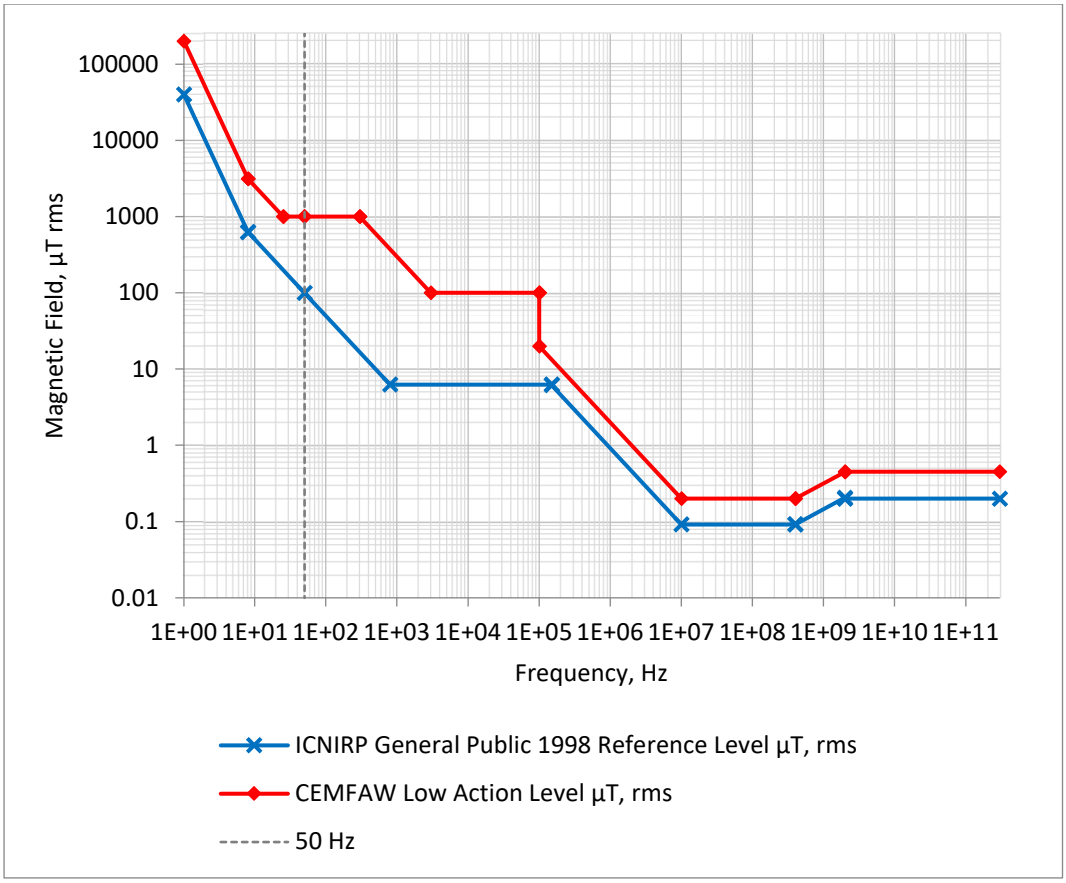


Figure 4. Magnetic field limits – ICNIRP 1998 General Public and CEMFAW Low Action Level.

The CEMFAW Regulations 2016 set an additional static (0Hz) limit of 0.5mT for magnetic fields, specifically to avoid interference with active implanted devices such as heart pacemakers.

Significant magnetic fields will exist in the regions surrounding cables that are carrying high currents (e.g. greater than 100A); cables running from transformers and LV switch rooms in the new installation will almost certainly be rated to carry currents in excess of 100A. It is likely that magnetic fields in excess of the CEMFAW limits will exist at some distance (of the order of tens of centimetres) away from the cables; this distance will increase where the cables are not in a symmetric (equilateral triangle) 'trefoil' arrangement, as will be the case at their connection to a switchboard or transformer. As mentioned in Section 1.4.1, EN 50499:2019 requires that cables carrying more than 100A per phase at 50 Hz should be assessed to ensure that the magnetic fields arising from the current will not affect workers or members of the general public at particular risk (see List of Terms and Abbreviations). According to the earlier (superseded) standard EN 50499:2008 [50], Annex F, currents in excess of 500A may produce magnetic fields in

excess of the ICNIRP 1998 [13] occupational reference level (EN 50499:2008 refers to this as the 'action value', see Figure 4), unless the fields are cancelled by opposing currents. Specific consideration of the magnetic fields emanating from the wires therefore needs to be given, in order to ensure exposures are within the limits stated in ICNIRP 1998 guidance, both for workers and members of the general public who are at particular risk and for occupational personnel who are not at particular risk. This consideration is intended to be given in the Design Review Document for the Birtles (C2) building fixed installation (see Sections 2.3 and 7.1.3).

In most cases the assessment will recommend a minimum protection distance to be maintained between cabling and personnel. Protection distances may be implemented through warning signage and/or natural or forced physical barriers. In the case of LV switch rooms, protection distances for maintenance personnel may be implemented through the use of painted lines on the floor.

