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Technical Direction – TD 00052:2024

Issue date: 22 May 2024

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Title: Update to requirements for self-service ticketing machines – Amendment to TS 04955.1:2.0 *Services, Systems and Equipment – Part 1: Principles*

This technical direction is issued by the Asset Management Branch (AMB) as an update to TS 04955.1:2.0 *Services, Systems and Equipment – Part 1: Principles*.

This technical direction amends the requirements for self-service ticketing machines.

1 Amendment to TS 04955.1:2.0

The following section in TS 04955.1:2.0 is amended as follows:

Section 7.16.3 Self-service machines

Delete the contents of Section 7.16.3 in their entirety and replace with the following:

Self-service machines and top up machines are provided for customers to purchase or reload smart cards using cash or cards.

There are currently three variations of ticket machines that may be deployed:

- Astreo Cash self-service machines – top up of the Opal card and vending of single trip tickets. Accepts credit and debit cards and cash.
- Astreo Cashless self-service machines – top up of the Opal card and vending of single trip tickets. Accepts credit and debit cards only.
- Galexio self-service machines – top up of the Opal card and vending of single trip tickets. Accepts credit and debit cards only.

CLD (cashless load device) machines are legacy equipment that is no longer available for new projects.

Authorisation:

Approved by	Director Interchanges and Buildings Asset Management Safety, Environment and Regulation

TS 04955.1:2.0

ESB 004

Standard

Services, Systems and Equipment

Part 1: Principles

Issue date: 28 March 2024

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Document information

Owner:	Director Interchanges and Buildings Asset Management Safety, Environment and Regulation
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Document history

Revision	Effective date	Summary of changes
1.0	31/08/2022	Supersedes ESB 004, v1.1. First issue as TS 04955.1. Version number recommenced in line with new designation.
2.0	28/03/2024	Second issue. Changes include document updated to apply to metro.

Preface

This standard is the second issue as TS 04955.1.

This document forms part of TS 04955 series of documents related to services, systems and equipment.

Transport facilities are considered an increased risk environment with constraints that may not be present in other buildings. Specific requirements are therefore necessary to ensure the safety, functionality and desired technical characteristics of the services and systems installations present within a transport facility.

This document contains functional, technical and operational requirements, and guiding principles associated with services, systems and equipment in transport facilities such as stations, bus terminals, interchanges, and so on.

This version has been updated to make this document applicable to metro.

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1 Scope

This standard sets the foundational requirements for services and systems in transport facilities and related transport infrastructure within the Transport network.

This document covers services, systems, infrastructure and equipment.

Services aim to enhance safety, efficiency and comfort of transport users, and include the following:

- mechanical services including heating, ventilation, air conditioning, refrigeration, escalators and lifts, emergency egress path pressurisation and smoke management
- electrical services, including power supply and distribution, metering, containment systems, LV installations, daylighting, artificial lighting (external, internal and emergency lighting), earthing and bonding, UPS and lightning protection
- hydraulic services including potable water supply and metering, drainage and plumbing
- fire services
- telecommunications services
- building control and management.

Systems aim to further enhance safety, aid operation and provide customer service. Systems include the following:

- information technology and customer information systems
- security systems
- ETS.

Refer to the relevant TfNSW standards for system-specific requirements.

Services and systems are connected to service-specific infrastructure. Infrastructure to which systems and services are connected includes the following:

- TfNSW owned, network-wide infrastructure
- public service provider owned infrastructure.

Equipment refers to salient components of services and systems described in this document and is not intended to describe specific equipment items in detail.

2 Application

This document applies to persons involved in the provision of services and systems within the Transport network.

This document applies to the planning, design, construction, operation, maintenance, and decommissioning stages of services, systems and equipment life cycle.

This document applies to all new installations.

This document applies to upgrades, additions, or changes to existing installations.

