Chapter 22

Electromagnetic Compatibility and Stray Current

Contents

22. Electromagnetic Compatibility and Stray Current

22.1. Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) identifies, describes and provides an assessment of the likely significant effects of Electromagnetic Fields (EMFs) as a result of the proposed Project. The proposed Project will be an electrified Direct Current (DC) rail system. Upon completion of DART+ South West electrification, new electric DART trains will be used on this railway corridor, similar to those currently operating on the Malahide / Howth to Bray / Greystones Line.

22.1.1. Basis of Electromagnetic Fields

In addition to naturally occurring geomagnetic fields, EMFs are generated wherever electricity is produced, distributed and consumed; including by railway electric traction systems, power lines and electrical and electronic equipment. EMFs are also generated intentionally by radiocommunication systems. The trains and infrastructure introduced by DART+ South West will contribute to the overall level of EMFs which are already established by the multitude of man-made sources in the area.

EMFs can take the form of self-propagating waves in air, consisting of electric and magnetic field components which oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation. In this context the fields are often referred to as electromagnetic radiation and are classified into different types according to the frequency of its wave, forming the electromagnetic spectrum shown in Figure 22-1.

The electromagnetic spectrum covers a very wide frequency range and there are many aspects of it with which we are familiar and exposed to daily. In order of increasing frequency (and decreasing wavelength) common types of electromagnetic radiation include; radio waves, microwaves, terahertz radiation, infra-red radiation, visible light, ultraviolet radiation, X-rays and gamma rays. An EMF carries energy away from its source which can be imparted to another entity.

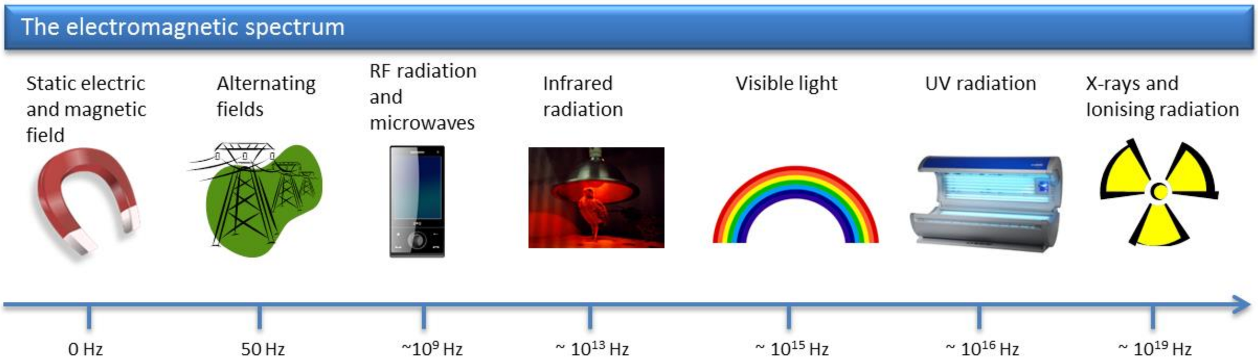

Figure 22-1 The Electromagnetic Spectrum

At low frequencies, the electric and magnetic fields can be considered as being generated and acting independently; with the electric field related to the voltage of a source and the magnetic field associated with the current (flowing charges).

22.1.2. Electromagnetic Interference to Electrical Equipment

Electromagnetic Interference (EMI) is an unwanted electromagnetic disturbance that may affect electrical systems due to the interaction of magnetic fields, electric fields or electromagnetic radiation, preventing electrical or electronic equipment from functioning correctly.

Sources of EMF in the existing environment includes items such as (but not limited to); electrical equipment, power lines, telephone lines, signals from existing telecommunications masts (mobile phone and radio), underground communication cables, electrified trains and broadcast transmitters. The emissions from these sources in a given area or location combine to make up the current baseline electromagnetic environment (EME).

The electromagnetic spectrum is used by many services, such as television broadcasts, mobile phones, satellite communications and radar systems. Allocation of parts of the spectrum to different services and unintentional emissions into the spectrum are controlled by EU Directives and National Regulations. This means that all equipment placed on the EU market, including rail systems, must meet strict emission and immunity limits.

Electromagnetic Compatibility (EMC) is the engineering discipline concerned with ensuring that electrical and electronic equipment function normally in their intended operating environment without introducing intolerable electromagnetic disturbances to anything in that environment. EMC also ensures that the equipment will not be adversely affected by levels of EMI that might reasonably be expected to be present in that environment. To achieve EMC, three aspects need to be considered when making changes to a system:

- Emissions: The generation of electromagnetic energy (either intended or unintended) by a source which is termed emissions. Countermeasures may need to be taken to reduce such energy generation or avoid the escape of the energy into the external environment;
- Susceptibility or immunity: The ability of electrical equipment, referred to as receptors, to operate as intended in the presence of a certain level of EMF is termed the immunity or susceptibility level of the equipment; and
- Consideration for the coupling path: The path by which EMFs propagate from their source to a receptor. This can be:
    - Conductive: A direct electrical connection which allows the flow of current, possibly through the ground;
    - Capacitive / inductive: Localised interaction between the electric / magnetic field of the source at low frequencies with the receptor;
    - Radiative: Long range coupling by the propagation of electromagnetic waves (radiation).

The DART+ Programme is proposed as an electrified 1500 V DC rail system, which provides synergy with the existing DART network. Traction power is to be provided to the trains using an Overhead Contact System (OCS). The construction and operation of the new system may affect the existing EME and has the potential to disturb sensitive and safety critical equipment across a wide range of frequencies. Potential sources of EMI from the proposed Project are:

- Direct current (DC) fields and quasi-DC fields (taken here to be frequencies below 1Hz), generated by the current circulating in the traction conductors;
- Alternating current (AC) fields, generated by the electricity drawn by the system from the Electricity Supply Board (ESB) and used to power the electrical equipment at all the stops; and
- Radiofrequency fields, generated intentionally by the systems used for communications and, also as an unintentional by-product of the operation of every electrical and electronic system such as the train drive systems and signalling systems.

Stray DC currents which may leak from their intended return path (via the rails) and conduct through the earth and other nearby metallic structures, which may cause corrosion of the structures and may damage or disrupt the operation of electrical equipment. The structures potentially at risk are usually large electrically conductive systems such as utility pipes or cables running close to and parallel with the track.

22.1.3. Electromagnetic Exposure of People

Strong EMFs can also have a short-term impact on human health. EMFs in the electromagnetic spectrum with frequencies below 300 GHz are considered as non-ionising radiation; they do not carry enough energy to knock electrons out of any atomic structures they impinge upon (unlike gamma-rays and X-rays which are classed as ionising radiation). The established adverse health effects from non-ionising EMFs are broadly classified into either non-thermal effects (below about 10 MHz) and thermal effects (above 100 kHz), with an intermediate region from 100 kHz to 10 MHz in which both are significant. The effects of EMFs are highly localised and have the most potential to affect people in buildings and locations that are immediately adjacent to high voltage traction power distribution equipment, electricity sub-stations and transformers.

22.1.4. Receptors of Electromagnetic Fields

The following potentially sensitive receptors of EMFs were considered in this assessment:

- Local residents and the community;
- Domestic and industrial electrical equipment;
- Telecommunications infrastructure (including wireless radio services);
- Sensitive medical and research equipment;
- Utilities; and
- Mainline rail, suburban rail, and light rail systems.

A change in the EME due to increased emissions from the proposed Project may already be adequately mitigated by the immunity level of the existing equipment at receptor locations.

22.2. Legislation, Policy and Guidance

The key legislation and guidance referenced in the preparation of the EIAR is outlined in Chapter 1 (Section 1.5, 1.6 and 1.7).The assessment of the likely significant effects of the proposed Project on electromagnetic and stray current sensitive receptors has taken account of key legislation, standards and guidance. These are outlined below.

22.2.1. Legislation

The assessment has been undertaken in accordance inter alia with the Transport (Railway Infrastructure) Act 2001 (as amended) provides for the making of a Railway Order application by Córas Iompair Éireann (CIÉ) to An Bord Pleanála. The European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 (S.I. No. 743 of 2021) gives further effect to the transposition of the EIA Directive (EU Directive 2011/92/EU as amended by Directive 2014/52/EU) on the assessment of the effects of certain public private projects on the environment by amending the Transport (Railway Infrastructure) Act 2001 ('the 2001 Act'). An examination, analysis and evaluation is carried out by An Bord Pleanála in order to identify, describe and assess, in the light of each individual case, the direct and indirect significant effects of the proposed project (comprising inter alia railway works), including significant effects derived from the vulnerability of the activity to risks of major accidents and disasters relevant to it, on: population and human health; biodiversity, with particular attention to species and habitats protected under the Habitats and Birds Directives; land, soil, water, air and climate; material assets, cultural heritage and the landscape, and the interaction between the above factors.

Further legal measures which inter alia have informed this assessment include the following:

- European Directive on Electromagnetic Compatibility (2014/30/EU);
- Low Voltage Directive (2014/35/EU);
- Radio Equipment Directive (2014/53/EU);
- European Union (Radio Equipment) Regulations 2017 (S.I. No. 248 of 2017);
- European Union (Low Voltage Electrical Equipment) Regulations 2016 (S.I. No. 345 of 2016); and
- European Communities (Electromagnetic Compatibility) Regulations 2016 (S.I. No. 145 of 2016).