5.5.2 Electric fields

The ICNIRP 1998 General Public limits shown in Figure 5 are applicable.

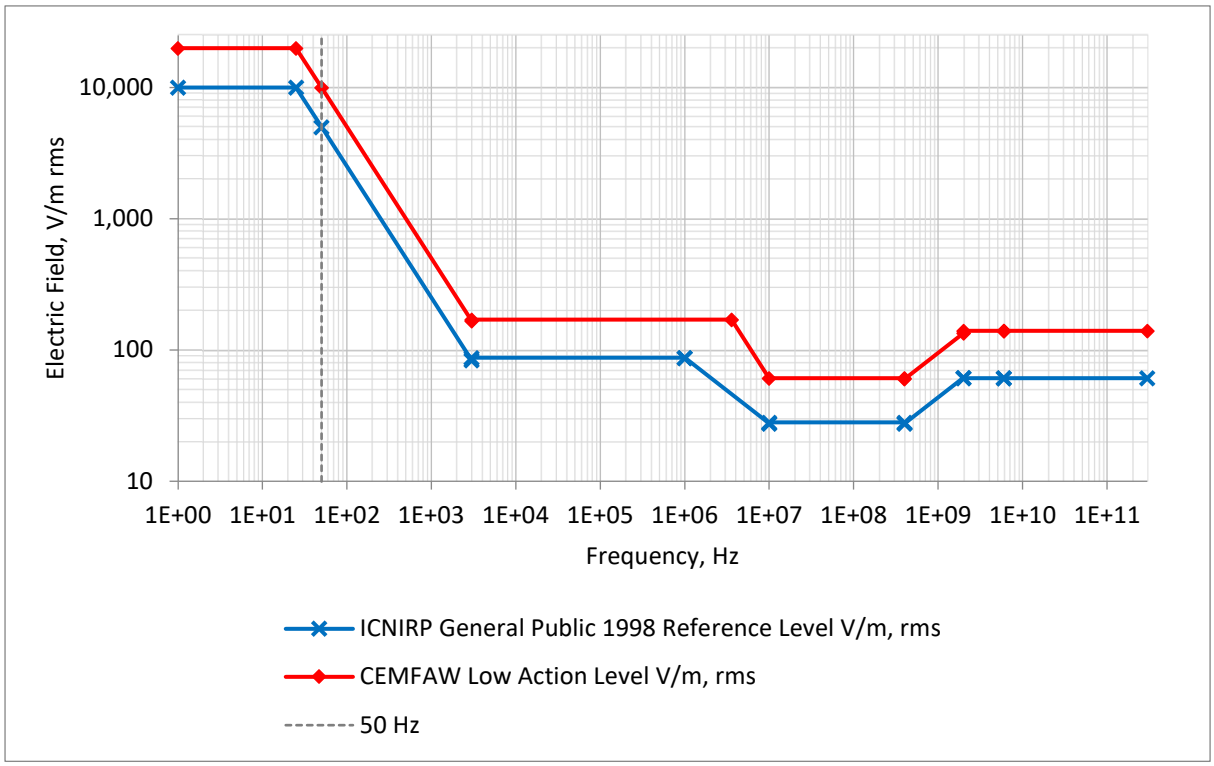


Figure 5. Electric field limits – ICNIRP General Public and CEMFAW Low Action Level.

As mentioned in Sections 1.4.2 and 2.1, the Fixed Installation works will include the provision of numerous Wi-Fi access points (for routers). In addition, there are plans for

a (partially) radio based emergency communications system. The antennas of such transmitters have the potential to produce electric fields that exceed the ICNIRP 1998 General Public (GP) limits shown in Figure 5. With regard to Wi-Fi routers, it is noted in EN 50499:2019 that where such apparatus has been tested to a relevant EMF standard (such as EN 50360:2017), no further action or analysis will be required, even where there are multiple units installed. Otherwise, where the transmit power (EIRP) is unknown, information should be obtained from the manufacturer regarding such parameters as the transmit power and antenna gains (this is particularly relevant to the emergency radio system, which is likely to be of medium power). An appropriate analysis should be performed in order to determine the minimum protection distance that should be maintained between the Wi-Fi routers or emergency radio antennas and personnel. Such protection distances are generally of the order 50mm – 100mm (or possibly greater for the emergency radio) and are readily achievable by locating the antennas at some distance (e.g. 300mm) above head height, or within a non-metallic container (forming an enforced barrier) that cannot easily be accessed. As noted in Section 1.4.2, where Wi-Fi routers are limited in power to 100mW, they are deemed not to pose a threat to personnel who are not persons at particular risk. However, in order to mitigate the hazards from Wi-Fi antennas and emergency radio antennas to persons who are at particular risk (see Page 7), it is recommended that:

- The operation and maintenance (O&M) manual should highlight the EMF hazard for personnel at particular risk.
- Adequate briefing of the EMF risks should be given for personnel who are at particular risk and who will operate the radio systems.