This document should be read and applied in conjunction with relevant legislation, Australian standards and TfNSW 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

ANSI/ASHRAE Standard 52.2 *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*

ANSI/ASHRAE Standard 55 *Thermal Environmental Conditions for Human Occupancy*

Australian standards

AS 11801.6 *Information Technology – Generic cabling for customer premises – Part 6: Distributed building services (ISO/IEC 11801-6:2017, MOD)*

AS 1210 *Pressure vessels*

AS 1345 *Identification of the contents of pipes, conduits and ducts*

AS 1428.1 *Design for access and mobility – Part 1: General requirements for access – New building work*

AS 1428.2 *Design for access and mobility – Part 2: Enhanced and additional requirements – Buildings and facilities*

AS 1668 (all parts) *The use of ventilation and airconditioning in buildings*

AS 1668.1 *The use of ventilation and airconditioning in buildings – Part 1: Fire and smoke control in buildings*

AS 1668.2 *The use of ventilation and airconditioning in buildings – Part 2: Mechanical ventilation in buildings*

AS 1768 *Lightning protection*

AS 4254.2 *Ductwork for air-handling systems in buildings – Part 2: Rigid duct*

AS/CA S009 *Installation requirements for customer cabling (Wiring Rules)*

AS/NZS 1158 (all parts) *Lighting for roads and public spaces*

AS/NZS 1170.2 *Structural design actions – Part 2: Wind actions*

AS/NZS 11801.1 *Information Technology – Generic cabling for customer premises – Part 1: General requirements (ISO/IEC 11801-1:2017, MOD)*

AS/NZS 1680 (all parts) *Interior and workplace lighting*

AS/NZS 2293 (all parts) *Emergency lighting and exit signs for buildings*

AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 3013 *Electrical installations – Classification of the fire and mechanical performance of wiring system elements*

AS/NZS 3500 (all parts) *Plumbing and drainage*

AS/NZS 3500.1 *Plumbing and drainage – Part 1: Water services*

AS/NZS 3500.2 *Plumbing and drainage – Part 2: Sanitary plumbing and drainage*

AS/NZS 3500.3 *Plumbing and drainage – Part 3: Stormwater drainage*

AS/NZS 3666 (all parts) *Air-handling and water systems of building – Microbial control*

AS/NZS 4282 *Control of the obtrusive effects of outdoor lighting*

AS/NZS 5149.1 *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Definitions, classification and selection criteria (ISO 5149-1:2014, MOD)*

AS/NZS 5149.2 *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation (ISO 5149-2:2014, MOD)*

AS/NZS 5149.3 *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site (ISO 5149-3:2014, MOD)*

AS/NZS ISO 817 *Refrigerants – Designation and safety classification*

Transport for NSW standards

TS 00008 (all parts) *Fire Life Safety*

TS 00008.1 *Fire Life Safety – Part 1: Principles*

TS 00008.2 *Fire Life Safety – Part 2: Stations*

TS 00026 *Ambient Environmental Conditions*

TS 00050 *Video Surveillance System Architecture*

TS 01452 (T MU AM 00002 GU) *Assurance and Governance Plan – Guidelines*

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

TS 01472 *Operational Concept Definition*

TS 01504 Asset *Assurance and Governance Plan Technical Requirements*

TS 01505 (T MU AM 01001 ST) *Life Cycle Costing*

TS 01506.1 *Development of Technical Maintenance Plans – Part 1: Development Process*

TS 01508 *Asset Handover Requirements*

TS 01510 (T MU AM 01008 ST) *Technical Maintenance Plans and Coding System*

TS 01515.1 *Asset Information – Part 1: Management of Asset Information*

TS 01516 (T MU AM 06009 ST) *Maintenance Concept Definition*

TS 01547.1 (T MU MD 00006 ST) *Engineering Drawings and CAD Requirements*

TS 03947 (T MU MD 21001 ST) *Equipment Rooms and Cubicles for Programmable Electronic Systems*

TS 03948 (T MU MD 81001 ST) *Common Requirements for Programmable Electronic Equipment*

TS 03954 *Low Voltage Electrical Installations*

TS 04935 (T HR SS 80001 ST) *Infrastructure Lighting*

TS 04936 (T HR SS 80003 ST) *Infrastructure Emergency Lighting*

TS 04951 (all parts) *Functional Spaces*

TS 04955.3 *Services, Systems and Equipment – Part 3: Lifts*

TS 04955.4 *Services, Systems and Equipment – Part 4: Escalators and Moving Walks*

TS 04982 (T MU MD 20002 ST) *Risk Criteria for Use by Organisations Providing Engineering Services*

TS 04989 *Public Transport Closed Circuit Television Functional Requirements Standard*

