



TS 00049:1.0

Standard

Electromagnetic Energy, Emissions and Compatibility – Fixed Transport Infrastructure

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Preface

This standard is the first issue and supersedes TD 00024:2023 *Limits for Static Magnetic Field Emissions from Transport Infrastructure Assets*.

This standard covers the requirements for static and time-varying electromagnetic exposure, emissions, immunity and compatibility for fixed TfNSW infrastructure assets.

The changes from the previous content include the following:

- Expanded electromagnetic exposure limits to cover time-varying fields.
- Introduced electromagnetic emission and immunity requirements for electronic and electrical equipment.
- Added new requirements for managing electromagnetic energy and compatibility across all TfNSW fixed infrastructure assets.

This standard has been reviewed by:

- Australian Radiation Protection and Nuclear Safety Agency
- Australian Communications and Media Authority
- Chief health officer – TfNSW.

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1 Scope

This multimodal standard covers the requirements for static and time-varying electromagnetic human exposure safety limits, emissions, immunity and compatibility for fixed TfNSW infrastructure assets.

This document provides the following:

- electromagnetic exposure requirements applicable to health and safety
- electromagnetic emission requirements to prevent interference with electrical equipment and systems
- electromagnetic immunity requirements for electronic and electrical equipment
- requirements for managing electromagnetic compatibility in TfNSW projects, across TfNSW fixed infrastructure assets.

2 Application

This standard applies to all new and modified TfNSW fixed infrastructure assets.

The electromagnetic energy human exposure limits specified in this standard apply to members of the general public in publicly accessible areas and to workers in occupational areas.

This document is only applicable to TfNSW fixed infrastructure assets. Electromagnetic emissions and immunity requirements relating to fleet are covered by specific Transport Australian, IEC, ISO and EN standards.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

EN 50121 (Series) *Railway applications – Electromagnetic compatibility*

EN 50121-2 *Railway applications – Electromagnetic compatibility – Part 2: Emission of the whole railway system to the outside world*

EN 50121-5 *Railway applications – Electromagnetic compatibility – Part 5: Emission and immunity of fixed power supply installations and apparatus*

EN 50500 *Measurement procedures of magnetic field levels generated by electronic and electrical apparatus in the railway environment with respect to human exposure*

EN 50527-1 *Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices – Part 1: General*

Australian standards

AS 2344 Limits of electromagnetic interference from overhead a.c. powerlines and HV equipment installations in the frequency range 0.15 MHz to 3000 MHz

AS/NZS 3820 Essential safety requirements for electrical equipment

AS/NZS 4417.1 Regulatory compliance mark for electrical and electronic equipment – Part 1: Use of the mark

AS/NZS 4417.2 Regulatory compliance mark for electrical and electronic equipment – Part 2: Specific requirements for particular regulatory applications

AS/RISSB 7722 EMC Management

AS/RISSB 7722:2016 EMC Management

AS/NZS 61000 (Series) Electromagnetic compatibility (EMC)

HB 101 Coordination of power and telecommunications – Low frequency induction (LFI) – Code of practice for the mitigation of hazardous voltages induced into telecommunication lines

ARPANSA Radiation Protection Series (RPS) S-1 Standard for Limiting Exposure to Radiofrequency Fields – 100 kHz to 300 GHz

Transport for NSW standards

TS 00003.1 Concessions to Transport Standards – Part 1: Concession Process

TS 00004.1 Nonconformances to Transport Standards – Part 1: Nonconformance Process

TS 00006 HV Earthing Design

TS 01455 Configuration Management

TS 01465 (T MU AM 06014 GU) Guide to Systems Integration

TS 01466 (T MU AM 06016 GU) Guide to Verification and Validation

TS 01471 (T MU AM 06006 ST) Systems Engineering Standard

TS 03648 (TSI-SP-012) General Requirements for Roadside Equipment Housings

TS 03650 (TSI-SP-016) General Requirements for Outdoor Electronic Equipment

TS 00161 Requirements for Software Tools used for Engineering Simulation and Modelling

Legislation

Environmental Planning and Assessment Act 1979 (NSW)

ACMA EMC Standard

Note: The ACMA EMC Standard incorporates by reference the list of mandated EMC standards, which is published on the ACMA website as a two-part document

Radiocommunications Equipment (General) Rules 2021 (the General Equipment Rules)

State Environmental Planning Policies

Note: The *State Environmental Planning Policies* are a group of environmental planning instruments under the *Environmental Planning and Assessment Act 1979*

Telecommunications (Labelling Notice for Customer Equipment and Customer Cabling) Instrument 2025

Work Health and Safety Act 2011 (NSW)

Other referenced documents

CIGRE Responsible management of electric and magnetic fields (EMF) WG C3.19 TB 806

Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC

Energy Networks Australia *EMF Management Handbook*

ICNIRP 2009, *Guidelines on Limits of Exposure to Static Magnetic Fields*

ICNIRP 2010, *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz – 100 kHz)*

TfNSW, *Work Fitness Procedure* (This document is not publicly available. To obtain access email standards@transport.nsw.gov.au)

Parramatta Council *Development Control Plan 2023*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

ac alternating current

ACMA Australian Communications and Media Authority

ARPANSA Australian Radiation Protection and Nuclear Safety Agency

Asset Steward – delivery the entity responsible for procurement of an asset from investment decision to commissioning; delivering the benefits; translating the requirements from the client and managing delivery outcomes; selecting the most appropriate supplier/s to meet project objectives

Asset Steward – operate or maintain the entity responsible for the day-to-day operations and/or maintenance of an asset once commissioned. This role may be part of the asset custodian division or a separate entity. Operator and maintainer of the assets may be separate entities

B-field magnetic flux density

controlled environment an area that is accessible by workers for occupational purposes

dc direct current

design service provider delivers EMC and EME design expertise and design assurance during all phases of a project

E-field electric field strength

EESS electrical equipment safety system; this is a regulatory framework established by the Electrical Regulatory Authorities Council

ELF extremely low frequency; electric and magnetic fields occupy the lower part of the electromagnetic spectrum in the frequency range 0–100 kHz

EMC electromagnetic compatibility; the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment (Source: IEC)

EME electromagnetic energy; EME relates to the potential health effects associated with exposure to electromagnetic fields

EMF electromagnetic field

EMI electromagnetic interference

extra low voltage is defined as below 50 V ac rms or 120 V ripple free dc

fixed infrastructure assets permanently installed and stationary in nature; non-stationary assets, such as trains, heavy or light rail, ferries, busses, or other fleet types, are not considered fixed infrastructure

general public the entire population. It also includes individuals of all ages, and of varying health status, and this will include particularly vulnerable groups or individuals such as the frail, elderly, pregnant persons including pregnant workers, babies, young children. It should be noted that an employee that is not expected to be aware of electromagnetic exposures and thus to mitigate risk, is also considered a member of the general public (i.e., office workers).

general public exposure received by persons as defined under “general public”. This definition excludes occupational exposure. For details, refer to the definition in the relevant ARPANSA standard or ICNIRP guideline.

H-field magnetic field strength

HF high frequency

HV high voltage; This includes voltages exceeding 1000 V ac and exceeding 1500 V dc.

IMD implantable medical device

integrating service provider (also referred to as the system integration TAO or may be also the principal contractor) brings together component elements into one system, ensuring that the elements function together as a complete system, and also ensuring that the new system integrates within the existing system of systems. Refer to TS 01465 for the full definition.