22.2.2. Standards

Relevant European standards that have informed the assessment and which the project must comply with include:

- EN 50121-1 (2017) Railway applications - Electromagnetic compatibility - Part 1: General;
- EN 50121-2 (2017) Railway applications - Electromagnetic compatibility Part 2: Emissions of the whole railway system to the outside world;
- EN 50121-3-1 (2017) Railway applications - Electromagnetic compatibility Part 3-1: Rolling stock - Train and complete vehicle;
- EN 50121-3-2 Railway applications - Electromagnetic compatibility Part 3-2: Rolling stock – Apparatus;

- EN 50121-4 Railway applications - Electromagnetic compatibility Part 4 – Emission and Immunity of the Signalling and Telecommunications Apparatus;
- EN 50121-5 Railway applications - Electromagnetic compatibility Part 5 - Emission and Immunity of Fixed Power Supply Installations and Apparatus;
- EN 61000-6-1 Electromagnetic Compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments;
- EN 61000-6-2 Electromagnetic Compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments;
- EN 61000-6-3 Electromagnetic Compatibility (EMC) – Part 6-3: Generic standards – Emission standard for equipment in residential environments;
- EN 61000-6-4 Electromagnetic Compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments; and
- EN 50122-2 Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 2: Provisions against the effects of stray currents caused by DC. traction systems.

22.2.3. Guidance

There is no specific guidance of relevance to this chapter, other than the broader Environmental Protection Agency (EPA) guidance referred to in Chapter 1 (see Section 1.7.1) of this EIAR and that listed below:

- ICNIRP. Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys 118(5):483-524; 2020;
- ICNIRP Guidelines for limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz – 100 kHz). Health Phys 99(6):818-836; 2010;
- ICNIRP. Guidelines on limits of Exposure to Static Magnetic Fields. Health Phys 96(4): 504-514; 2009; and
- 1999/519/EC Council Recommendation of 12th July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz).

22.3. Methodology

The baseline environment is defined as the existing environment against which future changes can be measured. This section presents the methodology used in assessing the perceived impact the Project will have on the baseline environment, as well as considering the relevant guidance with respect to environmental impact. The scope and methodology for the impact assessment has been devised with consideration of the legislation (see Section 22.2.1).

The assessment carried out is focused primarily on the impact of EMFs on members of the public and the impact of EMI on third party equipment. A combined EMC and Earthing and Bonding (E&B) routewide desktop survey[1] has also been conducted as part of the design of the Project. A register has been produced based on the results of the survey that contains all equipment and assets which were identified as being of significance when considering EMC and E&B along the railway line.

22.3.1. Limit Values

22.3.1.1. Human Exposure

International guidelines for limits on the levels of EMF required to protect the public and workers from established acute adverse health effects are published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The guidelines establish basic restrictions on exposure based on a systematic review of all available scientific evidence regarding health effects due to EMFs. The guidelines also provide reference levels on easily measured or estimated characteristics of EMFs that guarantee that the basic restrictions are satisfied if the reference levels are not exceeded. Exposure assessments are generally made against the reference levels.

The ICNIRP limits have been adopted by the European Commission for the public and occupational exposure within EU Recommendation 1999/519/EC and the EMF Directive respectively. In Ireland, Government policy is set by the Department of Environment, Climate and Communications (DECC) which continues to adopt the guidelines developed by the ICNIRP. In 2019, the Government published a Statutory Instrument (S.I. No 190/2019) which assigns responsibility to the Environmental Protection Agency (EPA) for providing advice to the Government and the public on exposure to EMF.

There is no scientific consensus on possible long term health effects from exposure to low levels of EMFs. This study only addresses effects for which established assessment criteria exist.

22.3.1.1.1. Public Exposure

The ICNIRP limits for public exposure reference levels for the various frequency ranges are provided in Table 22.1, taken from EU Recommendation 1999/519/EC. For static magnetic fields (up to 1Hz) the limit is 40 mT (0.04 T). These limits have been chosen as they are the most stringent to apply[2].

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[1] DP-04-23-REP-EL-TTA-09433-V01-S03, “DART Expansion Project – Kildare Line, EMC/E&B Routewide Asset Survey Report.

[2] Please note that the limit stated within 1999/519/EC is more stringent than the 400 mT limit stated within the ICNIRP Guidelines on Limits of Exposure to Static Magnetic Fields. The more onerous limit has been applied when carrying out the assessment in this report.

Table 22.1: Public exposure reference levels from Council Recommendation 1999/519/EC

Frequency Range	Electric Field Strength (V/m) Note 1	Magnetic Field Intensity (A/m) Note 2	Magnetic Flux Density (µT) Note 3	Equivalent Plane Wave Power Density (W/m²) Note 4
up to 1 Hz	-	3.2×10^4	4×10^4	-
1 – 8 Hz	10000	$3.2 \times 10^4 / f^2$	$4 \times 10^4 / f^2$	-
8 – 25 Hz	10000	4000 / f	5000 / f	-
0.025 – 0.8 kHz	250 / f	4 / f	5 / f	-
0.8 – 3 kHz	250 / f	5	6.25	-
3 – 150 kHz	87	5	6.25	-
0.15 - 1 MHz	87	0.73 / f	0.92 / f	-
1 – 10 MHz	$87 / f^{1/2}$	0.73 / f	0.92 / f	-
10 – 400 MHz	28	0.073	0.092	2
400 – 2000 MHz	$1.375 f^{1/2}$	$0.0037 f^{1/2}$	$0.0046 f^{1/2}$	f / 200
2 – 300 GHz	61	0.16	0.20	10

Note: "f" is the frequency in Hz

Note 1: Expressed in volts per metre (V/m)

Note 2: Expressed in amperes per metre (A/m)

Note 3: Expressed in microtesla (µT)

Note 4: Expressed in watts per square metre (W/m^2)

22.3.1.1.2. Occupational Exposure

For occupational exposure, the limits specified in the EMF Directive are typically a factor of 5-10 higher than those for public exposure. The limits for occupational exposure to static magnetic fields for the head and limbs are 8T and 2T respectively. This is provided for information; the assessment undertaken in this chapter focuses on exposure to the general public.

These limits will apply to any staff working within the railway corridor, for example those working in the National Train Control Centre (NTCC), maintenance facilities such as Inchicore Works, Heuston Yard and substations.

22.3.1.2. Equipment Emissions and Immunity

The EN 50121 series of railway-specific standards define electromagnetic emissions and immunity test limits for equipment placed within the railway boundary that are generally applied to demonstrate compliance with the EMC Directive. Compliance with these standards limits emissions from the railway system to the outside world. EMC immunity limits contained within the EN 50121 suite of standards are generally equivalent to the limits defined in the generic EMC standards for "heavy" industrial environments in EN 61000-6-2 (immunity) and EN 61000-6-4 (emissions).

Beyond the railway boundary EMC standards EN 61000-6-1 (immunity) and EN 61000-6-3 (emissions) for "light industrial", commercial and residential environments apply. The power frequency magnetic fields generated by the traction power system are assessed against the industrial (EN 61000-6-2) and residential and commercial (EN 61000-6-1) limits of 30 A/m and 3 A/m respectively.

All electrical/electronic equipment being procured by the project shall be assessed to ensure that it satisfies the appropriate EMC standards. Equipment that is being installed within the railway boundary (as defined in Figure 22-2) should comply with the emissions and immunity levels of the EN 50121-X series of standards. For example, electrical and electronic equipment being installed in substations should comply with EN 50121-5 to ensure it operates reliably and does not interfere with other electrical systems or generate significant levels of EMFs.

The intended rolling stock could be a source of electromagnetic emissions and therefore it is necessary that the rolling stock specification is compatible with the infrastructure and its surroundings. Rolling stock used within the project shall comply with the relevant National and International Standards. The main impact of EMI resulting from the rolling stock is on the railway infrastructure itself, such as train detection assets.

22.3.2. Desktop Study Area

There is a gradual change in the EME away from the railway boundary as the electric and magnetic field strength decreases with distance from the source. The extent of any noteworthy electromagnetic effects will be limited to only a short distance from the railway corridor. Existing published calculations and measurements of EMFs from power lines indicate that the strength of both the power frequency magnetic and electric field would be expected to reduce proportionate to approximately the inverse square or inverse cube (depending on design and phasing) of distance from the source.

With respect to EMC, there are several zones which can be defined as study areas:

- The railway boundary is defined as an area up to 10m from the centre of the nearest running line and extending 3m from a substation boundary (EM Area 1), as shown in Figure 22-2. Equipment within this boundary is assumed to satisfy rail EMC standards;
- As the immunity levels for railway equipment are higher than those for residential and commercial applications, a 10m buffer area (EM Area 2) is then considered; within which the risk of EMI to safety-critical equipment and equipment providing important services that has not been tested to industrial EMC limits needs to be assessed; and
- Outside the buffer area in EM Area 3 the "light industrial", commercial and residential EMC immunity limits are deemed sufficient to mitigate the risk of interference for all but the most sensitive receptors as identified in Table 22.2.

These zones are in line with guidance provided in the EN 50121 suite of standards for determining the area of influence and study area for EMI to and/or from the railway that has been used as a basis for this assessment.