TS 04990 (T MU SY 10010 ST) *Cybersecurity for IACS – Overview*

TS 04991 (T MU SY 10012 ST) *Cybersecurity for IACS – Baseline Technical Cybersecurity System Requirements and Countermeasures*

TS 04992 *Surface Transport Fixed Infrastructure Physical Security Standard* (This document is not publicly available; to obtain access email standards@transport.nsw.gov.au)

TS 04993 (T MU SY 10013 PR) *Cybersecurity for IACS – Cyber Risk Management Procedure*

TS 05164 (SPG 0705) *Construction of Cable Routes and Signalling Civil Works*

TS 06206 (T MU TE 61005 ST) *Customer Information Systems for Public Transport Buildings and Conveyances*

TS 06207 (T MU TE 61006 ST) *Help Points*

TS 06210 (T MU TE 01001 ST) *Campus Backbone Telecommunication Routes and Cabling*

TS 06218 *Packet Switched Networks – Wired Networks*

TS 06219 *Radiocommunication in LIPD Class Licensed Bands*

TS 06220 *Packet Switched Networks – Wireless Local Area Networks*

TS 06305 *Application Guide to NSW Cyber Security Policy for Operational Technology*

Legislation

Security of Critical Infrastructure Act 2018 (Cth)

Other reference documents

ASHRAE 135 *BACnet – A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved)*

ASME Boiler and Pressure Vessel Code

Australian Building Codes Board, *National Construction Code*

Australian Building Codes Board, *National Construction Code, Volume One*

Australian Building Codes Board, *National Construction Code, Volume Three*

Commonwealth of Australia, Attorney-General's Department, *Protective Security Policy Framework – Securing government business: Protective security guidance for executives*

Communications Alliance Ltd, Industry Guideline G630:2020 *Accessibility of Payphones*

NSW Department of Planning, Industry and Environment, *Service and Installation Rules of New South Wales*

NSW Department of Planning and Environment, Environment and Heritage Group, *Section 170 State agency heritage and conservation register*

Transport for NSW, DMS-SD-081/4.0 *TfNSW Climate Risk Assessment Guidelines*

Transport for NSW, June 2013, *Transport Environment and Sustainability Management Policy Framework*

Transport for NSW, ST-114, *TfNSW Sustainable Design Guidelines,* Version 4.0

Transport for NSW, *Transport Sustainability Plan 2021*

4 Terms, definitions and abbreviations

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

access path a path that permits independent travel for all passengers within public transport premises, infrastructure or conveyances (Source: *Disability Standards for Accessible Public Transport 2002*)

AIRAH Australian Institute of Refrigeration, Air Conditioning and Heating

AHU air handling unit

AMB Asset Management Branch

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers

asset steward the entity given the responsibility by an asset custodian to oversee part of the life cycle process for an asset

asset steward – operate or maintain the entity responsible for the day to day operations and maintenance of assets once commissioned. May be a part of the asset custodian division or a separate entity. Operator and maintainer of the assets might be separate entities.

BMCS building management control system

CIBSE Chartered Institution of Building Services Engineers

COP coefficient of performance

Crown certifier an appropriately competent person who:

a. acts on behalf of the Crown to confirm Building Code of Australia compliance of building works under Clause 6.28 of the *Environmental Planning and Assessment Act 1979*

b. has been endorsed (approved) by the TAO that holds authorisation to issue Crown Certificates.

DB dry bulb

DDC direct digital controls

DX direct expansion

ECS environmental control system

EGOP emergency gate operation panel

ETS electronic ticketing system

fabric all physical material of the place including elements, fixtures, contents and objects (Source: Burra Charter)

facility a zonal area (within a precinct boundary) that contains buildings, systems, plant and associated infrastructure assets to support the operation and maintenance of transport services

FCU fan coil unit

HMI human machine interface

HVAC heating, ventilation and air conditioning

Note: HVAC is also referred to as environmental control system (ECS) within the metro environment.