ISM Industrial scientific medical; Equipment or appliances designed to generate and use locally radio-frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications. (source: IEC)

ITC inspection test checklist

ITP inspection test plan

ITS intelligent transport systems

LFI low frequency induction

occupational exposure of workers incurred in the course of their work who are generally appropriately trained of the exposure hazards or who are supervised in a controlled environment. For details, refer to the definition in the ARPANSA RPS S-1 standard or ICNIRP guidelines.

power frequency mains power electromagnetic fields at 50 Hz, though extends to other frequencies such as the harmonics of 50 Hz, which may extend to approximately 3 kHz. Examples of sources that emit higher magnitudes of power-frequency electromagnetic fields include, power lines, electrical switch boards, electrical substations, electrical risers, high power electrical appliances, and so on.

publicly accessible areas can be accessed by the general public. Examples include railway stations, bus stops and ferry wharfs

radiofrequency radio frequency (fields) nominally from 100 kHz to 300 GHz

RCM regulatory compliance mark

RF radio frequency is a term used for describing the range of oscillation of radio waves, which is generally from 100 kHz to 300 GHz. Some examples of radio waves are radio & TV broadcasts, mobile phone communications, WiFi, Bluetooth and so on

rms root mean square

TAO Technically Assured Organisation

TfNSW Transport for New South Wales

TV television

UHF ultra high frequency

VHF very high frequency

WiFi a wireless networking technology that uses radio waves to provide wireless high-speed Internet access

Units

T	tesla (magnetic flux density)
mT	milli-tesla (magnetic flux density)
μ T	micro-tesla (magnetic flux density)
Hz	hertz (frequency)
kHz	kilohertz (frequency)
MHz	Megahertz (frequency)
GHz	gigahertz (frequency)
kV/m	kilovolt per meter (electric field strength)
V/m	volt per meter (electric field strength)
A/m	ampere per meter (magnetic field strength)

5 Introduction

5.1 What is EMC and EME?

Electromagnetic compatibility is the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

Electronic and electrical equipment and systems (referred to as electrical equipment and systems) generate EMFs, either intentionally through wireless communication systems using antennas or unintentionally as spurious emissions from cables, wires, and electrical components. Unintentional emissions that can propagate through conduction over long conductor lengths may act like an antenna and cause unintentional emissions into the air.

To ensure compatibility, electromagnetic emissions (both intentional and unintentional emissions) shall be limited to not cause interference to radiocommunications receivers and electrical equipment and systems in the surrounding environment. To ensure an acceptable level of compatibility, the ACMA requires unintentional emissions from electrical equipment to be in accordance with ACMA EMC standards applicable to the type of electrical equipment.

All intentional emissions shall comply with the requirements of radiocommunications licenses regulated in Australia by the ACMA.

When electromagnetic emissions are strong enough at the location of other electrical equipment, the electromagnetic field can induce a voltage and current into the equipment of concern and may potentially cause interference which could degrade performance, cause

malfunction, reset, or in extreme cases permanently damage the componentry. The ACMA does not regulate immunity requirements for electrical equipment and systems. Therefore, all electrical equipment shall be tested by the manufacturer to comply with the applicable international or Australian electromagnetic immunity standards, to provide a level of assurance against electromagnetic interference and its compatibility when utilised in TfNSW fixed infrastructure installations.

When intentional emissions are strong, such as from a radio frequency transmitting installation, or when the transmitter is in close proximity, the EME may be a health and safety risk to persons. In Australia, ARPANSA has established requirements for acceptable RF field exposure limits to ensure the health and safety of individuals. For static and ELF fields, ARPANSA recommends the use of ICNIRP's EME human exposure safety limits.

Compliance with the applicable EMC standards, guidelines and requirements by adhering to design, testing, survey and desktop assessments, can assure electromagnetic compatibility of electrical equipment and systems.

There are various regulatory and industry EMC and EME requirements that are referenced or documented in legislation, specifications, standards and guidelines that apply to electrical equipment and systems depending on the type and the environment of use.

5.2 Objectives of EMC and management of EME

Compliance with the applicable regulatory requirements, Transport standards, industry standards and guidelines enable the objectives in Sections 5.2.1 to 5.2.4 to be met.

5.2.1 Prevention of radio receiver interference

A low level of noise (or limit level of unintentional emissions required in an EMC standard) within or adjacent to the frequency band of reception can prevent or minimize the likelihood of reception interference problems.

5.2.2 Orderly and efficient use of radiofrequency spectrum for communications

Compliance with EMC standards, guidelines and requirements limits the level of noise (electromagnetic field pollution) in the spectrum due to unintentional spurious emissions generated by electrical equipment and systems. The spectrum can be used efficiently and compatibly, thus congestion can be avoided or minimised.

5.2.3 Compatibility and reliability of electrical equipment and systems

Electrical equipment and systems, whether wireless or not, are often designed to tolerate limited levels of radiated and conducted emissions required by the immunity requirements in EMC

standards. Compliance with the immunity requirements provides assurance that the electrical equipment and systems are robust or immune to interference effects on an individual basis if the equipment's classification (that is, industrial, light industrial, residential, and so on) corresponds to the electromagnetic environment in which it is intended to operate. Electrical equipment that complies with industry standards is only electromagnetically compliant on an individual basis when used in accordance with the operating instructions supplied. When a system is made from the integration of electromagnetically compliant electrical equipment, the whole system cannot be assumed to be compatible as the electromagnetic signature has changed to some extent due to the change in installation environment. In situations where there is concern about the change in electromagnetic behaviour and its potential impact, the following assessments shall be conducted:

- an electromagnetic compliance assessment during the design phase (that is, the compatibility between the electrical equipment working as a system)
- a survey assessment during the commissioning phase to confirm the emissions outside the system of installation.

5.2.4 Management of EME (health and safety assurance)

Electromagnetic fields that are emitted intentionally, such as radiofrequency transmissions from antennas, or that are unintentionally emitted such as from powerlines, electrical substations, and other types of high-powered electrical equipment and HV networks, can potentially be strong enough to be of concern for the health and safety impact to persons. Compliance with electromagnetic field exposure guidelines and EME standards can provide assurance for the health and safety of persons exposed to EME.

5.3 Types of electromagnetic fields

5.3.1 Static fields

Static magnetic fields are constant fields, that do not change in intensity or direction over time. Static magnetic fields are produced by steady dc currents or permanent magnets where the magnetic field does not change over time (0 Hz).

Static magnetic fields can be generated from dc sources such as dc railway traction substations, dc railway cables and overhead wiring, electric vehicles, electric vehicle dc charging stations, and solar power cells.

5.3.2 Time-varying fields

Time-varying electromagnetic fields are generated from ac sources. When near the source the emission is in the form of magnetic or electric fields, and when further away in the far-field

region the two fields couple to become a transverse electromagnetic field that radiates with magnetic and electric field components.

Time-varying electromagnetic fields can be one of three main types, quasi-static fields, ELF including power frequency fields, and radiofrequency fields.

5.3.2.1 Quasi-static fields

Quasi-static electromagnetic fields vary slowly with time, typically with frequency slightly greater than 0 Hz and up to a few hertz (5 Hz for the context of this standard). Changes to a field are usually due to changes in source current caused by a slowly varying load, or a surrounding environment condition that influences the field behaviour.

5.3.2.2 Extremely low frequency and power-frequency fields

ELF electromagnetic fields are nominally within the range of 1 Hz to 100 kHz and are usually detected as magnetic or electric fields in the near-field region.

Power-frequency magnetic and electric fields are part of the ELF range fields and typically start at the fundamental power frequency of 50 Hz and extend into the kHz range due to harmonic frequency components and changes in power loading.