5.6 UK Radio Equipment Regulations

All apparatus supplied for the Birtles C2 Fixed Installation must meet the essential requirements of the EMC Regulations, as outlined in (a) and (b) of Section 5. In addition, since the Wi-Fi routers and Emergency radio system listed in Table 5 will be generating radio frequency signals with the specific intention of providing a radio frequency link, this apparatus must also adhere to the requirements of the UK Radio Equipment Regulations SI 2017 No. 1206 [18]. Adherence to the requirements of the Radio Equipment Regulations can be demonstrated through compliance with the technical

requirements on radio frequency generation performance (e.g. suppression of sidebands), as indicated in Table 5.

5.7 EREC G5/5

The (existing) substation for the Birtles C2 building will take power from the local network at 11kV and use a step down transformer to provide a dedicated 400V 3 phase supply for the building. As such, there is a requirement to demonstrate, through a staged assessment, that the levels of harmonic voltages making their way back from the installation into the 11kV network will be acceptable at the point of common coupling (PCC). That is, it should be demonstrated that the level of total harmonic distortion (THD) in the voltage waveform will not exceed the planning levels set out in EREC G5/5 [51]. This is usually achieved through a 'desktop exercise' which makes use of manufacturers' data on conducted 50Hz harmonic emissions from their apparatus. In preparation for this exercise therefore, such data should be requested from manufacturers of apparatus to be installed, where that apparatus is drawing high levels of current (e.g. greater than 16A, see Table 6 of Section 5.4.1). Typically, such apparatus would include Lifts, UPS, Heaters/AHU and other GI heavy duty plant apparatus. It is noted in general that EMC standards for GI apparatus do not provide any conducted emission limits at all in the frequency range below 150kHz, beyond the requirement of limiting their effects on the 11kV system, as described in EREC G5/5. Where the EREC G5/5 assessment indicates that a significant breach of the permitted total harmonic distortion (THD) in the 11kV system is likely (a THD level of 4.5% is permitted at 11kV), it may be beneficial to install an active filter and/or power quality meter within the substation as part of the installation.

6 EMC TESTING AND COMMISSIONING ARRANGEMENTS

EMC and EMF site Surveys shall be made where a risk assessment reveals a requirement. EMC surveys are normally made in two stages: a pre-construction survey and a post-construction survey (only a post-construction survey is required with respect to EMF issues).

6.1 EMC surveys

The main purpose of these surveys is to demonstrate that the new Fixed Installation (comprising the completed Birtles C2 building) will not substantially disturb radio reception. Although the Birtles C2 building is not directly railway related, it is recommended that the limits and methods used in UK designated standard EN 50121-2:2006 [52] should be applied, using the most stringent limits that appear in this standard (which correspond to a railway substation). The limit levels in this standard are set with the explicit intention of protecting radio services (specifically, from radiated EMI from a railway. However, the same limits can clearly and reasonably be applied to a new and/or refurbished building). Railway installations that conform to this standard are endowed with a legal presumption of conformity to the EMC Regulations, and it can reasonably be argued that a similar presumption of conformity should be conferred to other Fixed Installations (such as the Birtles C2 building) that meet the same standard.

In this respect it is noted that it may be difficult to separate out the EM radiated emissions from the new building and from the railway itself, particularly during the post-construction survey. For this reason, it is recommended that a pre-construction survey should be carried out, to gauge the levels of emissions from the tramway itself. This will enable any potentially problematic existing radio emissions from the tramway (for example, as part of the MESH radio system) to be identified and assessed (e.g. as part of the Design Review document [see Section 7.1.3]). At the same time, it will enable any such problematic emissions to be discounted from originating from the new Birtles C2 building, when the post-construction survey is undertaken.

Measurements should be made at the following position:

- On or near the turning area located between substation and the tramway, with antennas sighted on the tramway;

- On or near one of the car parking spaces located east of the existing substation, with antennas sighted on the substation.

EMC Measurements should be made both before and after the Fixed Installation comprising the Birtles C2 building is energised.

6.1.1 Pre-construction survey

These measurements are made to indicate the current status of the locations with respect to the EN 50121-2 (most stringent, substation) limit, and to provide comparative data for the post-energisation measurements. In case of complaints of EMI by third parties upon completion and energisation of the Birtles C2 building, recourse can be made to the pre-energisation and post energisation surveys. It may be possible to demonstrate that the EM environment has not been significantly impacted on by the introduction of the Birtles C2 building, and that the source of EMI (where present) is not in fact the Birtles C2 building. Conversely, it may be possible to ascertain that the likely source of EMI is indeed the Birtles C2 building, where a significant degradation of the EMI environment is observed.

With regard to the frequency range for measurements, EN 50121-2:2006 has a normative frequency range from 9kHz to 1GHz. However, it is recommended that this frequency range should be extended to 6GHz, since there are numerous radio services that operate in the frequency range 1GHz – 6GHz (including mobile phone handsets and base stations). Similarly, it is possible that the VECOM loops associated with the tramway will make use of frequencies extending into the audio frequency range. For this reason, it is recommended that the EMC survey is extended into the frequency range below 9kHz.