IPLV integrated part load value

LV low voltage

MDF main distribution frame

NCC National Construction Code

PA public address system

PAC packaged air conditioning

PID passenger information display

PSD platform screen door

RCD residual current device

repair direct action taken to effect restoration (Source: IEC 60050-192); the actions restore (but do not enhance) the functionality of the item

SCADA supervisory control and data acquisition

SELV separated extra-low voltage system; as defined in AS/NZS 3000

SFAIRP so far as is reasonably practicable

TAO Technically Assured Organisation

TDEI total direct environmental impact

TfNSW Transport for NSW

UPS uninterruptible power supply

UTP unshielded twisted pair

5 Compliance framework

5.1 General

While compliance with legislative requirements always takes precedence, the order of priority of other compliance documents shall be as follows:

- TfNSW standards and processes specified in applicable TfNSW documents

- Australian standards not called out by legislation
- international standards where Australian standards do not provide sufficient guidance
- local industry and other national standards.

5.2 Requirements for new and existing installations

Upgrades, additions, or changes to existing installations shall comply with the following:

- repairs to an existing installation shall not degrade the compliance level of the repaired part or other parts of existing installation
- any alteration, addition to an existing installation or modification to part or parts of an installation shall be deemed to be a new installation, and all relevant provisions of this document shall apply.

The application of this document shall not degrade the compliance of the remaining unaltered parts of the existing installation.

Works performed shall maintain system operation and not diminish the performance, reliability or safety of the unaltered parts. Works performed shall not increase the risk profile of the existing or the combined (altered) installation.

Any upgrade or modification at an existing transport facility may be required to interface and integrate (or just coordinate) new and existing services and systems and existing or new infrastructure.

New installation that depends on existing infrastructure, services or systems to function in a compliant manner may necessitate upgrade of the existing infrastructure, services or systems. Such consequential work shall ensure that legacy issues affecting the new installation are thoroughly examined and unique needs of each transport facility are addressed in accordance with this document, so that the new installation is able to operate as intended.

Any new work to be certified in accordance with NCC shall be certified by an appropriate Crown certifier.

6 Functional outcomes

6.1 General

The services, systems and equipment within transport infrastructure shall achieve the outcomes specified in Section 6. In addition, legislation provides requirements for safe customer commute and safe operation of transport facilities.

6.2 Objectives

Services and systems at transport facilities shall achieve the following:

- protect property against adverse events such as fire, accidental or intentional damage including terrorism and vandalism
- facilitate quick recovery and continuity of ongoing operation both locally and network wide after an emergency (for example, an accident or a fire)
- promote sustainable and innovative solutions that appropriately mitigate and minimise any adverse societal and environmental impacts, including optimisation of energy use and application of energy conservation measures
- incorporate sufficient technical provisions for every new service or system installation so that management of normal and emergency operation can be executed from a single point (location) on the Transport network
- integrate new parts of services or systems installation with the relevant network-wide system.

Services and systems shall be selected to fulfil these objectives and be incorporated in transport facilities with regard to function, service location and its accommodation including connection to the infrastructure, network-wide integration and operation management.

6.3 Fitness for purpose

6.3.1 General

Services, systems, and equipment shall be fit for purpose as specified in the descriptions and processes.

Fail-safe principles shall be applied to the design of all services and systems except where fail-secure is required by the system design and specific functional outcome.

Where appropriate, services and systems related to digital and cyber security shall comply with the following:

- TS 04990
- TS 04991
- TS 04993
- TS 06305.

Additional cyber security requirements applicable to services, systems and equipment are set out in *Security of Critical Infrastructure Act 2018*.

All services and systems installations shall observe critical proximities, clearances, separation distances and safety precautions.

The equipment placement and performance characteristics of different services and systems shall be fully coordinated with the requirements of all other systems, trades, architectural features, building fabric and structural elements to ensure that the capabilities of individual system are not compromised.

Harmonic distortion and voltage levels in a rail network electricity system can be significantly higher than in a public service provider network. All equipment shall be designed and installed to operate properly in site-specific conditions.

6.3.2 Design life

The following general design service life periods shall be used for the design of the nominated services, systems and equipment unless a documented engineering assessment determines that the equipment has a lesser life cycle due to installation location:

Table 1 specifies the design life for services, systems and equipment used on the Transport network.