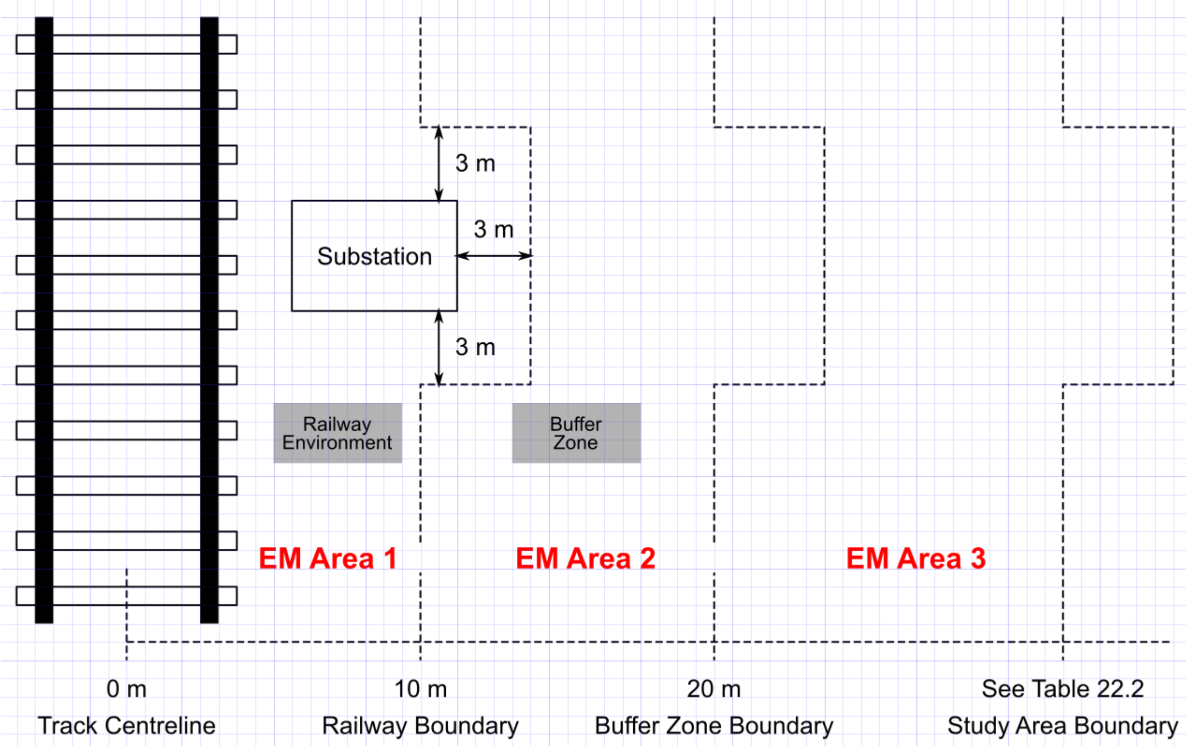

Figure 22-2 Electromagnetic Zoning Principle for Assessment of EMC

The areas immediately surrounding the railway corridor on the DART+ South West Project include predominantly residential and commercial premises. The precise distance at which the risk of EMI can be considered negligible depends on the sensitivity of individual receptors. Due to the potential for extremely sensitive equipment being used in medical, research or manufacturing facilities the corridor of influence was extended to precautionary distance of 100m.

In addition, DC stray currents can propagate a significant distance from the railway, depending on the ground conditions and the presence of earthed metallic services running parallel to the tracks.

Table 22.2 summarises the study area either side of the alignment for different aspects of the study.

Table 22.2: Study Area relevant to EMF and Stray Currents

Criteria	Width of Study Area (each side of the alignment)
Potential impacts from Direct Current (DC) fields	100m
Potential impacts from Alternating Current (AC) fields	100m
Potential impacts from Radiofrequency (RF) and microwave fields	100m
Potential impacts from stray currents	100m

22.3.3. Desktop Study Methodology

Within the study area potentially sensitive receptors/locations and relevant stakeholders were identified. By using a combination of data sources, as listed in Section 22.3.3.1, an asset register was formulated. The register includes (but is not limited to) sensitive third-party installations along the line of route (hospitals, schools and emergency service dispatch centres), existing electricity transmission networks and towers, GSM-R, known buried services and mobile communications masts as well as electrical systems at existing stations or places of interest. EMC zones along the entire length of the route were defined to visually assess and quantify the levels of EMC risk for assets that fall within (or are adjacent to) these zones.

22.3.3.1. Desktop Surveys

Relevant information within the EMF and stray current study area was collected through a detailed desktop review of existing data sources, such as available imagery and mapping. Sources of information that were used to inform the desk study assessment in the preparation of this chapter are listed in Table 22.3.

Table 22.3: Data sources used to inform the assessment.

Data Source	Nature of the information acquired	Accessed
Aerial photography and Google Maps	Sensitive locations and receptors	August 2021
Ordnance Survey Ireland (OSI) maps	Sensitive locations and receptors	August 2021
Utilities maps	Locations of utilities including gas, electricity and water	August 2021

22.3.4. Desktop Study Outcomes

The receptors identified by this study are presented in Section 22.4 along with a categorisation of their perceived risk with regards to EMFs. It should also be noted that a separate EMC/E&B Asset Survey report was produced (referred to in Section 22.3.3). This document has produced a register which catalogues the findings of the survey and highlights the assets that require further consideration regarding EMF, EMC and stray current risks. This will be carried over into the detailed design development stage of the project and managed by the project Hazard Identification (HazID) and control process. A summary of the asset types identified and the proposed stray current mitigation measures is provided in Section 22.6.

22.3.4.1. Field Surveys

No field surveys have been completed to inform this assessment.

22.3.5. Assessment Methodology

The methodology for the baseline assessment is devised from the guidelines listed in Section 22.2.3 above as well as by considering the relevant EPA guidance with respect to EIAR (EPA, 2022). The proposed Project is assessed by way of limiting exposures to EMFs and stray currents. Section 39 (2) (a) (ii) of the Transport (Railway Infrastructure) Act 2001, requires that proposed developments are examined in terms of their expected effects.

The assessment methodology adopted is as follows:

- Categorisation of the baseline environment (i.e. importance and sensitivity);
- Determination of a baseline rating; and
- Evaluation of impacts and defining significance.

22.3.5.1. Categorisation of the Baseline Environment

The assessment requires an understanding of the existing baseline EME. Based on importance, sensitivity and existing adverse effects, the baseline environment/sensitive receptor is assigned a particular baseline rating. Each of these three terms are explained in detail in this section. The professional opinion and experience of the specialist can also play an important role in assigning the baseline rating. The baseline rating is subsequently used in the impact assessment (see Section 22.5) to determine the level of significance for each sensitive receptor.

22.3.5.1.1. Importance of the Receptor

The importance of a receptor is determined by its value and how serious the anticipated consequence of a change or failure in its function may be. Receptors are considered important depending on their value/rarity within a defined geographic context and whether the consequences of their loss or failure may cause negative effects to arise.

EMI can potentially affect and cause disruption to critical sensitive equipment in medical centres, data centres, airports and railway equipment. It may also cause disruption to medical equipment in the home and affect normal household appliances. Therefore, such receptors are important because of the potential safety and medical implications that could arise.

EMI can also affect wider infrastructure; such as telecommunications equipment, cabling, electrical equipment (such as substations), computer screens, communication devices, machinery, aircraft instrument landing systems and sensitive instruments in commercial, industrial, pharmaceutical and educational facilities. Therefore, such receptors are also considered important.

In conjunction with the effects of EMI, stray currents can cause corrosion and ultimately lead to stability issues in structures (i.e. breakage and leaking). They can cause corrosion in metal parts and structures such as utility infrastructure, pipelines and underground cabling. This is particularly an issue where metal is used as reinforcement materials in bridges and buildings which run parallel and close to the existing railway line. Safety implications and loss or damage to infrastructure concerned may be greatly disruptive and therefore are also considered to be important.

22.3.5.1.2. Sensitivity of the Receptor

The sensitivity of a receptor is determined by its potential to be significantly affected in the presence of EMFs. Exposure of an important receptor to EMFs can cause equipment malfunctions and failures. Equipment which fails when exposed to even weak fields is considered sensitive, while equipment which continues to operate in much stronger fields is not considered sensitive.

Examples of equipment which uses EMFs to operate includes telecommunications receivers, rail signalling systems and household appliances such as radios and televisions. As these rely upon EMFs to function, they are the most sensitive to EMFs. Other equipment which can operate normally at much higher EMF levels, such as non-radio equipment and high end medical and research equipment, is considered less sensitive.

Pipes and cable utilities are particularly sensitive and notable when it comes to stray current, since stray currents can be conducted some distance away from the railway and utilities are commonly located under and along railways. Nearby utility lines will need to be carefully evaluated for the possibility of effects from stray current. Utilities are identified as part of the baseline and listed as a sensitive receptor for this assessment.

22.3.5.1.3. Baseline Rating

The baseline rating of the existing electromagnetic and stray current environment is determined by having regard to the range of criteria which reflect its importance, sensitivity and existing adverse effects of the baseline environment. The baseline ratings that have been defined for EMF and stray current receptors are shown in Table 22.4 and Table 22.5 respectively.