6.1.2 Post-energisation survey

The measurement procedures and positions used for the pre-energisation EMC survey will be repeated with the Birtles C2 building energised. The purpose of the measurements is to verify that that the RF emissions from the Birtles C2 building have not increased above those prescribed in EN 50121-2:2006. The post-energisation surveys can also generally be compared with the pre-energisation measurements, in order to ascertain at what frequencies and to what extent the Birtles C2 building has degraded (or not) the EM environment. Such information will prove invaluable in case of complaints of EMI from third parties. The post-energisation survey will demonstrate (as

far as possible) that the completed the Birtles C2 project meets the requirements of EN 50121-2.

6.2 EMF surveys

The main purpose of these surveys is to ensure that identified locations meet the requirements of the ICNIRP 1998 guidelines, to protect personnel at particular risk (e.g. with implanted/body-worn medical devices, and pregnant workers).

6.2.1 Pre-construction survey

A pre-construction survey is not required – there is no benefit or requirement for a comparison with pre-energisation levels.

6.2.2 Post-energisation survey

In conjunction with the EMC survey, measurements will be made at locations identified in the HAZID and Design Review documents. Such locations are likely to include the transformer rooms, current carrying risers that convey power from the substation upwards through the building and any apparatus that has been identified as drawing large currents (>100A). The purpose of the measurements will be to demonstrate that the completed Birtles C2 building does not give rise to magnetic field strengths above the ICNIRP 1998 general public limits (to protect workers at particular risk), and that any zones where exceedances do occur (for example, adjacent to a sub-station) are appropriately managed (e.g. through signage and limitations on access).

7 DELIVERABLES SCHEDULE

The EMC Documentation should demonstrate *"that good engineering practice has been used and the information on the intended use of its components has been respected"*. For a small installation this could be demonstrated in a single document but for a large installation such as the Birtles C2 building it is more convenient to break the task into a number of documents, as summarised in Table 7.

Document	To Demonstrate	
	Good engineering practice	**Intended use of components respected**
EMC Control Plan	✓	
EMC Hazard Identification and Risk Analysis	✓	
EMC Design Review	✓	
EMC Procurement Review		✓
Cable Study	✓	
Site Measurement Reports	✓	
EMC Project File	✓	✓

Table 7: Purpose of the documentation with respect to the requirements of the EMC Regulations.

7.1 Documentation

The following sub-sections describe the purpose and expected contents of each document to be produced.

7.1.1 EMC Control Plan

This document constitutes the EMC Control Plan.

7.1.2 EMC Hazard Identification and Risk Analysis

The principal EMC hazards will be identified in a Hazard Log, and specific mitigations will be detailed. It is expected that in general hazards will be mitigated by:

- conformance to relevant standards where appropriate (as established in the EMC Procurement Review);
- design measures;
- EMC and EMF surveys.

As part of this document a Hazard Matrix and Risk Register shall be prepared. This will follow a format to be agreed with Caddick. However, the process is generally expected to be compatible with the methodology outlined in EN 50126-1:2017+A1:2024 [53], which

is a standard that has been highlighted as appropriate to use in LU standard G222 [3]. Other formats are also possible, for example NR/L2/RSK/00001 [54]. The document is expected to have some open hazards that will be resolved in subsequent documentation (e.g. the Design Review or the Project File), and will highlight Safety Hazards. There will be a statement that safety related hazards should also be assessed independently at a higher level, in addition to being assessed by Eurofins' documentation.

7.1.3 EMC Design Review

This document reviews the design of the project, in particular the relative location of assets, issues of parallelism and cable routing, as directed by the risk analysis. Where particular issues are especially complex, individual studies may be required (e.g. cable studies). EMF issues for persons who are at particular risk and potential adverse interactions with tramway signalling systems will be analysed.

7.1.4 EMC Procurement Review

This document will list the systems that are to be supplied by all sub-contractors for the Birtles C2 building, and will examine the collated documentary evidence that individual items of equipment and systems provided comply with the EMC Regulations. The documentation collated for the Procurement Review will consist of Declarations of Conformity (DoCs), and where appropriate, additional Technical Documentation (TD) or other additional evidence. The documentation collated will be presented as Appendices in the report. A summary table will be presented showing each provided system's EMC evidence. Where EMC Installation instructions are given these will also be recorded in an appendix of the Review.

Where EMC certification for apparatus does not exactly match the EMC standards mandated in Section 5.4 of this document (EMC Control Plan), a standards gap analysis will be performed, highlighting areas where there may be shortfalls in the standards of emissions or immunity. Where possible, a technical justification (TJ) will be provided for the use of the alternative standards of certification used. Where no such TJ is possible, the resulting EMC risk will either need to be accepted, or other mitigating actions will be suggested. In the worst case (there is no EMC certification available whatsoever) an alternative supplier may be recommended.

7.1.5 Cable Study

This document (which may be incorporated into one of the other documents outlined in Table 7) will analyse the arrangements for the Manchester tramway traction power, LV and HV cabling with respect to unwanted magnetic induction into nearby 'sensitive' cabling (e.g. telephone cabling). A judgment will be made as to the likely outcome (e.g. unintelligible speech or undeliverable data packets).