Table 1 – Design life of services and systems

Services and systems	Design life
Pumps, jockey pumps and pump control systems	25 years
Drainage elements that are not accessible	100 years
Drainage elements that are accessible for refurbishment	20 years
Drainage sump pumps and control systems	30 years
Electrical and mechanical fixed piping and wiring installation elements	35 years
Electrical and mechanical equipment not itemised separately in this table	20 years
Light fittings	18 years
Escalators and lifts equipment not listed in this table	20 years
Lift car assembly, doors, landing equipment, motors, drives and controller	20 years
Lift hoisting structural equipment, guide rails, roller guides, lift shaft equipment	25 years
Escalator truss, structural equipment	50 years
Escalator drive system, steps, step chain, controllers	30 years
Escalators control systems	30 years
Multi-user screens	5 years
Fans, ventilation and air-conditioning systems	15 years

Services and systems	Design life
Variable speed drives	8 years
LV switchboards, and electrical systems	35 years
Building services – central chilled water systems, plant and reticulation components	35 years
Tanks, and valves and accessible pipe systems	20 years
BMCS equipment – Software shall be open source and maintain equivalent service life as the BMCS as a minimum	20 years
Cabling, conduits and cable support systems	30 years
Public telephone operator communication systems, public information systems and security systems	20 years
Multi-user screens, IT equipment and general whitegoods	5 years
Ticketing system – structures, gantries, and other equipment structures not supplied by TfNSW	30 years
PSDs – glazing, frames, fixtures and fittings	30 years
UPS batteries, control batteries and battery chargers	7 years

The TAO or service provider shall provide documented evidence from an authoritative, reputable, professional and independent source confirming that the design life of the selected equipment will be achieved. Where the full duration of design life is unlikely be achieved, the expected life estimation together with considerations of available alternative options shall be provided.

6.4 Safety and security

Services and systems design, installation on site, physical security, operation and maintenance shall comply with TS 04992.

All installations shall be protected against accidental or intentional damage in proportion to the consequences of such adverse events on life safety, and safety and continuity of the service or system operation. Measures to prevent theft and vandalism, such as secure mounting or protection by placing out of reach, shall be implemented.

All equipment shall be protected against lightning and surges in accordance with AS 1768.

6.5 Safety-critical and operation-critical systems

Many of the services and systems support safety-critical and operation-critical functions necessary for continuity of transport operation either at a facility or network wide. The design, installation and operation of such systems shall ensure high levels of availability and reliability. The design, installation and operation shall include suitable, practical technical arrangements such as redundant equipment, redundant power supplies, redundant routes, secure

connections, fail-safe operation, and appropriate additional steps to minimise the possibility of unplanned outages.

The features of safety-critical and operation-critical systems shall include automatic notification of faults to a nominated control or management centre in accordance with the relevant maintenance and emergency management plan.

To ensure network-wide consistency, safety services and critical services equipment is subject to operator and maintainer acceptance and approval.

6.6 Equipment location and access

For positioning and location of services and systems equipment in the context of urban and transport facility design, refer to TS 04951 (all parts).

The location and orientation of equipment shall support equipment functionality and its correct operation and facilitate easy access. For example, hydrant valves should be oriented so that they can be easily accessed and not blocked by other features.

Unless specifically required by service-specific or system-specific functional requirements, services and systems equipment shall not be installed in areas accessible to the public. Equipment shall be mounted such that it does not impinge on circulation routes or create a hazard to facility users.

Unimpeded access to equipment for operational purposes, such as functional checks or meter reading, shall be provided. The unimpeded access shall complement the equipment functions and provide for ergonomic use of equipment. Service or containment shall not interfere with access to any equipment.

Services or systems shall be located in areas such that access to these services and systems does not interrupt transport services.

Maintenance access to all relevant equipment shall be provided at all times with machinery spaces being sized and arranged for safe inspection and maintenance activities.

6.7 Holistic asset management

6.7.1 General

Maintenance and replacement strategies shall be developed by the operator and maintainer.

An asset register of all services, systems and equipment shall be developed by the operator and maintainer. The asset register shall comply with TS 01515.1 and include all relevant technical information about each asset.

The scope of renewal, upgrade or improvement, and like-for-like replacement of existing assets shall be identified and defined well in advance, to ensure that the works are coordinated with the asset maintenance program's timeline.