Table 22.4: Criteria for Baseline Sensitivity Categorisation of Receptors with respect to EMF

Sensitive locations/receptors	Baseline rating
• Facilities with highly sensitive equipment on the premises on a permanent basis; • Public/private health facilities; • Signalling on rail networks; and • Highly sensitive equipment in universities, colleges and schools.	Very High
• Telecommunications infrastructure; • Public/private scientific/research institutes; • Medical Centres including dentists and vets; • Universities, colleges and schools that may have potentially sensitive equipment; • Emergency services mobile radio; and • Locations with installations of custom audio-visual equipment.	High
• Facilities that have sensitive equipment on the premises on a permanent basis; • Some residential areas, e.g. containing specific medical equipment; • Industrial facilities with potentially sensitive equipment; and • Universities, colleges, and schools which do not have sensitive equipment.	Medium
• All other residential areas; • Mixed units with a residential component; • Electricity substations with earthing equipment; and • Educational institutions without sensitive equipment.	Low
• All other areas.	Very Low

Table 22.5: Criteria for Baseline Sensitivity Categorisation of Receptors with respect to Stray Current

Sensitive locations/receptors	Baseline rating
• Any ground embedded metal shielded facility which has a high requirement for safety, e.g. high-pressure gas or water pipes; • Chemical industry installations; • Large ground embedded fuel tanks, e.g. fuel depot; and • Signalling on rail networks.	Very High
• Any ground embedded metal shielded facility which has a medium requirement of safety, e.g. low-pressure gas or water pipes, heating pipes.	High
• Pre-stressed reinforcement of tunnels, bridges or port structures other than the project's proposed structures; • Metal shielded cables; • Other rail infrastructure, e.g. track; and	Medium

Sensitive locations/receptors	Baseline rating
• Small ground embedded fuel tanks, e.g. petrol stations.	
• Other metal reinforced structures parallel to the alignment with a minimum length of 100 m, e.g. buildings.	Low
• Industrial facilities with large metal structures; and • All other areas.	Very Low

22.3.5.2. Predicting Theoretical Worst-Case EMF Levels

22.3.5.2.1. Modelling Methodology for Study of Quasi DC Electromagnetic Fields

A study of the quasi-DC magnetic fields levels that are expected to be generated around the operational railway has been undertaken using finite element modelling. The modelling was conducted in Matlab, a proprietary commercial software using the finite element method. The study identified the worst-case magnetic flux density levels around the railway OCS used to distribute electrical power between the traction substations along the route of the railway and the rolling stock. Both normal feeding arrangements[3] and degraded feeding[4] of the traction power system were considered. The predicted worst-case EMF levels were compared to public exposure limits and equipment immunity levels. Protection distances from the energised traction conductors beyond which the limits are complied with were then determined.

The electrical configuration of the OCS and rail profiles have been taken from the traction power modelling report:

- The OCS consists of one stranded copper parallel feeder wire (FW) with a cross-sectional area (CSA) of 240 mm² (61/2.25mm), one stranded copper catenary wire with a CSA 95 mm² (19/2.52mm) and one solid hard drawn contact wire with a CSA of 120 mm²;
- The running rails are assumed to be 113 lb/yd rail;
- The traction negative return circuit used to return the current to the substations is assumed to be four running rails, which are cross bonded together at periodic intervals along the line; and
- As an exception, there is no parallel FW on the OCS between the junction at Island Bridge and the buffer stops at Heuston.

The OCS geometry is taken from the indicative cross-section in the design drawing, as reproduced in Figure 22-3. This shows the relative locations of the different conductors in a plane normal to the railway alignment for a twin track cantilever arrangement. The earth wires (EWs) on a DC system only carry current under fault conditions and as such are not included in the modelling.

[3] Normal feeding arrangements refers to when the traction power system is working as normal with no issues affecting the system's ability to provide power to the trains
[4] Degraded feeding refers to when equipment failure or faults (e.g. dewirement of the contact wire, damage to substation equipment) leads to unavailability of parts of the traction power system while trains are still running.

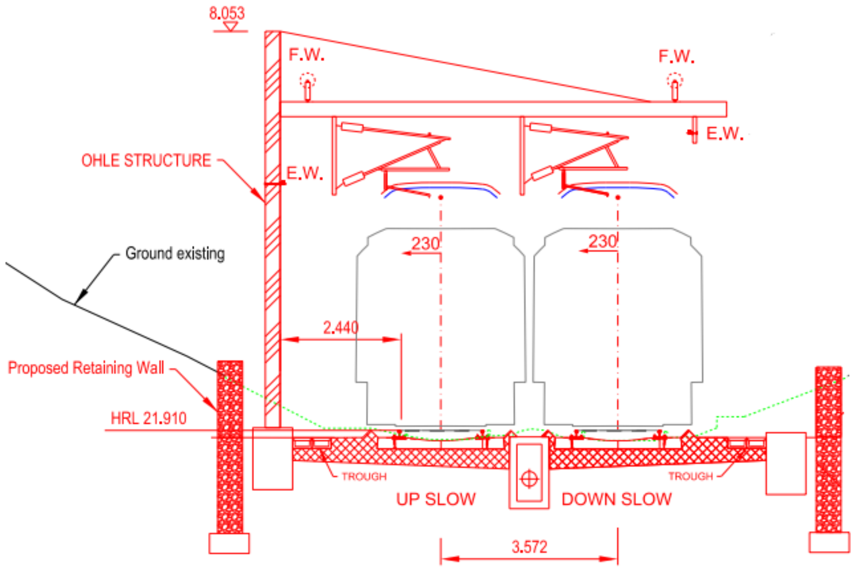

Figure 22-3 Typical OCS Cross Section Geometry

The overall geometrical and electrical parameters derived from these sources are summarised in Table 22.6.

Table 22.6: OCS Electrical and Geometrical Parameters

Conductors	Horizontal Position (m)	Vertical Position (m)	Cross-Sectional Area (mm^2)	Overall Radius (mm)	Resistivity (nΩm)	Resistance (Ω/km)	Type
Up outer rail	-2.504	-0.08	7169	47.8	223.7	0.0312	113 lb/yd
Up inner rail	-1.069	-0.08	7169	47.8	223.7	0.0312	113 lb/yd
Up contact wire	-1.786	4.700	120	6.2	18.4	0.153	Cu
Up catenary wire	-1.786	5.300	95	5.5	18.4	0.193	19/2.52 Cu
Up feeder wire	-3.700	7.010	240	8.7	18.4	0.0754	61/2.25 Cu
Down outer rail	2.504	-0.08	7169	47.8	223.7	0.0312	113 lb/yd
Down inner rail	1.069	-0.08	7169	47.8	223.7	0.0312	113 lb/yd
Down contact wire	1.786	4.700	120	6.2	18.4	0.153	Cu
Down catenary wire	1.786	5.300	95	5.5	18.4	0.193	9/2.52 Cu
Down feeder wire	3.700	7.010	240	8.7	18.4	0.0754	61/2.25 Cu

The electrical traction load currents in the conductors are taken from Table 5-61 in the traction power modelling report:

- In the normal feeding state the maximum 60 seconds root-mean-square (RMS) current in the OCS across all feeding section is 4.4 kA / 4.9 kA in the feeders ISL-TFB-004 / ISL-TFB-003 which feed the Down / Up sections to the west of Island Bridge; and

- The degraded feeding arrangement (outage) giving the worst-case maximum 60 seconds RMS current in the OCS across all feeding section is 4.0 kA / 6.3 kA in the feeders ISL-TFB-002 / ISL-TFB-001 which feed the Down / Up sections to the east of Island Bridge.

Additionally, the following assumptions are made regarding the current distribution in the conductors:

- For the DC current all the return current is flowing in the rails. This is the case close to the feeder stations where any stray current is returning into the rails. This is also where the OCS currents are the highest and is therefore worst-case;
- The current division between the conductors at DC is determined in proportion to their per unit length conductance according to Ohm's Law; and
- For 50Hz content on the OCS arising from the traction substations the typical current division for an alternating current (AC) with a railway with a FW and no return conductor have been taken from Table 5-9 in the traction power modelling report. It is assumed that any 50 Hz component on the OCS and traction return conductors is 1% of the DC current level.

The scenarios listed in Table 22.7 have been assessed. The scenarios without the FW correspond to the configuration of the OCS from the junction at Island Bridge and the buffer stops at Heuston.

Table 22.7: Scenarios Assessed

Scenario	Feeding State	FW	Frequency
NF	Normal	Yes	DC
OF	Outage	Yes	DC
N	Normal	No	DC
O	Outage	No	DC
NF50	Normal	Yes	50 Hz

The applicable public magnetic flux density exposure and equipment immunity limits are summarised in Table 22.8. The limits are given in linear units (tesla) and in decibels units (dBµT) which are used on the contour plots below. Note that there are no equipment immunity limits for DC fields.

Table 22.8: Exposure and Equipment Magnetic Flux Density Assessment Criteria

Criteria	Tesla	dB µT
Magnetic flux density < 1 Hz, EU 1999/519/EC	40 mT	92
Magnetic flux density @ 50 Hz, EU 1999/519/EC	100 µT	40
3 A/m 50 Hz residential and commercial immunity limit, EN 61000-6-1	3.7µT	12
30 A/m 50 Hz industrial immunity limit, EN 61000-6-2	37µT	32

The currents in the traction conductors have been determined based on the inputs and assumptions above. Ampère's Law has then been applied to each conductor, assuming the conductors are long compared to the cross-section of interest, to determine each conductor's contribution to the magnetic flux density. The principle of superposition has then been applied to sum the contributions from each conductor to give the overall magnetic flux density in the railway cross-section. The results are presented as hybrid heat map and contour plots for the magnetic flux density in decibel units (dB µT).

This allows the variation of the magnetic flux density to be clearly seen over a wide dynamic range. The public exposure and equipment immunity levels in these units are provided in Table 22.8.