7.1.6 Site Measurement reports

7.1.6.1 EMC Test Plan

The EMC test plan will describe the arrangements for the two phases of on-site EMC testing as described in Section 6. The test plan will describe:

- The purpose of the tests.
- The tests to be performed, and the duration of the measurements.
- The locations of the tests.

7.1.6.2 Method Statement

The Method Statement is a companion document to the Test Plan. It assures all health, safety and welfare aspects have been correctly considered and assessed, and that appropriate safeguards have been implemented where necessary to reduce risks to acceptable levels.

7.1.6.3 Pre-construction EMC Test Report

The pre-construction survey will demonstrate that the existing site meets (or not) the requirements of EN 50121-2. The pre-construction test report will describe the results of this survey.

7.1.6.4 Post-energisation EMC Test Report

The results of the post-energisation EM survey will be described in this report. They will be compared with the results of the pre-construction survey with the aim of demonstrating compliance of the Birtles C2 building with EN 50121-2.

7.1.7 EMC Project File

A whole installation EMC assurance document (the EMC Project File) will be produced. It will summarise the activities and findings of the previous documents.

The aim of this document is to:

- summarise the activities and findings of the previous documents;
- review any hazards which have not been closed by subsequent activities and documentation.

It is expected that the EMC and EMF survey test results will contribute to this process. If it is not possible to close certain hazards, they will be reported as residual risks that must be accepted by Muse. In particular, the status of the Birtles C2 building with respect to the EN 50121 series of standards will be discussed (see Section 6.1).

7.1.8 Earthing and Bonding Plan

It is expected that an Earthing and Bonding (E&B) Plan will be produced and implemented for the Birtles C2 building. In particular, the E&B Plan is expected to address such safety issues as touch voltages and residual earth currents. However, it is noted that assessment and amelioration of E&B issues is considered to be beyond the scope of Eurofins E&E UK. The E&B plan, whilst mandated by this EMC Control Plan, is therefore not considered to be a deliverable that will be supplied or assessed by Eurofins E&E UK.

7.2 Dates for Deliverables

The schedule of dates for submitting the deliverables described above will be as shown in Table 8.

Item	Date
EMC Control Plan	16th July 2026
EMC Hazard Identification and Risk Analysis	TBC
EMC Design Review	TBC
EMC Procurement Review	TBC
Cable Study	TBC
Site Measurement Reports	TBC
EMC Project File	TBC

Table 8: Deliverable Dates for Birtles C2 EMC Documentation.

APPENDIX 1 – THIRD PARTY INTERFACING APPARATUS AND SYSTEMS

Asset	Distance from C2 Birtles
Manchester tramway and rolling stock	16m
Tram related signalling systems (see Section 1.2.2)	16m
Residential buildings, Poundswick Lane	47m
Wythenshawe FM radio station	120m
Peel Hall Medical Practice	175m

Note that the threats from mobile phone masts have not been included in the table above. Although information on mobile phone masts was once freely available (e.g. at [55]), detailed information on locations, powers and frequencies of mobile phone masts are generally considered commercially sensitive, and such information is no longer easy to obtain. However, if it is assumed that:

- there are currently no EMC issues with excessive mobile phone mast emissions at the proposed site for the C2 Birtles building;
- all new apparatus to be installed will be compliant with the standards required of it by this EMC Strategy;

the EMC hazards from mobile phone masts can be considered ALARP. It is noted that the vast majority of apparatus, including RCLI [domestic] apparatus with comparatively low levels of immunity to radiated emissions at GSM/UMTS/4G and 5G mobile phone mast frequencies, will be operating without incident at or near the proposed site for the C2 Birtles building.

APPENDIX 2 - CABLE SEPARATION DISTANCES, SIGNAL AND POWER CABLING

This appendix summarises the principal advice given on cable separations in EN 50174-2 [9], EN 50174-3 [10], BS 7671 [11], NR/SP/ELP/27224 [22] and G222 [3]. The approaches are not necessarily consistent between standards. Where in doubt, the most stringent requirement should be followed. However, it is possible that individual installations may not practically be able to fulfil all requirements. The implications of any non-compliances will be investigated in the Design Review document (see Section 7.1.3).

EN50174-2:

Determine the IT cabling segregation classification (a, b, c or d) from Table 9.

Information technology cable			
Screened	**Unscreened**	**Coaxial/twinaxial**	
Coupling attenuation at 30 MHz to 100 MHz dB	**TCL at 30 MHz to 100 MHz** dB	**Screening attenuation at 30 MHz to 100 MHz** dB	**Segregation classification**
≥ 80 [a]	≥ 70 − 10 × lg *f*	≥ 85 [d]	d
≥ 55 [b]	≥ 60 − 10 × lg *f*	≥ 55	c
≥ 40	≥ 50 − 10 × lg *f* [c]	≥ 40	b
< 40	< 50 − 10 × lg *f*	< 40	a

[a] Cables meeting EN 50288–4-1 and EN 50288-9-1 (EN 50173–1:2018, Category 7 and Category 7A) meet Segregation Classification "d".