Power-frequency fields can be generated from power sources such as electrical powerlines, substations, switch rooms, major power cabling, distribution boards and high loads (caused for example from heating, cooling, ventilation, motors, and industrial equipment).

5.3.2.3 Radiofrequency fields

Radiofrequency electromagnetic fields are nominally within the range of 100 kHz to 300 GHz. Radiofrequency fields exist in the forms of electric and magnetic fields in the near-field region and become transverse electromagnetic fields in the far-field region.

There are numerous types of radiofrequency electromagnetic field sources. Some of the more commonly known types are:

- AM (amplitude modulation) and FM (frequency modulation) radio
- TV broadcast transmitters
- HF, VHF and UHF radios used by couriers, taxis, fire and rescue emergency services, ambulance and police communications
- mobile phones
- microwave point-to-point links
- satellite communications.

6 EME and EMC applicable standards and compliance requirements

6.1 EME health and safety requirements

6.1.1 General

TfNSW serves a diverse range of commuters on various modes of transport assets across the state of NSW. Commuters across NSW utilise public transportation such as trains, buses, ferries and light rail systems.

This document defines the safe human exposure limits for EME emitted by fixed transport infrastructure assets. These limits are designed to ensure public safety, with particular consideration given to vulnerable individuals, including those with IMDs.

The radiated exposure limits are aligned with the immunity thresholds of IMDs to ensure the safety of the general public in publicly accessible areas. For controlled environments, the exposure limits are set in accordance with occupational guidelines established by ICNIRP for the ELF range and by ARPANSA RPS S-1 for the RF range.

Occupationally exposed pregnant employees are classified as members of the general public. These employees shall notify their employer when they become aware of their pregnancy in accordance with ARPANSA RPS S-1 and ICNIRP guidelines. Occupationally exposed pregnant employees shall not be exposed to EME exceeding the general public exposure limits.

Any employee with an IMD shall confirm its safety for workplace use with their physician. The employee shall notify their employer of any restrictions imposed by their physician in accordance with the TfNSW *Work Fitness Procedure*, and other agency-specific policies and procedures. Refer to Section 28 of the *Work Health and Safety Act 2011 (NSW)* for further requirements.

Sections 6.1.2 to 6.1.4 provide human exposure limits applicable to static and time varying (ELF and RF) electromagnetic fields.

6.1.2 Static magnetic fields (0 Hz)

The reference levels for static (0 Hz or dc) magnetic field human exposure given in the *ICNIRP 2009* (recommended by ARPANSA) shall apply for occupational exposure, as summarised in Table 1.

The scope of *ICNIRP 2009* does not include the case of implantable medical devices. *ICNIRP 2009* states, "Because of potential indirect adverse effects, ICNIRP recognizes that practical policies need to be implemented to prevent inadvertent harmful exposure of people with implanted electronic medical devices and implants containing ferromagnetic materials, and

injuries due to flying ferromagnetic objects, and these considerations can lead to much lower restriction levels, such as 0.5 mT”.

To ensure the safety of the general public in TfNSW publicly accessible areas, including individuals with IMDs, a general public limit of 0.5 mT shall apply based on EN 50500, EN 50527-1 (both refer to EU Directive 2013/35/EU) and a comprehensive consultation undertaken with the major Australian IMD manufacturers and their environmental operating specifications as specified in Table 1.

Table 1 – Occupational and general public static magnetic human exposure limits

Exposure type	Magnetic flux density
Occupational exposure Exposure of head and of trunk	2 T ⁽¹⁾⁽²⁾⁽³⁾
Occupational exposure Exposure of limbs	8 T ⁽¹⁾⁽²⁾⁽³⁾
General public exposure Exposure of any part of the body	0.5 mT ⁽¹⁾

Notes:

1. ICNIRP recommends that these limits should be viewed operationally as spatial peak exposure limits.
2. For specific work applications, exposure up to 8 T can be justified, if the environment is controlled and appropriate work practices are implemented to control movement-induced effects in accordance with *ICNIRP 2009*.
3. The scope of *ICNIRP 2009* does not include the case of implantable medical devices, and hence the limits in the above table listed for occupational exposures apply purely to the body only.

(Source ICNIRP 2009)

The static limits in Table 1 for both occupational and public exposures shall also apply for quasi-static magnetic fields in the frequency range from 0 Hz up to 5 Hz due to the peak-to-peak amplitude of the non-zero frequency component not exceeding the amplitude of the dc component.

6.1.3 ELF electromagnetic fields (1 Hz to 100 kHz)

ARPANSA recommends using the *ICNIRP 2010* human exposure safety limits for the ELF range.

However, compliance with *ICNIRP 2010* might not prevent interference with, or effects on, medical devices such as metallic prostheses, cardiac pacemakers, implanted defibrillators and cochlear implants, as interference may occur at levels below the reference levels.

To ensure the safety of the general public in TfNSW publicly accessible areas, including individuals with IMDs, the magnetic and electric field limits shown in Figure 1 and Figure 2 shall apply from 10 Hz to 100 kHz for H-fields and from 1 Hz to 100 kHz for E-fields.

Note: At a power frequency of 50 Hz, to protect individuals with IMDs, the general public reference level of 200 μT specified in *ICNIRP 2010* is reduced to 100 μT to comply with immunity requirements for IMDs. These limits are provided in Table 2.

Table 2 – Human exposure limits to 50 Hz time-varying electric and magnetic fields

Exposure type	Applicable guideline	Electric field strength (kV/m rms)	Magnetic flux density B (T rms)
Occupational exposure	ICNIRP 2010	10 ⁽¹⁾⁽²⁾	1 mT ⁽¹⁾⁽²⁾
General public exposure	TfNSW publicly accessible exposure curve	5	100 μT

Notes:

1. *ICNIRP 2010* is consistent with ARPANSA’s understanding of the scientific basis for the protection of people from exposure to ELF EMF.
2. The scope of the *ICNIRP 2010* does not include the case of IMDs, and hence occupational limits in the above table apply purely to the body only.

(Source ICNIRP 2010)

The human exposure reference safety levels applicable to controlled environments in the ELF range shall comply with the occupational limits set forth in *ICNIRP 2010*.

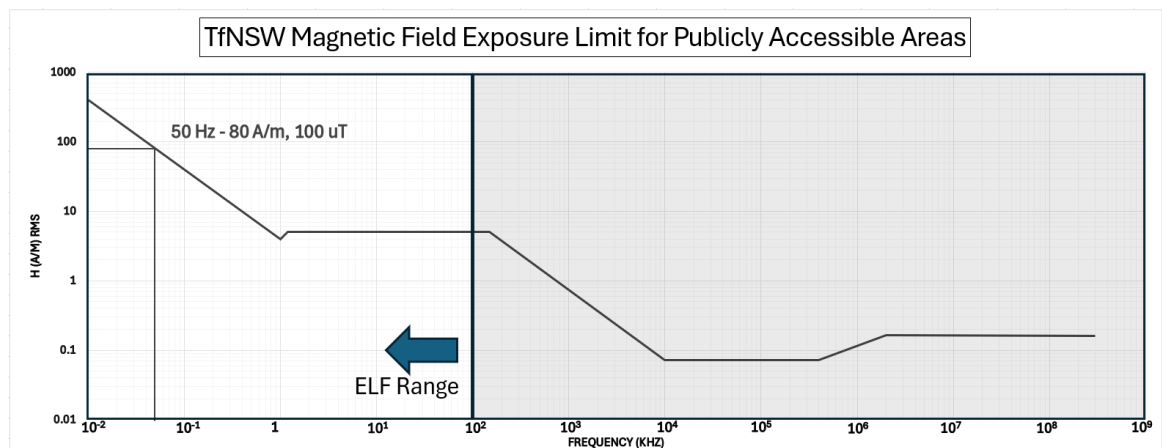


Figure 1 – TfNSW magnetic field exposure limits for publicly accessible areas (10 Hz to 100 kHz frequency range with the 50 Hz power frequency limit shown)