The modelling results are provided in Section 22.5.2.

22.3.5.3. Evaluating Impacts and the Significance of Effects for the General Public

The ICNIRP limits for public exposure reference levels for various frequency ranges are provided in Table 22.1 as outlined in Section 22.3.1.1.1. Levels up to the reference levels contained in the ICNIRP 1998 guidelines shown in Table 22.1 are considered safe for members of the public and, for the purpose of this assessment, are classed as having a significance of effect of imperceptible with the quality of effect being neutral.

Any predicted levels in excess of the limits set out in Table 22.1 are classed as having a significant effect, with the quality of the effect being negative.

22.3.5.4. Other Criteria in the Assessment of Impacts

When describing the significance of effects, specific definitions will also be used to confer the context, likelihood and duration and frequency of effects. The likelihood of the occurrence of identified impacts is also discussed. Typical operational emissions that would be expected day to day and their associated impacts on the baseline would be classed as likely for example. In discussing potential impacts, worst-case conditions are also required to be considered. An example would be fault conditions that may result in higher (or lower) localised electromagnetic emissions than would persist during normal operation. A failure of an individual substation being one such scenario would be considered unlikely on a frequent basis.

EMF impacts in terms of probability (or likelihood) of effects are characterised with the following qualitative terms, as relevant (EPA, 2022):

- Likely effects: the effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented; and
- Unlikely effects: the effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.

EMF impacts in terms of duration and frequency of effects are characterised with the following qualitative terms, as relevant (EPA, 2022):

- Momentary Effects: Effects lasting from seconds to minutes;
- Brief Effects: Effects lasting less than a day;
- Temporary Effects: Effects lasting less than a year;
- Short-term Effects: Effects lasting one to seven years;
- Medium-term Effects: Effects lasting seven to fifteen years;
- Long-term Effects: Effects lasting fifteen to sixty years;
- Permanent Effects: Effects lasting over sixty years; and

- Frequency of Effects: describe how often the effect will occur. (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually).

22.3.6. Consultation

The overall project stakeholder and public consultation undertaken in respect of the Project is set out in the Public Consultation No. 1 Findings Report (for PC1) and Public Consultation No. 2 Findings Report (for PC2) which are included in Volume 4, Appendix 1.3 and 1.4. All feedback was collated, including feedback specific to the EIAR topic 'Electromagnetic Compatibility and Stray Current'. This feedback has informed this chapter including the baseline and impact assessment presented.

Specific consultation was also undertaken with key stakeholders in relation to EIA Scoping. A summary of the issues raised in relation to the scope of the EIA is included in Volume 4, Appendix 1.2. Feedback on the scope and level of detail of the assessment, data sources and methodologies as they pertain to the EIAR topic 'EMF and Stray Current' have been reviewed and have influenced this chapter of the EIAR.

Specific consultation was also undertaken with representatives of various Departments in Kildare, South Dublin and Dublin City Councils. This included a combination of presentations, workshops and meetings to discuss the project, technical design issues and environment and planning matters.

Nine pre-application meetings were held with ABP to explain the project and present technical and environmental information. A summary of the information presented, and the environmental issues discussed at the nine meetings is provided in Volume 4, Appendix 1.6. Feedback relevant to the topic 'Electromagnetic Compatibility and Stray Current' has been reviewed and has influenced this chapter of the EIAR.

Specifically in relation to EMF, potentially sensitive receptors and relevant stakeholders have been identified. Sensitive receptors which have been identified as having "Medium" sensitivity or above (based on their potential to have critical sensitive equipment) such as medical centres, data centres etc. will be the subject of separate specific engagement by the Project Design Team at detailed design stage.

22.3.7. Difficulties Encountered / Limitations

This chapter of the EIAR has been prepared based upon the best available information and in accordance with current best practice and relevant guidelines. There were no technical difficulties or otherwise encountered in the preparation of this chapter of the EIAR.

22.4. Receiving Environment

22.4.1. Current Baseline Environment

The proposed Project has been divided into four distinct geographic zones along the length of the corridor (Zones A to D) as outlined in Chapter 4 Project Description and summarised below. The proposed Project is described from west to east along the railway corridor:

- Zone A - Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station (refer to Section 4.6);

- Zone B - Park West & Cherry Orchard Station to Heuston Station (incorporating Inchicore Works) (refer to Section 4.7);
- Zone C – Heuston Yard & Station (incorporating New Heuston West Station) (refer to Section 4.8); and
- Zone D - Liffey Bridge to Glasnevin Junction (Phoenix Park Tunnel Branch Line) (refer to Section 4.9).

A description of the receiving environment as it relates to EMC and stray current has been provided by geographic area. This approach allows for a focused analysis of each area rather than a general overview of the entire study area.

Also note that Figure 22-9 shows the magnetic flux density levels at various distances (up to 100 m) from the railway and so can be read in accordance with Table 22.9, Table 22.10 and Table 22.11. This will help to give an indication of the magnetic field levels at each of the receptors identified.

22.4.2. Zone A: Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station

The following receptors within 100m of the railway centreline have been identified within Zone A as outlined in Table 22.9 below. In addition to the below receptors, it should be noted that there is residential development along the railway corridor.

Table 22.9: Zone A Sensitive Receptors

Category	Receptor Type	Description	Distance	Baseline Rating with respect to EM Fields	Baseline Rating with respect to Stray Current
Medical, Dental & Veterinary Clinics	Medical	-	-	-	-
	Dental	-	-	-	-
	Veterinary	-	-	-	-
	Pharmacies	-	-	-	-
Schools & Educational Facilities	Primary Schools	Adamstown Castle Educate Together National School	48m	Medium	Very Low
		St. John the Evangelist National School	55m	Medium	Very Low
	Secondary Schools	Adamstown Community College	59m	Medium	Very Low
	Special Education	-	-	-	-
Community Facilities	Community Centre	Adamstown Community Centre	65m	Low	Very Low
Places of Worship	-	-	-	-	-

Category	Receptor Type	Description	Distance	Baseline Rating with respect to EM Fields	Baseline Rating with respect to Stray Current
Emergency Departments & Hospitals	-	-	-	-	-
Sports Facilities & Parks	Sports	Celbridge Elm Hall Golf + Pitch & Putt	Adjacent to railway line	Low	Very Low
	Parks	Griffeen Valley Park	63m	Low	Very Low
Industrial	Automotive	Motorfix Clondalkin	72m	Medium	Very Low
	-	Clondalkin Autoclinic	36m	Medium	Very Low
	Manufacturing	Metal Processors	86m	Medium	Very Low

Within Zone A, no emergency departments or hospitals are located within 100m of the railway centreline.

22.4.3. Zone B: Park West & Cherry Orchard Station to Heuston Yard

The following receptors within 100m of the railway centreline have been identified within Zone B as outlined in Table 22.10 below. In addition to the below receptors, it should be noted that there is residential development along the railway corridor.

Table 22.10: Zone B Sensitive Receptors

Category	Receptor Type	Description	Distance	Baseline Rating with respect to EM Fields	Baseline Rating with respect to Stray Current
Medical, Dental & Veterinary Clinics	Medical	Sarsfield Medical Centre	47m	High	Very Low
		Corvin Medical Centre	75m	High	Very Low
	Dental	-	-	-	-
	Veterinary	-	-	-	-
	Pharmacies	-	-	-	-
Schools & Educational Facilities	Primary Schools	Gaelscoil Inse Chor	83m	Medium	Very Low
	Secondary	-	-	-	-
	Special Education	St John of God Special School, Kilmainham	86m	Medium	Very Low
Childcare Facilities	-	Little Oaks	97m	Medium	Very Low
	-	Eden Early Learning Centre	62m	Medium	Very Low

Category	Receptor Type	Description	Distance	Baseline Rating with respect to EM Fields	Baseline Rating with respect to Stray Current
	-	Safari Childcare Ltd - Kilmainham	84m	Medium	Very Low
Community Facilities	Community Centre	-	-	-	-
Places of Worship	-	Victory Outreach Church Dublin	78m	Very Low	Very Low
	-	Tibetan Buddhist Meditation Centre	56m	Very Low	Very Low
Emergency Departments & Hospitals	-	-	-	-	-
Sports Facilities & Parks	-	-	-	-	-
Industrial	Automotive	Automotive Services DOE Test & Repair Centre	22m	Medium	Very Low
		Andrews Motors CVRT test centre	99m		
	Manufacturing	Henkel Ballyfermot	56m	Medium	Very Low
		Lynskey Engineering	98m		
Data Centre	-	Interxion	69m		
		Con Colbert House	12m	High	Very Low

Within Zone B, no emergency departments or hospitals are located within 100m of the railway centreline. The closest hospital, St Patricks University Hospital is situated over 300m from the railway. The closest emergency department at St. James's Hospital is located over 800m from the railway.

Con Colbert House is located at Memorial Road and consists of two buildings (East and West). The buildings are occupied by the Department of Employment Affairs and Social Protection and are in close proximity to the existing railway corridor, although the rail corridor is in cutting (i.e. the rail level is below the surrounding ground level). These buildings contain the Central Computer Units for the Department of Employment Affairs and Social Protection (data centre) to support its operations. As such, the location is likely to contain sensitive equipment.