[b] Cables meeting EN 50288–2-1, EN 50288–5-1 and EN 50288–10-1 (EN 50173–1:2018, Category 5, 6 and 6A respectively) meet Segregation Classification "c". These cables can deliver performance of Segregation Classification "d" provided that the relevant coupling attenuation requirements are also met.

[c] Cables meeting EN 50288–3-1 EN 50288–6-1 and EN 50288–11-1 (EN 50173–1:2018, Category 5, 6 and 6A respectively) meet Segregation Classification "b". These cables can deliver performance of Segregation Classification "c" or "d" provided that the relevant TCL requirements are also met.

[d] Cables meeting EN 50117–4-1 (EN 50173–1:2018, Category BCT-C) meet Classification "d".

Table 9. Segregation classifications of various IT cable types (taken from [9]).

Determine the separation factor 'S' for the installation, based on the type of containment (CMS) that is intended, from Table 10.

		Containment applied to information technology or power supply cabling (separation specified is in addition to that provided by any divider/barrier)		
Segregation classification (from Table 3)	**Separation without electromagnetic barrier**	**Open metallic containment** [a]	**Perforated metallic containment** [b, c]	**Solid metallic containment** [d]
d	10 mm	8 mm	5 mm	0 mm
c	50 mm	38 mm	25 mm	0 mm
b	100 mm	75 mm	50 mm	0 mm
a	300 mm	225 mm	150 mm	0 mm

[a] Screening performance (0 MHz to 100 MHz) equivalent to welded mesh steel basket of mesh size 50 mm × 100 mm. This screening performance is also achieved with steel tray (trunking without cover) of less than 1,0 mm wall thickness and/or more than 20 % equally distributed perforated area.

[b] Screening performance (0 MHz to 100 MHz) equivalent to steel tray (trunking without cover) of at least 1,0 mm wall thickness and no more than 20 % equally distributed perforated area. This screening performance is also achieved with screened power cables that do not meet the performance defined in footnote d.

[c] The upper surface of installed cables shall be at least 10 mm below the top of the containment.

[d] Screening performance (0 MHz to 100 MHz) equivalent to a steel conduit of 1,5 mm wall thickness. The assumption underlying the material performance of the conduit is that the product of the permeability and conductivity is greater that 38 H•S/m^2. This performance is not provided by stainless steel, aluminium and non-magnetic materials. A 1,0 mm wall thickness of the same material does not support S = 0 mm.

Table 10. Separation factor 'S' for IT cable segregation classifications a, b, c, d and various containment types (including non-conducting containment) (taken from [9]).

Determine the power cabling factor 'P' for the culprit power cabling, based on the number of individual current carrying conductors and the currents carried by individual cables (multiples of 20A), from Table 11.

Electrical circuit type [a, b, c]	**Quantity of circuits**	**Power cabling factor** P
20 A 230 V 1-phase	1 to 3	0,2
	4 to 6	0,4
	7 to 9	0,6
	10 to 12	0,8
	13 to 15	1,0
	16 to 30	2
	31 to 45	3
	46 to 60	4
	61 to 75	5
	> 75	6

[a] 3-phase cables shall be treated as 3 off 1-phase cables.

[b] More than 20 A shall be treated as multiples of 20 A.

[c] Lower voltage AC or DC power supply cables shall be treated based upon the their current ratings, i.e. a 100 A 50 V DC cable = 5 of 20 A cables (P = 0,4).

Table 11. Power cabling factor 'P' of culprit power cabling, based on number of conductors and currents carried by conductors (multiples of 20A) (taken from [9]).

The recommended minimum separation distance d between the culprit power cabling and the victim IT cabling is then calculated as

$$d = S \times P$$

EN50174-3:

Generally, information technology (IT) cables shall be positioned at a minimum distance of 0.3m from LV power cabling. IT cabling should be positioned at a horizontal distance of at least 4 m from the centre line of a railway track.

BS 7671:

1) Where the intended application of the IT cabling is not known:

Containment applied to mains power cabling		
No containment or open metallic containment	Perforated open metallic containment	Solid metallic containment
200mm	150mm	0mm (containment thickness separation only)

Table 12. Minimum separation distances between IT cabling and power cabling, where IT cable application is unknown (taken in part from [10]).

The definitions of containment types (no containment, perforated and solid) are similar to those used for open, perforated and solid in footnotes a, b and d of Table 10.

2) For long cable runs (the definition of 'long' is not given in BS 7671):

Power cable voltage (V)	Minimum separation (power cable to signal cable) (m)	Power cable current (A)	Minimum separation (power cable to signal cable) (m)
115	0.25	5	0.24
240	0.45	15	0.35
415	0.58	50	0.5
3300	1.1	100	0.6
6600	1.25	300	0.85
11000	1.4	600	1.05

Table 13. Minimum separation distances between IT cabling and power cabling, for 'long' cable runs (taken from [10]).

The most stringent (highest) value of separation should be used, based on voltage or current.