6.7.2 Reliability, availability and maintainability

The TAO or service provider shall ensure that the required level of safety, fitness for purpose, and operational ease is optimally achieved over the life cycle of the considered service or system. Assets shall be maintainable to the extent required by the strategic asset management plan (SAMP) and the equipment asset management plan (AMP).

RAM considerations described in this section do not apply to type-approved equipment. The TAO or service provider shall ensure that the asset to be procured will not be phased out and confirm the manufacturer's support and availability of spare parts and replacement equipment until the end of the asset life cycle. The information detailing anticipated availability over time shall be included in the asset operation and maintenance manuals.

Safety services and critical services equipment shall be selected, installed and maintained to provide uninterrupted, reliable operation throughout its service life.

Services and equipment that are not classified as safety or critical may utilise standard commercial products.

The TAO or service provider responsible for asset construction shall provide an asset-specific technical maintenance plan for each asset before the asset handover.

6.7.3 Whole-of-life

A whole-of-life approach shall be adopted in the selection of all services, systems and equipment. In addition to compliance assessment of relevant technical aspects, final selection of all systems and equipment shall take into account the construction, installation, operation, maintenance, decommissioning and end-of-life disposal costs using a life cycle analysis and costing process in accordance with TS 01505.

6.7.4 Equipment standardisation

Equipment and accessories used on the transport network should achieve a degree of standardisation and consistency throughout the network and optimise stock levels of spare parts.

The provision of building services systems shall incorporate:

- design for manufacture and assembly (DfMA) principles

- multiservice supports, brackets and trapezes where individual provisions would cause congestion
- prefabricated service modules to reduce site installation time where economically viable.

6.7.5 Maintenance strategies

Maintenance strategies shall ensure safety, integrity, acceptable condition and operating functions of services, systems and equipment to achieve their prescribed function and design life.

Maintenance strategies shall be in accordance with TS 01506.1, TS 01510 and TS 01515.1.

As a minimum, the maintenance strategies shall address the following:

- safety procedures
- key personnel authority and roles, minimum skill levels of each role and interfaces with overall organisation structures
- provision of operation and maintenance manuals
- description of location, functions and operating instructions for services, systems and equipment
- operating guidelines of services, systems and equipment
- working description of services, systems and equipment
- technical procedures to be used during specific maintenance activities
- shutdowns, abnormal operation, fault finding and recovery after a failure
- details of utilities critical to operation
- spare equipment and parts
- duty and standby arrangements.

The maintenance strategy shall take into account the criticality of the operating system and emergency systems.

The maintenance strategies shall include spare equipment and parts provision inclusive of the type, range and quantity of spares required to be available at any time to efficiently maintain the services, systems and equipment to meet prescribed availability requirements. As a minimum, spares provisions strategy shall include the following:

- predicted failure rates and usage rates
- number of items installed in the service, system or equipment
- nomination of equipment and spare parts to be procured and kept onsite

- identification of long-lead time items (greater than one month)
- price and ordering information.

6.7.6 Renewal, upgrade or improvement strategies

Renewal, upgrade or improvement strategies for services, systems and equipment shall be based on a systematic review of asset relevant data including, but not limited to, the following:

- initial estimation of the asset remaining life based on asset current chronological age compared with asset stated design life at the time of asset installation
- evaluation of safety aspects and anticipated deterioration over time
- assessment of asset current maintenance strategy and investigations as to if and how the asset useful life could be extended; the assessment shall include an investigation if efficiency level of the asset maintenance program can be raised
- asset detailed condition assessment including identifiable safety concerns, operational readiness and RAM
- the return-on-investment calculation reflecting the total cost of ownership of a possible upgrade against identified alternatives, to include capital expenditure, installation, operating costs, maintenance, and any other service requirements that have bearing on the cost.

6.7.7 Like-for-like replacement strategy

Like-for-like equipment replacement is defined as removal of all or any portion of the equipment as applicable, and replacing with the same or comparable equipment, as determined and approved by the operator and maintainer based on professional and business judgment.

Any renewal or equipment replacement that triggers or causes the following, shall not be deemed as like-for-like:

- increase in the level of risk
- change in regulatory compliance status, or the need to fulfil additional regulatory requirements for either the equipment replacement or other parts of the installation
- modifications to the related parts of the installation to ensure technical compatibility, or compliance with current standards
- any additional or consequential work needed to accommodate the equipment replacement
- change in the structural loading or increase in space required to accommodate equipment replacement
- an increase in energy consumption or an additional burden on the environment
- loss of amenity, loss of visual appeal, or decrease in commuter experience.