22.4.4. Zone C: Heuston Yard and Station (incorporating New Heuston West Station)

In relation to Zone C, the main features within this zone are the main Heuston Station building and an extensive railway yard area located to the west of this building. The station and yard area features various ancillary buildings, platforms, track areas, car parks and maintenance facilities. This zone also incorporates the site for the proposed Heuston West Station.

The main receptors located within this Zone are the Clancy Quay Residential development and Heuston South Quarter.

22.4.5. Zone D: Liffey Bridge to Glasnevin Junction

The following receptors within 100m of the railway centreline have been identified within Zone D as outlined in Table 22.11 below. In addition to the below receptors, it should be noted that there is residential development along the railway corridor.

Table 22.11: Zone D Sensitive Receptors

Category	Receptor Type	Description	Distance	Baseline Rating with respect to EM Fields	Baseline Rating with respect to Stray Current
Medical, Dental & Veterinary Clinics	Medical	-	-	-	-
	Dental	-	-	-	-
	Veterinary	Cara Veterinary Clinic	70m	High	Very Low
	Pharmacies	-	-	-	-
Schools & Educational Facilities	Primary Schools	-	-	-	-
	Secondary	-	-	-	-
	Special Education	-	-	-	-
Childcare Facilities	Bee Happy Playschool	-	79m	Medium	Very Low
	Naionra Bharra	-	54m	Medium	Very Low
Community Facilities	Community Centre	-	-	-	-
Places of Worship	-	-	-	-	-
Emergency Departments & Hospitals	-	-	-	-	-
Sports Facilities & Parks	Sports	St. Finbarr's GAA	26m	Low	Very Low
	Parks	Phoenix Park	-	Very Low	Very Low
Industrial	Automotive	Motorways Car Body Repairs	74m	-	-
	Manufacturing	Valeo Foods Cabra	91m	Medium	Very Low
		Batchelors Food Manufacturer	111m	Medium	Very Low

Within Zone D, no emergency departments or hospitals are located within 100m of the railway centreline. One veterinary clinic located within 100m of the railway centreline has been identified. This is likely to contain critical sensitive equipment.

22.4.6. Evolution of the Environment in the Absence of the Project (Do Nothing)

In the absence of the project, the interventions for the modernisation of the railway corridor and areas outside of CIÉ lands for the project would not be undertaken. In the absence of the project, there will be no construction, operation, maintenance or improvement of the electrified heavy rail from Hazelhatch to Heuston Station on the Cork Mainline, and to Glasnevin Junction on the Phoenix Park Tunnel Branch Line. In the absence of the project, there would be continued use of the existing railway line and the existing train service. There would be no introduction of Overhead 1500V DC electrification, including power supply and therefore no source to generate potential electric and magnetic fields that may impact on residential and sensitive receptors in the vicinity of the railway line.

22.5. Description of Potential Impacts

22.5.1. Potential Construction Impacts

The EMC of any electrical/electronic equipment used for construction activities will need to be considered. It is expected that such equipment will comply to EMC standards that make it suitable for use in the given EME.

A process for recording faults and disturbances should be employed to allow any issues to be flagged and corrective actions taken where necessary.

22.5.2. Potential Operational Impacts

22.5.2.1. Modelling Results of Study of Quasi DC Electromagnetic Fields

This section provides the results of the modelling detailed in Section 22.3.5.2.1. As outlined previously, the contour plots for the magnetic flux density are presented in decibel units (dBμT). This allows the variation of the magnetic flux density to be clearly seen over a wide dynamic range.

Figure 22-4 shows the predicted DC magnetic flux density in the normal feeding state for worst-case traction loading with a parallel Feeder Wire (FW). The 92 dBμT public exposure limit[5] is located within a few centimetres of the energised conductors. Figure 22-5 shows the DC magnetic flux density in worst-case outage feeding state with a parallel FW. The magnetic flux density is slightly enhanced compared to the normal feeding state; however, the 92 dBμT public exposure limit is still located within a few centimetres of the energised conductors. Beyond this distance, the field strength decreases to levels below that of the public exposure limit.

Figure 22-6 shows the DC magnetic flux density in the normal feeding state for worst-case traction loading without a parallel FW. The 92 dBμT public exposure limit is again located within a few centimetres of the energised conductors. Figure 22-7 shows the DC magnetic flux density in the degraded outage feeding state for worst-case traction loading without a parallel FW. The 92 dBμT public exposure limit is still located within a few centimetres of the energised conductors. Beyond this distance, the field strength decreases to levels below that of the public exposure limit. Compared to the situation with FWs present, the areas of high magnetic flux density are more restricted.

[5] 92 dBμT is equivalent to the 40mT limit stated in 1999/519/EC, the value has been converted to dBμT to allow for a clearer presentation of the modelling methodology and results. See Table 22.8 for further details

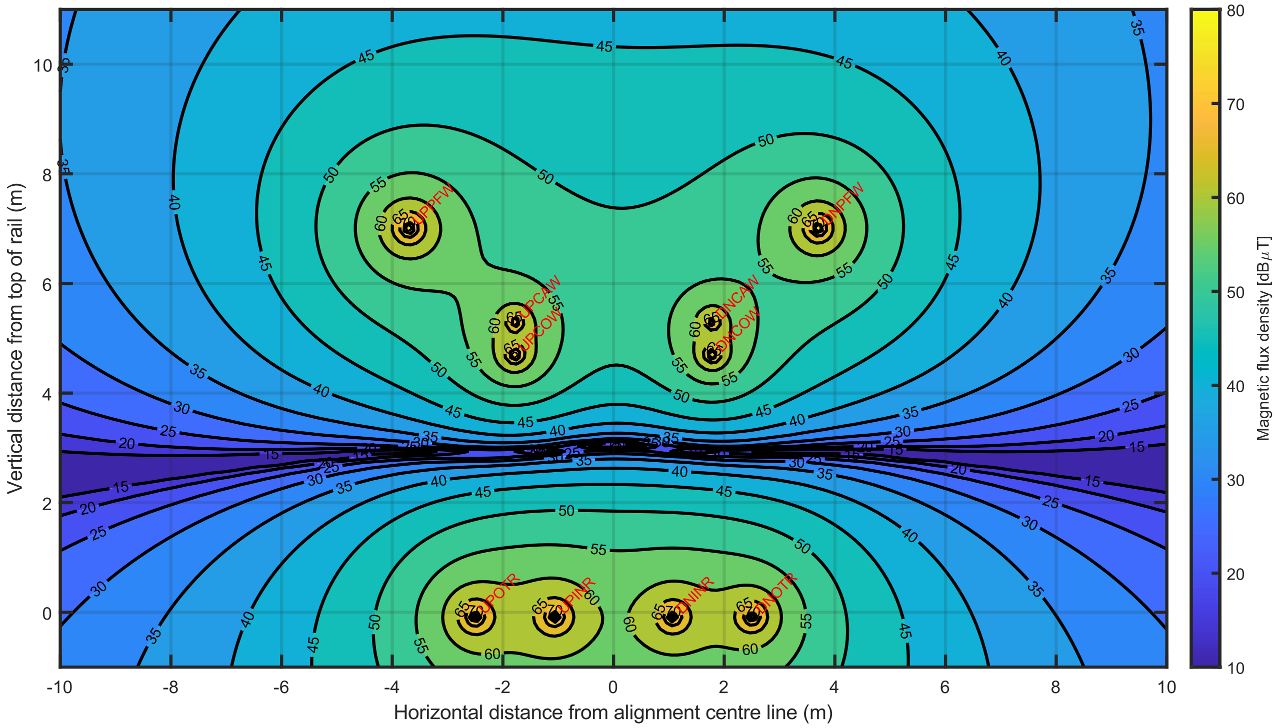

Figure 22-4 Magnetic Flux Density Contours in dBμT: DC Normal State with Feeder Wire