NR/SP/ELP/27224

NR/SP/ELP/27224 and its accompanying Letter of Instruction NR/BS/LI/217 [56] require newly introduced HV cabling or copper S&T cabling to be laid in such a manner that a minimum separation distance of 1m is maintained between the HV cabling and the S&T cabling (both with regard to existing and newly laid cables). If this is not possible

and a separation distance of less than 1m must be present, it should be ensured that the reduced separation does not persist for a combined distance of greater than 200m over the entire length of parallelism.

G222:

Characterise the cable type (radiator or susceptor) using the scheme in Table 14.

Classification	Description of cable function
R1 (Radiator)	Power cables up to 80A or up to 415V Transmitter output cables (systems operating below 100 kHz) Transceiver cables
R2 (Radiator)	Power cables (50Hz) more than 80A or more than 415V.
S1 (Susceptor)	Receiver input cables, systems operating below 100kHz, signals less than 100µV
S2 (Susceptor)	Receiver input cables, systems operating below 100 kHz, signals in the range 100µV to 100mV
S3 (Susceptor)	Cables that carry low level voltage and current signals (e.g. Signalling Cabling) Coaxial cables to receivers and video systems operating above 100 kHz.
G (General)	Coaxial cables to transmitters operating above 100 kHz, Cables carrying low frequency signals above 100mV.

Table 14. Characterisation of cables according to G222 [3].

Maintain distances between cables according to Table 15.

Cable Classifications	R1	R2	G
S1	100mm	150mm	100mm
S2	100mm	100mm*	75mm
S3	No entry	200mm*	No entry
G	75mm	100mm*	No entry
*Increase separation distance by 75mm for each additional 50A above 160A carried by R2			

Table 15. Minimum separation distances between cable types according to G222 [3]. All separation distances are described in G222 as 'for example only'.

REFERENCES

1 Statutory Instrument 2016 No. 1091, The Electromagnetic Compatibility Regulations 2016, November 2016.

2 S 1222, Issue A4, "Electromagnetic Compatibility", London Underground, May 2023.

3 G222, Issue A3, "EMC best practice", London Underground, September 2016.

4 NR/L1/RSE/30040, Electromagnetic Compatibility, Issue 2, September 2025.

5 NR/L2/RSE/30041, Electromagnetic Compatibility (EMC) assurance process, Issue 3, December 2025.

6 World wide web address https://engx.theiet.org/f/wiring-and-regulations/29228/solar-array---grounding , accessed 1st July 2026.

7 World wide web address http://www.geosolar.org.uk/DC%20earthing.html , accessed 1st July 2026.

8 IEC 61000-5-2, "Electromagnetic compatibility. Installation and mitigation guidelines. Earthing and cabling", IEC, November 1997

9 EN 50174-2: 2018, "Information technology. Cabling installation. Installation planning and practices inside buildings", CENELEC, June 2018.

10 EN 50174-3:2013 +A1:2017, "Information technology. Cabling installation. Installation planning and practices outside buildings", CENELEC, May 2017.

11 BS 7671 – 18th Edition, "The IET Wiring Regulations", The Institution of Engineering and Technology, 2018.

12 BS EN 50499: 2019, Procedure for the assessment of the exposure of workers to electromagnetic fields, CENELEC, October 2019.

13 ICNIRP, "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)", Health Physics **Vol 74** No 4, pp 494-522, April 1998.

14 Statutory Instrument 2016 No. 588, The Control of Electromagnetic Fields at Work Regulations 2016, May 2016.

15 ETSI EN 300 328 V1.8.1 (2012-04), Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive, ETSI, 2012.

16 N. Griffiths, Building Services Specification, C2 Apartments, Birtles House, Unit 1, Market Place, Civic Centre, Wythenshawe, Manchester, M22 5RE, Rev. P01, TACE Project No: PA1802, 13th February 2026.

17 World wide web address: https://www.google.com/maps/place/Wythenshawe,+Manchester/@53.380423,-2.2637553,3a,75y,73.76h,86.08t/data=!3m7!1e1!3m5!1s_nH6NEtwUcOKEEXrtCH4fg!2e0!6shttps:%2F%2Fstreetviewpixels-pa.googleapis.com%2Fv1%2Fthumbnail%3Fcb_client%3Dmaps_sv.tactile%26w%3D900%26h%3D600%26pitch%3D3.922313863070414%26panoid%3D_nH6NEtwUcOKEEXrtCH4fg%26yaw%3D73.76360710237174!7i16384!8i8192!4m6!3m5!1s0x487bad5d52d98b0d:0x135cdbd0a19ed1ac!8m2!3d53.3883742!4d-2.2560093!16zL20vMDRwNjdy?entry=ttu&g_ep=EgoyMDI2MDYyOS4wIKXMDSoASAFQAw%3D%3D , accessed 7th July 2026.

18 Statutory Instrument 2017 No. 1206, The Radio Equipment Regulations, 2017, December 2017.

19 Email Communication from Joe Hammerton (Caddick) to CUK034 Enquiry Shared Mailbox EEinfoUK@cpt.eurofinseu.com , dated 15th April 2026 10:26.