6.8 Environment and sustainability

Services, systems and equipment shall be designed, constructed and operated to satisfy community expectations and align with the eight focus areas outlined in TfNSW, *Transport Sustainability Plan 2021*. This is to avoid, minimise or mitigate adverse environmental, social and financial impacts. The eight sustainability focus areas are as follows:

- respond to climate change
- protect and enhance biodiversity
- improve environmental outcomes
- procure responsibly
- partner with communities
- respect culture and heritage
- align spend and impact
- empower customers to make sustainable choices.

Legislative requirements relating to environment and sustainability also apply to the provision of services, systems and equipment in transport facilities.

TfNSW *Transport Environment and Sustainability Management Policy Framework* identifies requirements describing minimum outcomes that shall be achieved by TfNSW and external delivery partners when undertaking activities for TfNSW during the entire asset life cycle.

The design of assets, services and systems shall ensure the following:

- Equipment and related construction are appropriate for climatic conditions in which the equipment operates and future predicted climatic conditions within the life of the asset. The climatic conditions include, but are not limited to, temperature extremes, excessive humidity and water ingress due to wind driven rain. Refer to TS 00026 for more information. Equipment and its components shall operate safely within the specified range of ambient conditions (temperature and humidity limits) without any adverse effects including brittleness, undue expansion or contraction, softening, melting or decomposition.
- Equipment and related construction are appropriate for other (non-climate related) environmental conditions in which the equipment operates with inbuilt protection against vibration and dust ingress. Equipment grouping, placement, and mounting shall be arranged to prevent vibration transfer.
- Equipment and metallic construction are protected against galvanic corrosion and stray currents.

- Noise pollution is controlled within acceptable limit for specific location within a facility. Equipment-generated noise shall not exceed limits permitted by Australian standards and local authorities' requirements.
- All transport assets that form part of a transport facility are designed and built to reduce resource consumption including energy and water. Refer to *TfNSW Sustainable Design Guidelines* for information.

All materials used in equipment components shall be suitable for the site-specific location the equipment is installed in. They shall:

- be resistant to corrosion, oxidation, rotting, and adverse effects caused by insects
- be resistant to chemicals such as acid, alkali, salts, oils, hydrocarbons, alcohol and detergents
- be manufactured to avoid premature aging; for example, only UV stabilised materials shall be employed in equipment exposed to UV radiation
- not absorb or retain water.

PVC materials shall not be utilised in enclosed public-accessible spaces.

The impacts from climate change pose a significant risk to transport assets and the communities Transport serves. The design of services and systems shall analyse these risks and include appropriate mitigation and adaptation methodologies, using *TfNSW Climate Risk Assessment Guidelines*. Equipment, materials, and related construction choices shall be selected through cradle to grave analysis (including the end-of-life recyclability) to minimise adverse environmental impacts.

6.9 Heritage

6.9.1 Services and systems principles

The following principles shall be adopted for planning, design, and construction of services and systems in a heritage place or item:

- When working in or around heritage buildings or infrastructure a full dilapidation survey shall be undertaken prior to works beginning to accurately record the condition of the asset.
- The legal protection of heritage shall be incorporated into due diligence when maintaining or proposing change to a transport place or building.
- The documented heritage significance of the heritage place or item shall be used to determine the scope, design, and planning process for installing or maintaining, or modifying services installations.

- Any proposed changes shall be sympathetic to the heritage place or item and its identified heritage significance, in respect of context, curtilage, built form, space, bulk, scale, footprint, materials, finishes, colour, detailing and the like.
- Heritage fabric shall not be damaged, relocated, demolished or otherwise impacted as a result of works to install, maintain or modify service installations. Where required works will impact heritage infrastructure, heritage assessments shall be undertaken to assess the impact. Works on heritage assets shall not progress before a heritage assessment has been undertaken and the works are determined as acceptable.
- In situations where impacts to heritage fabric are unavoidable, works shall seek to mitigate impacts by balancing heritage significance with legislative requirements, functional outcomes, future asset maintenance, and reversibility.
- Legislative processes exist to assess potential impacts to heritage significance. Works shall not be permitted to commence until required approvals are obtained.
- Services and systems design shall be carried out by relevant technical specialists. A competent heritage professional shall provide direction for services and systems design and installation within the heritage structures.
- Change to heritage fabric shall be documented and recorded in an approved TfNSW asset management system.
- When an inadvertent damage occurs to heritage fabric from approved works including the decommissioning process, or any works that cause undue damages, it shall be repaired to match the existing heritage fabric, in respect of material, colour, texture, finish, size, shape, pattern and profile.