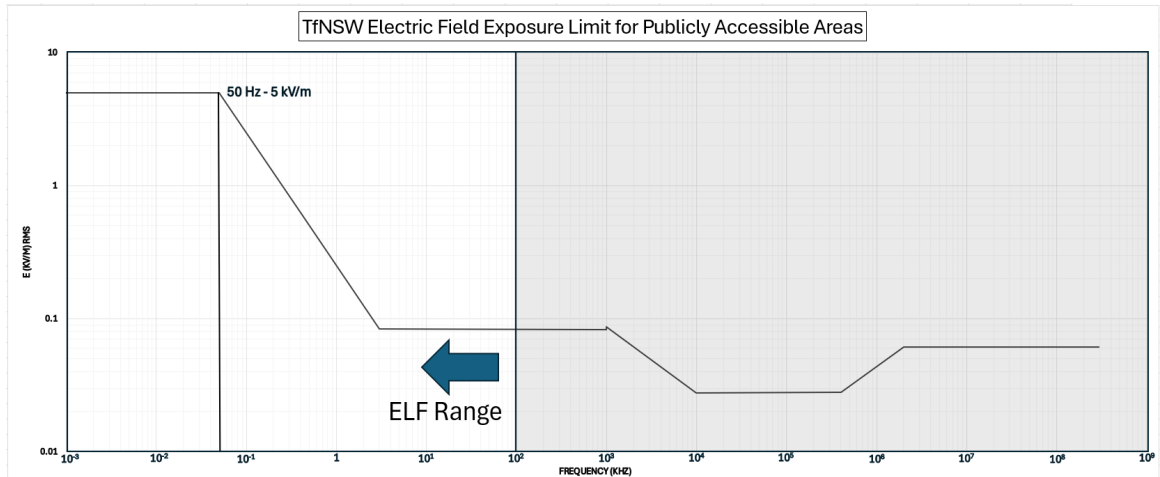


Figure 2 – TfNSW electric field exposure limits for publicly accessible areas (1 Hz to 100 kHz)

6.1.4 RF electromagnetic fields (100 KHz to 300 GHz)

Exposure limits for RF electromagnetic fields given in ARPANSA – RPS S-1 are applicable in Australia and are summarised in Table 3 for occupational whole of body exposure in controlled environments.

However, compliance with ARPANSA might not prevent interference with, or effects on, medical devices, as interference can occur at levels below the reference levels.

To ensure the safety of the general public in TfNSW publicly accessible areas, including individuals with IMDs, the magnetic and electric field limits shown in Figure 3 and Figure 4 shall apply from 100 KHz to 300 GHz for both H and E-fields.

Table 3 – RPS S-1 time-averaged occupational human exposure limits in controlled environments for whole body exposure – 0.1 MHz to 300 GHz electric and magnetic fields

Frequency range	Incident E-field strength (V/m rms)	Incident H-field strength (A/m rms)	Incident power density (W/m ²)
0.1 to 6.943 MHz	No reference level (3)	4.9/ f _M	N/A
>6.943 to 30 MHz	660/ f _M ^{0.7}	4.9/ f _M	N/A
>30 to 400 MHz	61	0.16	10
>400 to 2000 MHz	3 f _M ^{0.5}	0.008 f _M ^{0.5}	f _M /40
>2 to 300 GHz	N/A	N/A	50

Notes:

1. In the near-field, both electric field and magnetic field limits are applicable rather than power flux density, which is applicable in the far-field.
2. f_M is the frequency in MHz.

3. Means that no reference level is available, as it would be greater than the reference level for spatial peak and temporal peak field strength based on electrostimulation effects shown in Table 7 of ARPANSA RPS S-1.

4. N/A signifies 'not applicable' and does not need to be taken into account when determining compliance.

(Source: ARPANSA RPS S-1 modified)

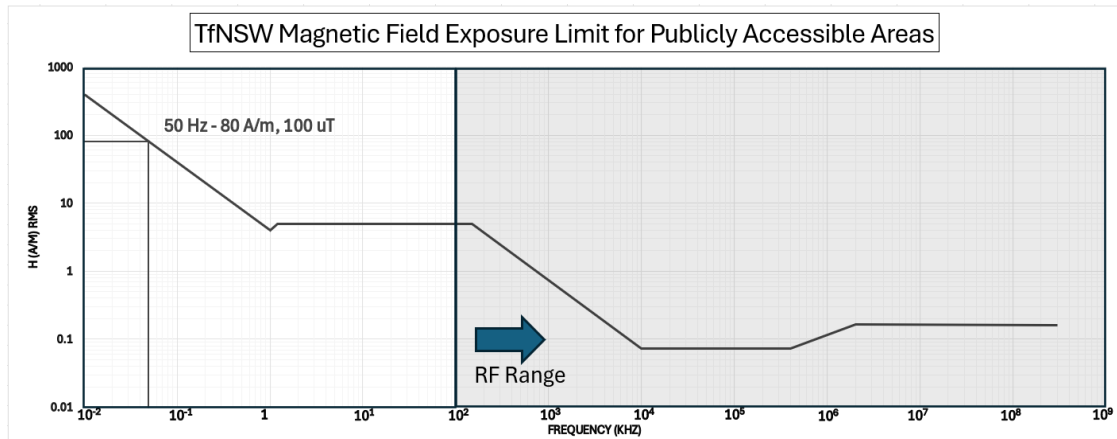


Figure 3 – TfNSW magnetic field exposure limits for publicly accessible areas (100 kHz to 300 GHz)

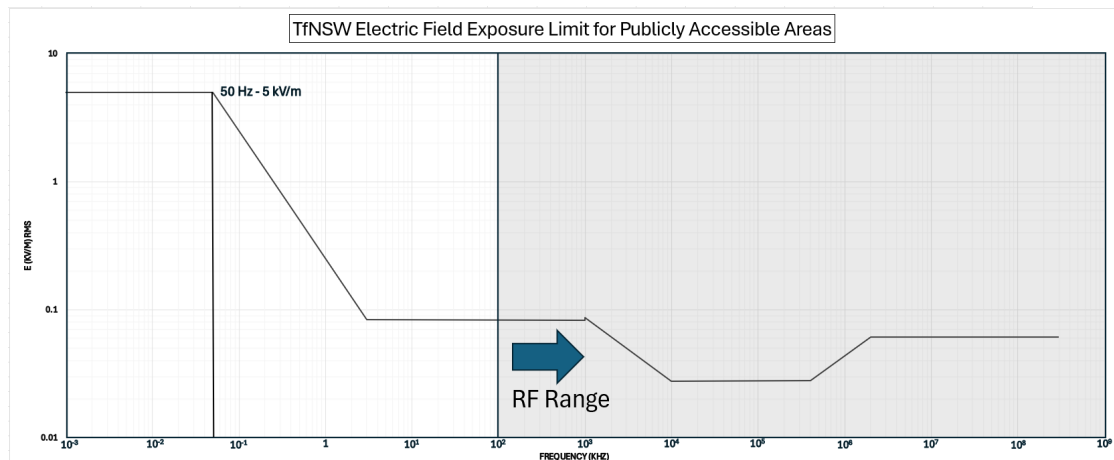


Figure 4 – TfNSW electric field exposure limits for publicly accessible areas (100 kHz to 300 GHz)

6.2 Federal, state and council requirements

6.2.1 General

Transport assets involving planning, development, upgrades, or decommissioning that require approvals from other government agencies (for example, federal, state, and local governments) shall refer to the respective agency's requirements. If there are any specific additional requirements to be met, the integrating service provider and the design service provider shall

determine those requirements to ensure the appropriate measures are taken to comply with those particular EMC and EME requirements throughout the asset life cycle.