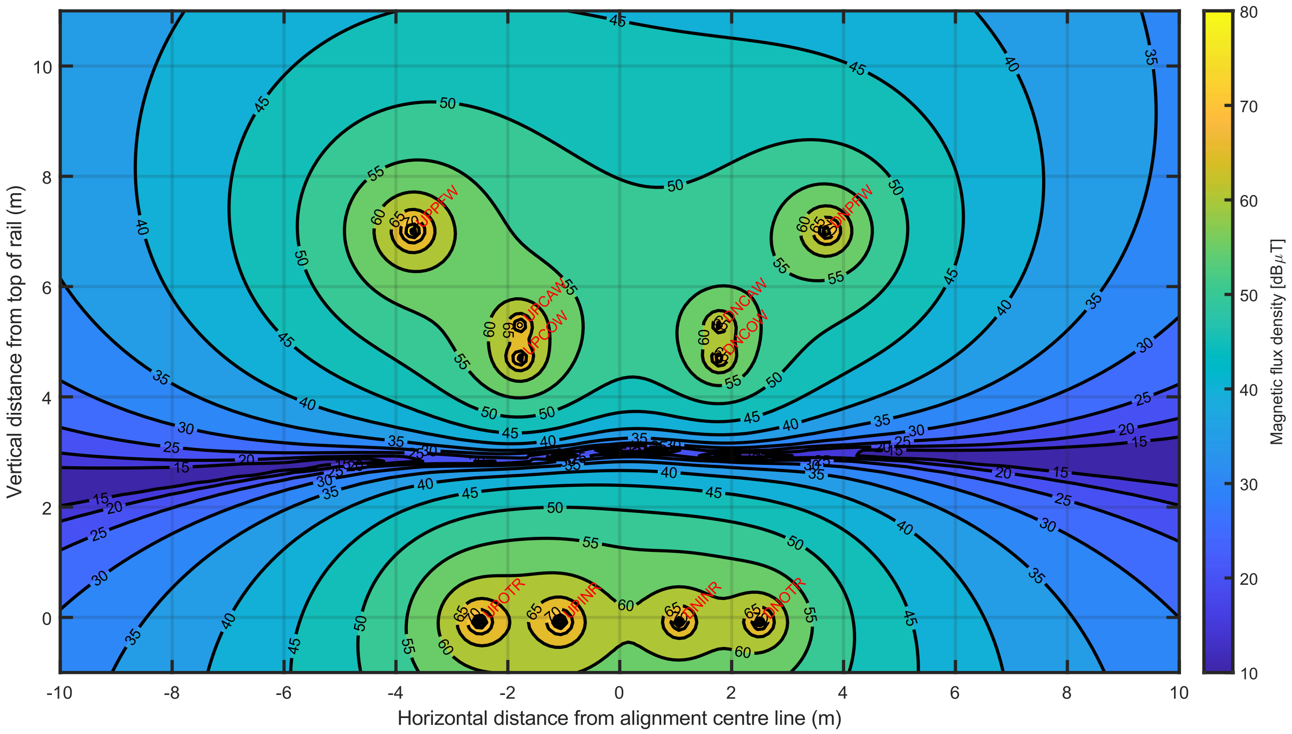

Figure 22-5 Magnetic Flux Density Contours in dBμT: DC Outage State with Feeder Wire

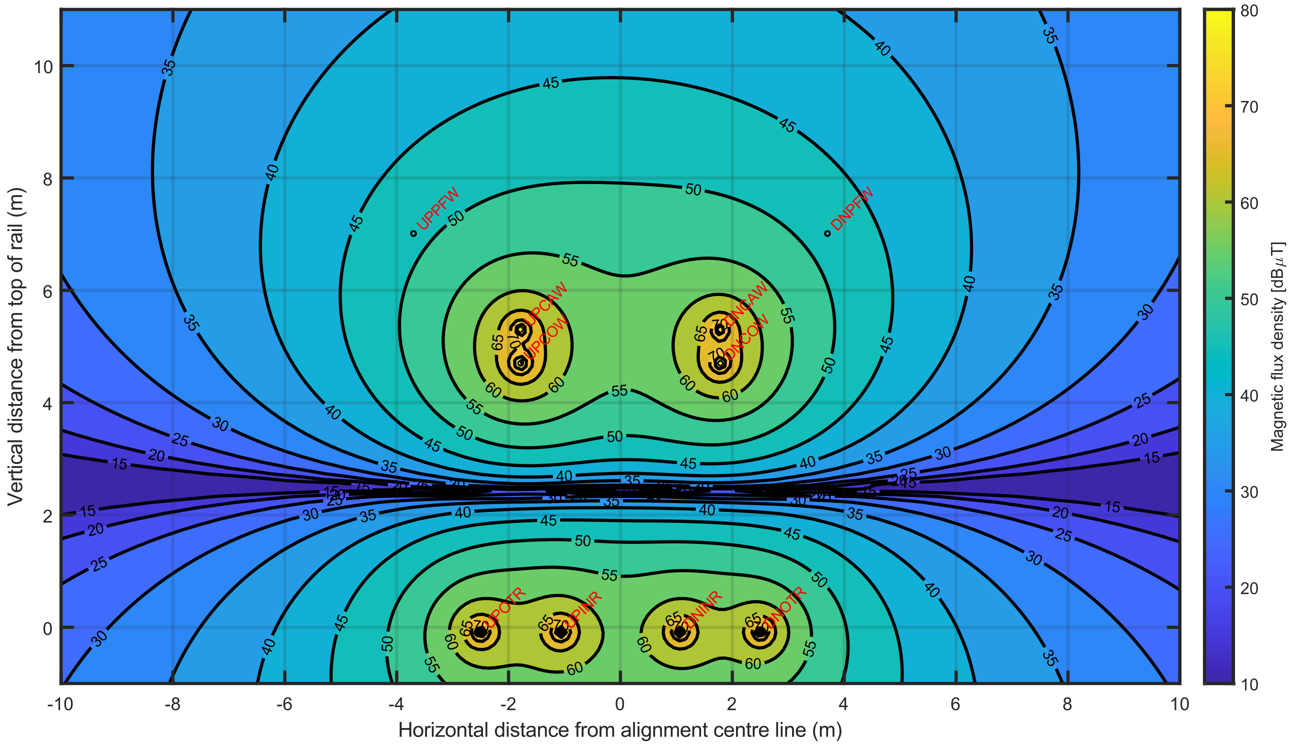

Figure 22-6 Magnetic Flux Density Contours in dBµT: DC Normal State Without Feeder Wire

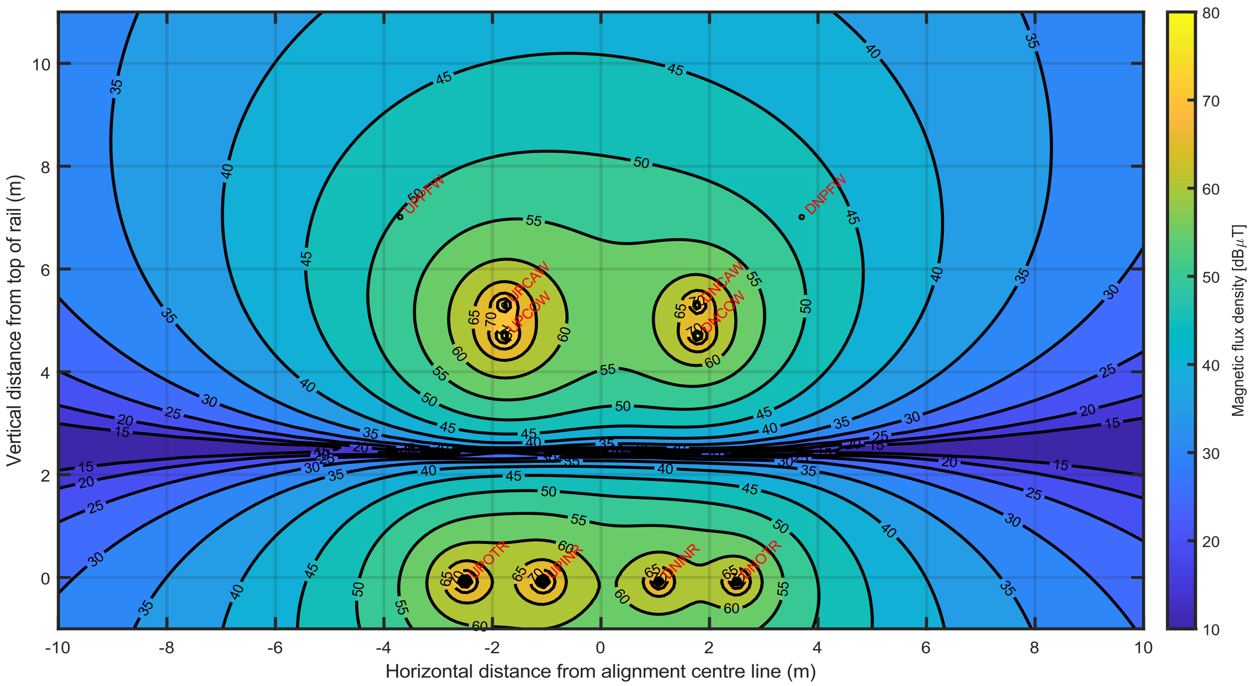

Figure 22-7 Magnetic Flux Density Contours in dBµT: DC Outage State Without Feeder Wire

Figure 22-8 shows the 50Hz AC magnetic flux density in the normal feeding state for worst-case traction loading without a parallel FW. The 40 dBµT[6] public exposure limit is located within a few centimetres of the energised conductors. Beyond this distance, the field strength decreases to levels

[6] 40 dBµT is equivalent to the 100µT limit stated in 1999/519/EC, the value has been converted to dBµT to allow for a clearer presentation of the modelling methodology and results. Refer to Table 22.8 for further details.

below that of the public exposure limit. The 12 dBµT[7] residential and commercial equipment immunity limit is contained horizontally within the railway corridor. Vertically the protection distance for such equipment above the parallel FW is about 1.3m which will need to be satisfied on overbridges.