20 NR/L2/RSE/30041/01, Module 01, EMC Assurance for Product Acceptance and Design for Reliability Issue: 1, December 2025

21 Regulation 37 of [1]

22 NR/SP/ELP/27224, “Specification for installation of cable routes forming part of the traction distribution system,” Network Rail, Issue 2, April 2006.

23 S1193, Issue A4, “Electromagnetic Compatibility (EMC) with LU Signalling System Assets”, London Underground, April 2017.

24 World wide web address https://assets.publishing.service.gov.uk/media/6356a7ced3bf7f0bd6f51773/ds-0071-22-emc-notice.pdf , accessed 9th July 2026.

25 EN 61000-6-4: 2007+A1:2011, Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments, CENELEC, February 2011.

26 EN55012:2007, Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers, CENELEC, November 2007.

27 EN 61000-6-2:2005, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments, CENELEC, August 2005.

28 EN 61439-1:2011, Low-voltage switchgear and controlgear assemblies – General rules, CENELEC, October 2011.

29 EN 62040-2:2006, Uninterruptible power systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements, CENELEC, March 2006.

30 EN 50470-1:2006 Electricity metering equipment (a.c.) - Part 1: General requirements, tests and test conditions - Metering equipment (class indexes A, B and C), CENELEC, 2006.

31 EN 55015:2019, “Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment”, CENELEC, August 2019.

32 EN 61547:2009, Equipment for general lighting purposes. EMC immunity requirements, CENELEC, August 2009.

33 EN 61000-6-3:2007+A1:2011, Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light- industrial environments, CENELEC, March 2011.

34 EN 50130-4:2011, Alarm systems. Electromagnetic compatibility. Product family standard: Immunity requirements for components of fire, intruder and social alarm systems, CENELEC, June 2011.

35 EN 62489-2:2014, Electroacoustics - Audio-frequency induction loop systems for assisted hearing - Part 2: Methods of calculating and measuring the low-frequency magnetic field emissions from the loop for assessing conformity with guidelines on limits for human exposure, IEC, 2014

36 PD IEC/TR 63079:2017+A2:2020, Code of practice for hearing-loop systems (HLS), IEC, April 2020.

37 EN 61000-6-1:2007, Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments, CENELEC, January 2007.

38 EN 62489-1:2010+A2:2018, Electroacoustics. Audio-frequency induction loop systems for assisted hearing, July 2018.

39 ETSI EN 301 489-1, “Electromagnetic compatibility and radio spectrum matters (ERM); Electromagnetic compatibility standard for radio equipment and services; Part 1: Common technical requirements,” V1.9.2 (2011-09), European Telecommunications Standards Institute.

40 ETSI EN 301 489-17 V3.2.4 (2020-09), Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems; Harmonised Standard for Electromagnetic Compatibility, ETSI, September 2020.

41 EN 61800-3:2004 +A1:2012, "Adjustable speed electrical power drive systems — Part 3: EMC requirements and specific test methods," CENELEC, March 2012.

42 EN IEC 61851-1:2019, “Electric vehicle conductive charging system –Part 1: General requirements,” CENELEC, July 2019.

43 EN IEC 61851-21-2:2021, “Electric vehicle conductive charging system -Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply — EMC requirements for off board electric vehicle charging systems,” CENELEC, April 2021.

44 EN 12015:2014 ‘‘Electromagnetic compatibility. Product family standard for lifts, escalators and moving walks. Emission’’, CEN, March 2014.

45 EN 12016:2013 ‘‘Electromagnetic compatibility. Product family standard for lifts, escalators and moving walks - Immunity’’, CEN, August 2013.

46 EN 50083-2:2012/A1:2015, “Cable networks for television signals, sound signals and interactive services - Part 2: Electromagnetic compatibility for equipment,” CENELEC, 2015.

47 ICNIRP, “Guidelines on limits of exposure to static magnetic fields”, Health Physics **Vol 96** No 4, pp 504-514, April 2009.

48 ICNIRP, “Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz), Health Physics **Vol 99** No 6, pp 818-836, December 2010.

49 ICNIRP, “Guidelines for limiting exposure to electric fields induced by movement of the human body in a static magnetic field and by time-varying magnetic fields below 1 Hz”, Health Physics **Vol 106** No 3, pp 418-425, March 2014.

50 EN 50499: 2008, Procedure for the assessment of the exposure of workers to electromagnetic fields, CENELEC, December 2008.

51 Engineering Recommendation G5, “Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom,” Energy Networks Association, Issue 5, 2020.

52 EN 50121-2: 2006, Railway applications - Electromagnetic compatibility – Emissions of the whole railway system to the outside world, CENELEC, July 2006.

53 EN 50126-1:2017+A1:2024, “Railway applications - The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Generic RAMS process,” CENELEC, November 2024.

54 NR/L2/RSK/00001, “Integrated Risk Management”, Issue 5, March 2012.

55 World wide web address https://mastdata.com/ , accessed 7th July 2026.

56 Nigel Edwards, NR/BS/LI/217, Letter of Instruction affecting NR standard NR/SP/ELP/27224, Issue 4. Compliance date: 25th January 2016; Expiry date: On update of standard NR/SP/ELP/27224.