6.2.2 Federal requirements

There is federal legislation that specifies electromagnetic requirements for EMC and EME. ARPANSA establishes national limits for EME, while the ACMA is responsible for regulating and enforcing compliance with those limits.

In Australia, the RF electromagnetic field spectrum is regulated by the ACMA. This involves the compliance and regulation of products, and also systems or installations. ACMA regulatory arrangements require sources of RF EME to comply with the public exposure limits in ARPANSA RPS S-1. The ACMA specifies requirements for equipment suppliers. Designers and suppliers of electrical and electronic equipment should refer to ACMA's website and publications for the latest information.

The main ACMA categories of compliance and regulation of particular relevance to this document are EMC, EME, and radiocommunications and telecommunications:

- EMC – the ACMA EMC standards specify requirements for electrical and electronic products. The ACMA EMC standards are in two parts. Part one has the general standards for emissions and part two groups the products and lists the standards to be met. The ACMA EMC Standards requires a device to comply with an applicable industry standard on the list of ACMA EMC standards.
- EME – the electromagnetic energy standard is in Schedule 4 to the *Radiocommunications Equipment (General) Rules 2021 (General Equipment Rules)*. The ACMA imposes EME requirements on equipment with an integral antenna (mobile stations with an integral antenna operating in the frequency band 100 kHz to 300 GHz inclusive) under the *General Equipment Rules* (applying to the supplier). The EME requirements for equipment without an integral antenna are regulated under the applicable radiocommunications licence (applying to the user). The ACMA mandates exposure limits that apply to the general public, as set out in ARPANSA RPS S-1.
- Radiocommunications – radiocommunications licences aim to assure compliant and orderly transmission and reception of RF signals, communications and broadcasts. Different licence classes are determined by the type of RF transmission, which primarily depends on frequency, transmit power, bandwidth, and duty cycle parameters, the type of RF communications technology and its application. Low power wireless communications such as Bluetooth, WiFi, and other ISM band communications are short range devices that only communicate over short distances and usually only for personal use with operators required to hold a class licence without an ACMA fee. Other types of RF transmissions, which are usually of greater power for communicating or broadcasting over greater distances, are assigned frequency spectrum parameters to operate within, and are

required to comply with, an applicable licence with an ACMA fee. Some common examples of RF transmitter installations that require a licence are HF, VHF/UHF radio communications, mobile phone base stations, microwave point-to-point links, and satellite communications. In addition to radiocommunication licences, all radiocommunication transmitters are required to comply with ACMA's mandatory radiocommunications standards – the *General Equipment Rules* set out in Schedule 5 and Subclause 53(4) of Part 15 of Schedule 5 testing methods. Compliance with the *General Equipment Rules* will ensure interference caused by intentional transmitters is avoided.

- Telecommunications – the relevant telecommunications standards can be found in Schedules 1 and 4 of the *Telecommunications (Labelling Notice for Customer Equipment and Customer Cabling) Instrument 2025*, which apply to telecommunications customer equipment and customer cabling.
- RCM – the ACMA conjointly owns the Regulatory Compliance Mark (RCM) trademark with the EESS. All suppliers and manufacturers providing electrical products are required by the ACMA to follow “5 steps for suppliers”. Under step 5 of this process, products regulated by ACMA may need a label to demonstrate their compliance.

The RCM is a symbol that represents compliance with the EESS and ACMA labelling requirements. The use of the RCM for products subject to ACMA arrangements (such as EMC, radiocommunications, telecommunications, EME) are set out in the ACMA regulatory arrangements. For electrical safety, the sale of in-scope electrical equipment is permitted only when the product is labelled with the RCM, in line with AS/NZS 4417.1 and AS/NZS 4417.2 and EESS requirements. Electrical equipment exclusively used in commercial, industrial, extra low voltage and high voltage is out of scope for EESS. The responsible supplier shall ensure that out of scope electrical equipment complies with AS/NZS 3820 and provide evidence of compliance with this document.

Generally, the RCM symbol or the Quick Reference (QR) code with the relevant link to information on a website that prominently displays the RCM is required to be displayed on electrical products before supplying the product to the Australian market.

6.2.3 NSW state requirements

Infrastructure development projects undertaken by the NSW State Government may be subject to electromagnetic field impact requirements, which shall be addressed during the review of environmental factors process. The *Environmental Planning and Assessment Act 1979* contains requirements for this process.

The EMC or EME requirements are set out in the applicable *NSW State Environmental Planning Policies*.

6.2.4 Council requirements

When a development application is lodged, a council could require that an electromagnetic requirement be satisfied. Council may need assurance that EMC or EME requirements are addressed during the planning and design phase of the project prior to approving the development works and may also require assurance upon completion of the works. The electromagnetic requirement could be related to health and safety, interference or compliance.

Requirements vary from council to council. For example, the Parramatta Council *Development Control Plan 2023* requires minimisation of possible adverse public health effects of electromagnetic radiation emitted from telecommunications facilities. It also recommends the separation of transmitters emitting electromagnetic radiation from concentrations of possible at-risk populations, such as hospitals, retirement villages, schools, childcare centres, children's playgrounds and residential land uses where practicable and reasonable.

6.3 TfNSW multimodal asset requirements

6.3.1 General

Compliance with industry standards or requirements may be necessary to ensure operational assurance and compatibility within a specific industry.

6.3.2 Common requirements for electrical infrastructure

Electrical equipment installations and ac overhead and underground powerlines can be significant sources and emitters of electromagnetic emissions that potentially cause ELF and radiofrequency interference as well as health and safety risks. Examples of electrical equipment installations include HV and LV equipment, substations, generators, inverters, rectifiers, and powerlines (distribution or railway traction). Electromagnetic emissions from HV equipment installations and ac overhead powerlines in the frequency range 0.15 MHz to 3000 MHz shall be in accordance with AS 2344. Immunity requirements for equipment used in substations and substation environments shall comply with AS IEC 61000.6.5. Where HV power and telecommunication routes follow parallel close proximity paths, electromagnetic coupling due to induction (low frequency induction) shall follow the requirements listed in HB 101.

Electromagnetic emission requirements for electrical and electronic equipment shall also comply with the requirements specified by the ACMA EMC Standard. Where no specific emission requirements are outlined in Part 2 of the ACMA EMC Standard, the equipment shall comply with the requirements specified in Part 1 of the ACMA EMC Standard, that is, AS/NZS 61000.6.3 or AS/NZS 61000.6.4.

The determination of whether equipment needs to comply with light industrial or industrial environment requirements under Part 1 of the ACMA-mandated EMC Standard shall be based

on verification that the equipment's classification corresponds to the electromagnetic environment in which it is intended to operate, and not on the origin of its electrical supply.

Any additional applicable requirements shall be assessed and determined on a case-by-case basis.

Mitigation guidelines for the reduction of electromagnetic fields from significant sources, including substations, overhead powerlines, and underground cables, are available in CIGRE C3 and the ENA EMF Management Handbook.

Earthing and bonding of electrical infrastructure can also have a significant impact on the electromagnetic performance and shall comply with TS 00006.