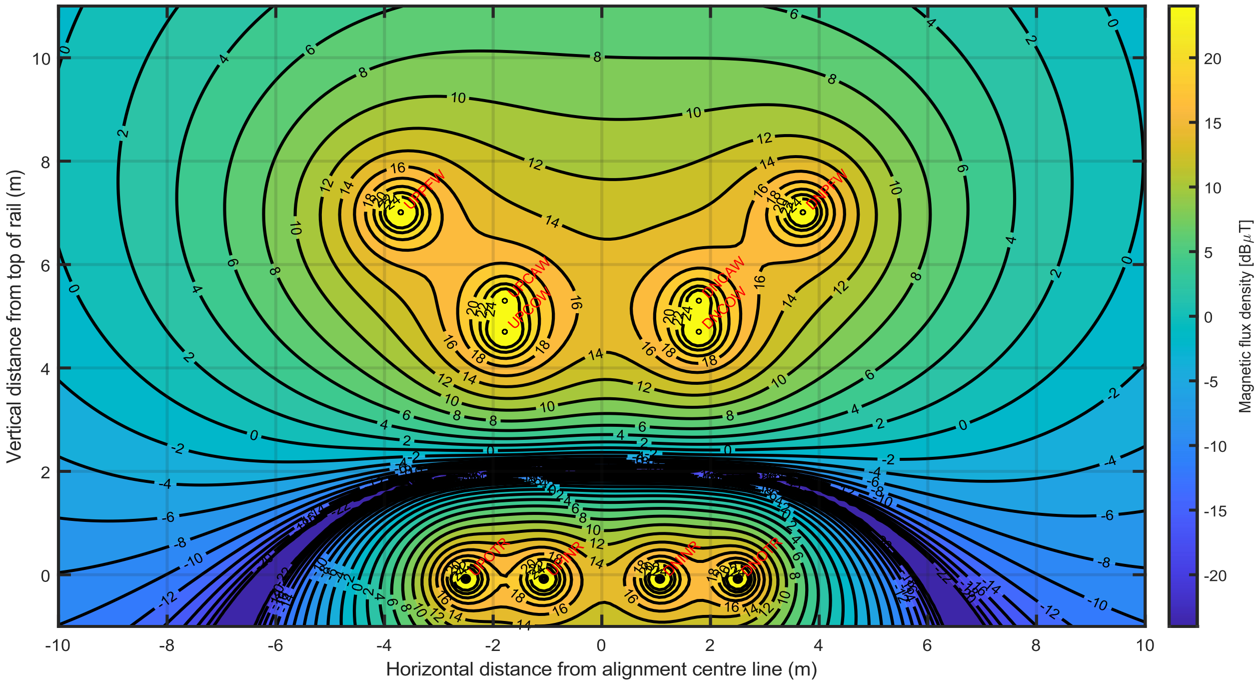

Figure 22-8 Magnetic Flux Density Contours in dBµT: 50Hz Normal State with Feeder Wire

Figure 22-9 shows the expected magnetic flux density levels (at ground level) in relation to distance from the centre line of the railway tracks. As shown in Figure 22-9, the green line represents the domestic background magnetic field level, which is the defined as the typical level recorded in the home (i.e. generated by domestic electrical appliances such as, TVs, fridge, washing machine, oven). The red line represents the ICNIRP limits for human exposure and it is noted that at ground level these limits are not exceeded by the traction power system of the railway.

[7] 12 dBµT is equivalent to the 3.7µT limit stated in EN 61000-6-1, the value has been converted to dBµT to allow for a clearer presentation of the modelling methodology and results. Refer to Table 22.8 for further details.

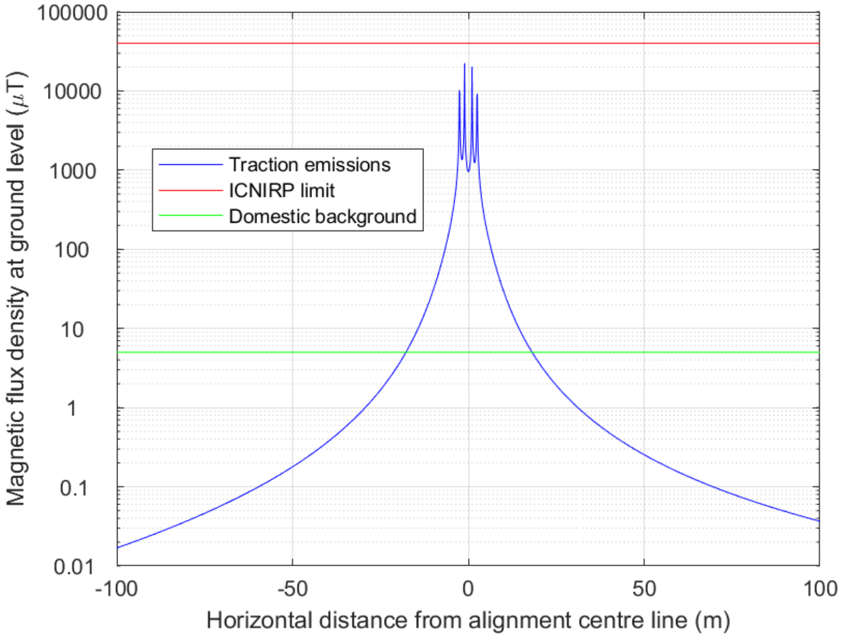

Figure 22-9 Magnetic Flux Density Levels in Relation to Distance (at ground level)

The overall conclusions of the modelling study were:

- The protection distance for public exposure from energised conductors for quasi-DC (<1Hz) and 50Hz magnetic fields is predicted to be a few centimetres under worst-case operating conditions of the railway. Beyond this distance, the field strength decreases to level below that of the public exposure limit. This protection distance is respected for publicly accessible areas on stations and for areas outside the railway boundary; and
- The 50Hz magnetic field equipment immunity limit of 3 A/m for residential and commercial equipment is not exceeded outside the railway boundary and not more than 1.3m vertically above FWs. The risk of interference to third-party equipment outside the railway boundary which is compliant with the residential and commercial EMC limits due to this source is therefore very low.

22.6. Mitigation Measures

The effects caused by EMI and EMF will be eliminated or reduced to acceptable levels during the ongoing design development and construction phases of the Project by the application of relevant legislation, standards and industry best practices.

In addition to this, third parties with potentially sensitive equipment will be engaged as specified in Section 22.3.6 to ensure that any risks of EMI are identified. It is expected that in the majority of cases that there are no specified receptors that are particularly sensitive to EMI and/ or conclude that the risk to any receptors from the new electrified railway is sufficiently low so that no additional mitigation measures are required. In the event that a receptor of concern is identified then further assessment will be carried out at the detailed design stage to determine suitable and appropriate mitigation measures.

As outlined in Section 22.3, a combined EMC and Earthing and Bonding (E&B) route-wide desktop survey[8] has also been conducted as part of the design of the Project. A number of assets were identified that require consideration regarding the risk posed to them by DC stray current. A full register of third-party assets was identified by the Project Design Team. Table 22.12 provides a summary of the asset types identified and the general approach to mitigating stray current corrosion. These should be reviewed, amended (if necessary) and incorporated into the detailed designs to ensure that the level of DC stray current on receptors is minimised.

Table 22.12: Summary of Asset Types and Stray Current Mitigations

Asset Type	Stray Current Considerations and Possible Mitigation(s)
Overline Structures (e.g. Bridges, Signal Gantries)	Bonding of overline structure to traction return system via a Voltage Limiting Device (VLD) and/or use of traction bonded flashover plates may be necessary dependent on the following factors: • Structure material (e.g. stone, brick, steel etc); and • Proposed clearance between bridge soffit and contact wire.
Radio Transmitters	N/A – earth mats for standalone transmitters will not have a direct galvanic connection to the traction return system and so any stray current flow through them will be incidental. Risk to these assets considered to be sufficiently low.
Buried Services (Electrical Cables)	N/A - No significant risk of increased stray current flow since buried electrical cables are typically insulated.
Buried Services (Gas/Water/Sewage Mains)	Underground metallic services may encourage additional stray current flow from the DC traction return system resulting in corrosion/damage to railway and third-party assets. Possible mitigations include the following: • Renewing pads between tracks and sleepers to increase rail-to-earth resistance; and • Use of collection mats and/or sacrificial anodes.

22.7. Monitoring

DART+ South West shall be provided with a stray current monitoring system at each traction substation. This will allow for a continuous monitoring of the rail to earth potential. The rail potential is monitored at dedicated locations along the line, typically at the substations. This will be used to demonstrate that:

- The electrification system does not introduce intolerable levels of stray current; and
- Ensure that the mitigations adopted by the design and construction delivery team have been correctly implemented and compliance with EN 50122-2 [5] has been achieved.

The DART+ South West stray current monitoring system is expected to use a centralised data acquisition system to allow it to be transferred to Iarnród Éireann SET Department.

[8] DP-04-23-REP-EL-TTA-09433-V01-S03, “DART Expansion Project – Kildare Line, EMC/E&B Routewide Asset Survey Report.

22.8. Residual Effects

Any residual effects will only be possible to determine following the completion of monitoring activities.

22.9. Cumulative effects

No other significant sources of EMF operating at the same frequency range of the DC traction electrification system have been identified that would otherwise compound the levels of EMF in the area. Therefore, with regard to EMF, the cumulative effects are expected to remain within acceptable limits.

The cumulative assessment of relevant plans and projects is undertaken separately in Chapter 26 of this EIAR.

22.10. References

ICNIRP (2020) Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). Health Phys 118(5):483-524.

ICNIRP (2010) Guidelines for limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz – 100 kHz). Health Phys 99(6):818-836.

ICNIRP(2009) Guidelines on limits of Exposure to Static Magnetic Fields. Health Phys 96(4): 504-514;

1999/519/EC Council Recommendation of 12th July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz). (1999) Official Journal L 199, 59-70. http://data.europa.eu/eli/reco/1999/519/oj

TTA JV (May 2022), DART Vision OSLO Power Study: DART+ South West (Ref: DP-04-23-REL-EL-TTA-22846-V02-S3)

TTA JV (March 2022), DART+ South West, EMC Management Plan (Ref: DP-04-23-REP-EL-TTA-22820-V01-S3)

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TTA JV (March 2022), DART+ South West, E&B Management Plan (Ref: DP-04-23-REP-EL-TTA-22821-V01-S3)

Energy Networks Association(2012) "Electric and magnetic fields: The facts", Jan 2012.