6.3.3 Rail specific requirements

The EN 50121 standard series includes emissions and immunity compliance requirements for the whole railway system, rolling stock, railway communications and signalling equipment, and railway substations. A survey assessment (baseline and post commissioning) of railway traction substations, including HV intake substations and powerline installations, shall be undertaken for the radiated emissions in accordance with the measurement techniques and limits stipulated in EN 50121-2, EN 50121-5 and AS 2344.

The radiated emissions limits of EN 50121-2 and EN 50121-5 are considered practical and achievable and are expected to be met within Europe. However, these limits are not sufficiently low to ensure adequate protection against interference with sensitive radiofrequency receivers and may not guarantee acceptable reception. RF electromagnetic emissions from TfNSW fixed transport infrastructure shall comply with the lower limits specified in AS 2344.

Equipment classified as light industrial, even if installed within the industrial railway environment, may comply with AS/NZS 61000.6.1 for immunity and AS/NZS 61000.6.3 for emission requirements. In accordance with AS/RISSB 7722, the acceptability of such equipment complying with light industrial environment standards shall require confirmation that the equipment functions adequately within the electromagnetic environment in which it is intended to operate. All TfNSW fixed rail infrastructure shall comply with the standards and requirements specified in AS/RISSB 7722. Regardless of the mode of transport, the requirements specified in Section 6.3.2 shall also apply to all rail electrical infrastructure.

Refer to TS 05258 for EMC and electrical power interface requirements applicable for signals and control systems equipment supplied as a separate configuration item.

6.3.4 Road specific requirements

Electrical equipment and systems shall comply with the EMC requirements specified in Section 6.3.2.

ITS and commercial off the shelf (COTS) electronic equipment supplied as components of intelligent transport systems used on roads, bridges, tunnels, and other road transport infrastructure shall comply with TS 03650 and TS 03648 unless otherwise specified in the dedicated equipment specification.

6.3.5 Maritime specific requirements (wharves)

Electrical equipment and systems shall comply with the EMC requirements specified in Section 6.3.2.

7 Non-compliance

The EMC and EME requirements are set out in regulatory requirements, industry standard requirements (international, national, TfNSW and this document) and project contractual requirements.

Any deviations to the requirements of this document shall require application for a concession in accordance with TS 00003.1.

Any non-conformances to the requirements of this standard shall follow the non-conformance process in accordance with TS 00004.1.

8 Compatibility, reliability and performance problems

Electromagnetic compatibility of the surrounding environment, equipment and systems is important for ensuring reliability and performance from an electromagnetic perspective. If electromagnetic emissions are excessive or electromagnetic immunity is inadequate, there is an increased risk of electromagnetic interference. Interference effects can cause degradation of performance, unreliability (including resets and failure), and in extreme cases, permanent damage to equipment and systems.

Design and integrating service providers shall ensure the EMC of equipment and systems for their application. In addition, they shall take into account the applicability of the following:

- desktop assessments during the planning and design phase
- survey assessments during the planning and commissioning phases
- the application of any required mitigations to help ensure a sufficient level of electromagnetic compatibility.

9 Prevention and mitigation design

To rectify an electromagnetic non-compliance (ordinarily identified through survey assessments during commissioning), mitigation methods may be necessary to address the problem in practice. Accurate design or survey assessments, mainly baseline surveys, could identify a possible risk of significant concern before it occurs, while precautionary mitigation may be applied in order to avoid a health and safety hazard risk, an interference risk, or a risk of non-compliance.

Various forms of mitigation may be applied depending on the risk, the effectiveness and the cost of implementing the mitigation measure.

Design and integrating service providers shall take into account the following as a minimum to avoid electromagnetic interference to electrical equipment and non-compliance during the design phase:

- Increasing the distance between the source and the affected area (for free space propagation).
- Introducing shielding (such as a screen or metal sheet) between the source and the affected area. Shielding is typically costly and most effective when applied to a general area rather than a specific area. Increasing the coverage area, increasing the thickness of the shielding or changing the material type can improve the field attenuation.
- Employing equipment that is rated and tested to perform with no degradation to its functions.
- Conducting electromagnetic field simulations using software compliant with TS 00161, to identify potential interference effects such as low-frequency induction on adjacent electrical infrastructure. These simulations shall be performed to identify and mitigate EMI issues.

Design and integrating service providers shall take into account the following as a minimum to avoid health and safety risks during design activities:

- Increasing the distance between the source and the closest accessible location to persons (public or occupational personnel).
- Avoiding placement of an electromagnetic emitter within an accessible area to the public.
- Conducting electromagnetic field simulations using software compliant with TS 00161, to identify potential human exposure risks. These simulations shall be performed to identify and mitigate such issues.

The following general types of mitigation methods should be considered throughout all stages of an asset's life cycle:

- reduce or change the source of the emissions:

- select the optimum form of aerial and underground cable configuration (designers may refer to CIGRE WG C3.19 for guidelines)
- change the form of the source so the emissions efficiency reduces (for example, minimising the separation between positive and negative return conductors might reduce the magnetic field)
- reduce the power, voltage or current at the source
- increase the distance separation between the source and the receiver:
 - relocate the source or person in the case of exposure to persons
 - relocate the source or radio receiver to prevent interference
 - isolate or segregate cabling and systems in the case of interference
- shield, suppress, reflect or deflect to control the exposure of the receiver to emissions:
 - Shielding may be passive in the case of using shielding materials or active in the case of field cancellation. The type and form of the shielding material to apply in a passive shielding solution will depend on many factors such as application, performance and cost, and will need to be designed. There are several considerations involved when considering shielding solutions, and these include the composition of the iron, steel or alloy material which affects properties such as permeability and conductivity.
 - Suppressing or attenuating by filtering or installation of absorption material.
 - Reflecting or deflecting through the installation of reflection materials.
 - Establishing exclusion zones to prevent a health and safety exposure risk to persons
- employ equipment which is less sensitive to interference:
 - equipment compliant for use in a residential commercial and light industrial environment may be substituted with equipment compliant for use in an industrial environment.

10 Requirements for managing EMC and EME

For managing the EMC and EME aspects in projects, the requirements in Sections 10.1 to 10.9 are given as a minimum for the planning, design, implementation, commissioning, and maintenance phases of the project.

10.1 EMC management plan

10.1.1 General

An EMC management plan outlines how EMC and EME aspects will be managed throughout the project. An EMC management plan is a live document that evolves with the project and the associated asset lifecycles. The EMC management plan shall establish the scope of work necessary to achieve EMC and the human exposure safety limits related to EME, ensuring overall compliance. The project EMC management plan shall be prepared and implemented in accordance with TS 01471 covering the full life cycle of the asset.

The actual content of an EMC management plan shall appropriately suit the needs of the project – it may not be necessary in some instances; could be minimal for small projects; and may need to be comprehensive for large-scale projects. An EMC management plan is required for all projects that require an EMC design (see Section 10.3).

An EMC management plan shall contain, as a minimum, the types of information given in Sections 10.1.2 to 10.1.8.

10.1.2 Introduction

The EMC management plan shall have general introductory information including:

- overview of the project
- objective
- general strategies
- applicable standards
- timeline and key deliverables
- applicability to EMF emitting or receiving systems of the project.

10.1.3 Applicable standards and requirements

The EMC management plan shall include requirements related to EME health and safety, electrical equipment and systems interference and compatibility to consider under the following hierarchy:

1. Federal, state and council requirements (see Section 6.2)
2. TfNSW multimodal asset requirements (see Section 6.3)
3. project specific requirements.

10.1.4 Sources of EMFs and nature of impact

The EMC management plan shall contain information about the types of systems and equipment which are sources of EMFs and the various means by which electromagnetic impacts may be transferred.

10.1.5 Risk assessment

The EMC management plan shall include identification of main risks and how they can be assessed. There may be risks due to the surrounding environment and vice versa, as well as risks within the project area due to the interaction of systems or equipment. Different methods may be identified to assess risks. These may include any of the following:

- desktop assessments
- measurements of equipment in a laboratory environment
- survey assessments at a project development site (baseline testing during the planning phase and commissioning testing during the commissioning phase)
- cross verification matrices (threat matrices). Appendix A of AS/RISSB 7722:2016 provides an example of a threat matrix for rail applications. Other modes of transport, such as roads and maritime, shall use the threat matrix outlined in AS/RISSB 7722.

Risk assessments shall account for safety risks associated with EMC in product design, system design, system installation, application, and potential failure modes.

10.1.6 Safety of persons

The safety of persons during the project development, design, construction, operation and maintenance and during upgrades or electrical system alterations shall be taken into account in terms of electromagnetic human exposure hazards in the EMC management plan. For example, industrial or electrical power equipment and associated powerlines or radiofrequency transmitters can potentially be a hazard to the safety of persons. Design and integrating service providers shall make an assessment for compliance with the applicable standards and take into account possible mitigations and strategies to eliminate or reduce the risks SFAIRP (so far as is reasonably practicable). Refer to Section 6.1 for electromagnetic human exposure safety limits applicable for TfNSW fixed assets.

10.1.7 Substantiation of EMC and EME compliance

Examples of various documentation that can substantiate EMC compliance and assurance during the phase of the project include:

- EMC plan with compliance requirements
- risk analysis and hazard analysis

- desktop or theoretical assessments
- test plans
- EMC tests and survey assessments (laboratory and onsite pre and post installation survey assessments)
- EMC assessment reports
- EMC pre-acceptance and trial reports
- final acceptance test (compliance and assurance).

Overall system compliance is achieved once all systems are commissioned and operating as intended, free from interference and fully compliant with human-exposure safety limits.

10.1.8 Roles and responsibilities

10.1.8.1 Integrating service provider (system integrating service provider)

The integrating service provider is responsible for:

- engaging the design service provider from the initiation stage and throughout all phases of the project
- managing EMC and EME requirements in accordance with the EMC management plan throughout all phases of the project
- adhering to the requirements outlined in the EMC management plan to ensure overall EMC compliance and assurance before asset handover
- ensuring that the Asset Steward – delivery and Asset Steward – operate or maintain are consulted at each phase of the EMC management plan within the project.

The integrating service provider shall be authorised under the TfNSW TAO Authorisation Scheme.

10.1.8.2 Design service provider

The design service provider shall be authorised under the TfNSW TAO Authorisation Scheme. The design service provider shall be engaged throughout every project phase.

The design service provider shall be responsible for providing:

- assurance that the overall design meets EMC (including EME) requirements and complies with this document, as well as other referenced standards and requirements
- design input to the integrating service provider and verify any hold or witness points as determined by the EMC management plan
- design input to the commissioning (and testing) team and endorsement of the ITPs and ITCs prior to use

- endorsement of the completed ITPs and ITCs in any of the following circumstances:
 - where the designer specifically requires test data to verify modelling completed during the design phase
 - a test failed to meet the initial pass or fail criteria
 - a design configuration change was required
- design personnel with appropriate expertise and capabilities.

10.1.8.3 Asset Steward – operate or maintain and Asset Steward – delivery

Throughout all phases of the project, Asset Stewards shall be consulted, while the integrating and design service providers apply their EMC expertise to ensure the implementation of works complies with this document.

The Asset Steward – operate or maintain shall be responsible for ensuring EMC and EME compliance with the requirements of the EMC management plan during the operation and maintenance phases of an electrical system or asset. Any configuration changes to the electrical system or asset requiring EMC design (see Section 10.3) shall be identified by the Asset Steward – operate or maintain. The integrating TAO engaged to undertake configuration changes on the system shall comply with the requirements of Section 10.1.8.1.

The Asset Steward – delivery is responsible for the procurement of qualified EMC and EME service providers and for defining the scope of EMC and EME services for the project.

10.2 EMC and EME test plan

10.2.1 General

An EMC and EME test plan, detailing the intended test methodology, shall be prepared for compliance and quality assurance purposes. Guidance on the engineering test and verification process is provided in TS 01466. The integrating service provider shall produce all necessary test plans in accordance with the requirements of the EMC management plan.

An EMC and EME test plan shall contain the following information at a minimum:

- scope of testing (applicable standards, pass criteria and accreditation if required)
- test equipment
- test equipment setup
- procedure including the tests to be performed and test conditions
- all electrical equipment loading conditions during testing.

The integrating service provider shall execute all tests required at each stage, including those specified in Sections 10.2.2 to 10.2.4.

10.2.2 Baseline survey testing

Baseline testing characterises the electromagnetic environment at the site or in the surrounding area for planning purposes or prior to the commencement of projects. The environment prior to works is recorded and understood to assist project planning and its potential impact on the surroundings and vice versa. Baseline testing shall be conducted at the project initiation phase. The design and the integrating service provider in consultation with the Asset Steward – delivery may consider the suitability of a desktop assessment depending on the project scope and their assessment of the operating environment.

The baseline test report shall include, at a minimum, recommendations, mitigation measures, and assessments addressing the following items:

- identification of potential sources of electromagnetic interference that may affect sensitive equipment
- comparison of baseline test results with acceptable limits for exposure (health and safety), immunity, and emissions to support project compliance
- possible EMI impact such as on malfunction or degradation of performance of electrical systems, including mitigation strategies
- recommendations regarding the suitability of electrical equipment for installation
- possible health and safety exposure related risks.

10.2.3 Asset survey assessment

An asset survey assessment (compliance testing) shall be conducted during the commissioning phase to verify compliance with regulatory, industry, and project-specific requirements. Testing shall be carried out with equipment operating under its maximum allowable loads and be documented. The design and the integrating service provider in consultation with the Asset Steward – delivery and Asset Steward – operate or maintain may consider the suitability of a desktop assessment instead of field testing. Justification for the desktop assessment may consist of information on the project scope and both the design and integrating service providers' evaluation of the operating environment following the modification of existing assets or the introduction of new assets. This evaluation shall be supported by calculations, simulations, and other relevant data.

The compliance test report shall include, at a minimum:

- confirmation of overall system compliance with the exposure (health and safety), immunity and emissions limits defined in the EMC management plan
- assessment of the consequences of any test failure, including potential impacts on the electrical system functionality and equipment performance

- remediation strategies to rectify non-compliance affecting system functionality and individual equipment operation.

10.2.4 Investigative testing

Investigative testing shall be conducted to examine issues related to reliability, performance, or compliance, which could be due to interference or health and safety concerns. Investigative testing may not be pre-planned by the EMC management plan however may be required in the event of non-conformances or equipment interference issues on site.

10.3 EMC and EME design

10.3.1 General

To achieve EMC and EME compliance and assurance, the EMC and EME requirements of a project shall be taken into account to ensure they are satisfied from a design perspective during the design phase of a project.

The designer shall assess the system (new assets and the surrounding existing assets and systems) as a whole to develop a detailed understanding of the EMC and EME requirements, ensuring that the final design will provide assurance for the chosen integrated equipment and surrounding environment including persons. The designer shall assess all future TfNSW or external infrastructure – installed or otherwise – to identify any possible EMC or EME risks.

10.3.2 Consideration of new installations versus like-for-like

Electrical and radiofrequency transmitting installations may be of the same type and replicated at multiple locations within a single facility or across different facilities. Given that equipment is of the same type, installed in a similar manner, and operates in comparable environments with similar usage by personnel, it should only be necessary to assess the EMC and EME aspects once for the like-for-like installations. The design and integrating service provider shall provide assurance of the like-for-like nature of the project, in consultation with the Asset Steward – operate or maintain and Asset Steward – delivery.

For new electrical and radiofrequency transmitting installations, the EMC and EME aspects shall be assessed at least once for a type of installation that is considered like-for-like. If new installations are large and complicated or situated in a sensitive location, the designer may deem it necessary to assess that particular installation due to the risk involved, regardless of it being like-for-like. For example, if a new installation of a HV substation (or communications system installation, or radiocommunication antenna installation) is situated near an airport with sensitive air traffic control communications operating on frequency channels (generally between 123 MHz and 125 MHz), then the installation's risk could be considered significant regardless of it being a like-for-like installation. Accordingly, a detailed EMC and EME design with survey assessments rather than a desktop only assessment shall be carried out.

In the case of maintaining or replacing an installation, the installation before and after could be considered like-for-like if equivalent replacement equipment is being installed. For example, an equivalent replacement transformer in a substation or the replacement of equivalent conductors and insulators on an overhead powerline structure might not require a detailed EMC design. The design and integrating service provider shall provide written assurance of the like-for-like nature of the project in consultation with the Asset Steward – operate or maintain and Asset Steward – delivery.

10.3.3 Considerations for both emissions and immunity

When taking into account the EMC aspects of electrical and radiofrequency transmitting installations, including equipment and systems, both electromagnetic emissions and immunity shall be assessed.

EMC immunity compliance of individual equipment ensures that the equipment can tolerate interference when integrated into a system or placed near other equipment or potential sources of interference. However, tolerance to interference of a system of integrated equipment or compatibility between the electronic equipment working as a system cannot be assured simply due to individual equipment of the system being compliant with an immunity or emission standard. The electromagnetic emissions from equipment or a system of integrated equipment may need consideration with respect to EME related health and safety and interference effects on adjacent potential victims (equipment or a system of integrated equipment or a publicly accessible area). For example, newly installed dc electric vehicle chargers at an electric bus depot, or a new large commercial type of solar inverter power system at the bus depot, might need the electromagnetic emissions assessed with respect to EME related health and safety of occupational and public persons depending on the accessibility. In addition, the susceptibility of adjacent equipment or systems of integrated equipment may also need to be assessed both within the depot and on neighbouring properties to ensure high current applications like dc vehicle chargers will not cause interference issues.

10.4 EMC and EME assessments in planning and design phases

During the planning and design phases of a project, the following EMC and EME assessments shall be conducted, at a minimum, to address electromagnetic concerns.

- theoretical or desktop studies
- baseline survey testing
- prevention and mitigation measure design.

The design or integrating service provider shall determine the appropriate level of EMC activities required within the planning or design phase of the project. If any of the minimum EMC and EME assessments are not performed, a clear justification shall be provided in the EMC

management plan and agreed with the Asset Steward – operate or maintain and Asset Steward – delivery.

Design and integrating service providers shall not place high electromagnetic field emitters in publicly accessible areas, to minimise health and safety exposure and interference impact in accordance with Section 6. For example, electromagnetic field emitters in the frequency range of 0 Hz to 1 kHz have significantly greater likelihood of interfering with pacemakers and ICDs (implantable cardioverter defibrillator). Thus, such electromagnetic field emitters shall not be placed in close proximity to publicly accessible areas.

10.5 EMC and EME assessments in implementation phase

During the implementation phase of a project, the following EMC and EME assessments shall be conducted, at a minimum, to address electromagnetic concerns:

- inspections of installations, that is, electrical cabling: distance to other cables and optimised installation configurations, and cable routes that have been specifically designed with specific EMC requirements, which will alter the electromagnetic footprint if installed incorrectly
- installation and inspections of mitigation measures (for example, shielding and other specialised mitigation measures)
- completion of inspection test checklists applicable to the installation
- other activities to manage EMC such as those specified by the equipment manufacturer.

The design and integrating service provider shall determine the appropriate level of EMC and EME assessments required within the implementation phase of the project. If any of the minimum EMC and EME assessments are not performed, a clear justification shall be provided in the EMC Management Plan and agreed with the Asset Steward – operate or maintain and Asset Steward – delivery.

10.6 EMC and EME assessments in commissioning phase

Prior to commencing the commissioning phase, pre-commissioning baseline testing or post installation testing (survey assessments) shall be completed in accordance with Section 10.2 of this document by the design and integrating service provider to demonstrate the emission compliance applicable to the installation.

During the commissioning phase of the project, the EMC and EME requirements shall be demonstrated by completion of an EMC compliance assessment. The EMC compliance assessment involves assurance of the individual equipment and the overall electrical system by means determined by the EMC commissioning, testing and management plans.

10.7 Maintenance and assurance

If any configuration changes occur to the electrical system or asset, they shall be managed in accordance with TS 01455. The Asset Steward – operate or maintain shall ensure compliance is reassessed and confirmed. Appropriately qualified design service providers shall be engaged to conduct the reassessment.

If any problems occur that affect operations, an investigative EMC and EME assessment shall be performed. The EMC management plan shall clearly specify the types of modifications that warrant a reassessment. The Asset Steward – operate or maintain shall carry out the assessment in accordance with the EMC management plan and the requirements in Section 10.1.8 of this document.

10.8 Examples of applicability of EMC and EME in TfNSW infrastructure

Examples of applicability of EMC and EME in TfNSW infrastructure include the following:

- dc installations:
 - traction railway substations
 - overhead traction railway powerlines
 - dc vehicle charging stations
 - solar cells
- HV installations:
 - traction railway substations
 - electrical power substations
 - overhead and underground powerlines
- electrical power substations and switch rooms:
 - traction railway substations
 - battery electric bus substations
 - LV installations such as chamber or kiosk substations, major power cabling, electrical switch rooms and boards, distribution boards, and plant rooms
 - wharf power supplies
- railway infrastructure:
 - traction powerlines
 - ac powerlines

- signalling equipment
- communications equipment
- radiocommunications towers and antenna installations
- road infrastructure:
 - HV road tunnel substations and switch rooms
 - ITS infrastructure
- power sources:
 - electric power generators (for example, diesel powered)
 - battery energy storage systems
 - solar power inverters
- radiocommunications:
 - land mobile VHF/UHF communications
 - surveillance and remote monitoring communications
 - E-tags (electronic tags)
 - RFID (radio frequency identification) electronic payment systems
 - RF local area networks
- telecommunications (such as mobile phones, point-to-point links, satellites):
 - mobile phone base stations
 - point-to-point microwave links
 - satellite communications.

10.9 Interpreting measurement results

Electromagnetic measurements can be performed in many ways with various types of measuring equipment. Measurement results are typically expressed as magnitudes (with units) over a specified bandwidth (that is, frequency range). They may be recorded as discrete values or presented as plots, such as magnitude versus time or magnitude versus frequency.

Measurement results shall be presented for direct comparison against the limits provided in Section 6 (EME and EMI safety limits). The discrete measurements shall be compared to their specified limit values. The plotted measurements shall include the limit line on the graph so that data can be clearly evaluated.

Compliance is achieved when all measured values or plot curves are equal to or below the applicable limit.