  Such works shall be contained to be within the limits of intervention imposed by relevant organisational exemptions. Relevant exemptions in legislation also apply. Where an exemption requires prior heritage approval or where the work involves an effective repair that exceeds the scope of the exemption, then approvals shall be obtained before the work is undertaken.
- At the completion of a services installation, a record of change shall be provided to the relevant Section 170 heritage and conservation register custodian, and form part of the approved asset management record in an approved TfNSW asset management system.
- A competent heritage professional, acting on behalf of the asset owner, shall confirm that works have been carried out in accordance with all legislative approvals.

6.9.2 Equipment principles

The following principles shall be adopted for equipment in a heritage place or item:

- Equipment and its installation shall comply with the design requirements including requirements for operational and maintenance access and circulation, and manufacturers' recommendations. Where an individual space size is not functionally adequate to accommodate necessary equipment, alternative locations shall be explored within the precinct to provide adequate space to accommodate services and systems equipment. Where proposed design requires ventilation, heating, cooling, or dust-free environments, the means of installation and maintenance, and the size of fans, units, ducting and the like shall be addressed with regards to heritage fabric appropriateness, during the consideration of options, with examples assessed by a competent heritage professional.
- Where possible, equipment including control systems, telecommunications equipment racks or rail mounts shall not be fixed to heritage fabric, including walls, floors, ceilings and awnings.
- Equipment shall sit proud of existing walls with adequate ventilation space to be operable in passive climatic conditions.
- All services and systems routes including power, control, and telecommunications wiring as well as piped infrastructure shall be designed and installed to present the least possible impact to heritage fabric. Legislative requirements also apply.

6.9.3 Fire

The following principles for fire detection and suppression in a heritage place or item shall be adhered to:

- Where applicable, fire engineered solutions and fire safety measures (active and passive) shall minimise impact to the heritage fabric, SFAIRP.
- Rooms containing batteries shall be fire separated from the rest of the building. Refer to NCC for additional requirements.

6.9.4 Impacts to heritage fabric

The following principles shall be adopted for impacts to heritage fabric in a heritage place or item:

- Existing penetrations to heritage fabric shall be re-used where logical to do so. Incompatible materials shall be avoided (such as fillers, sealants, coatings, or mortars that are not suitable to the heritage fabric being conserved).

- Penetrations into other heritage fabric shall be minimal and located such that they are concealed from view.
- Penetrations shall not be made to heritage plaster ceilings without robust justification. The justification shall demonstrate that a variety of options have been considered, reasons for the options selected, and concurrence from a competent heritage professional.
- Any penetrations to building fabric shall be neatly sealed to prevent pest and water ingress, and fire and smoke spread.

6.9.5 Trenching

The following principles shall be adopted for trenching in a heritage place or item:

- Trenching to surfaces for new cabling connections shall be avoided, to minimise disturbances to existing surface finishes.
- Where necessary, new trenching shall be located beyond the finished surfaces.
- Damaged surfaces shall be repaired to match existing surface finishes.

6.9.6 Conduits and cabling

The following principles shall be adopted for conduits and cabling in a heritage place or item:

- New conduits shall only be installed when the existing conduit is not able to be used or modified for use. Conduits shall be concealed from view. Conduits shall not be surface-mounted in publicly accessible locations.
- New conduits shall be finished in a colour (integral or applied) that is visually consistent with the dominant existing surface colour, except in cases where a predetermined colour is required.
- Conduits shall be re-enterable to allow for future re-use. Cables shall be installed within conduits or cable trays as applicable. Conduits or cables shall not be chased into heritage fabric.

6.10 Building management and control system

BMCS shall utilise an open technology platform utilising a software package and graphical user interface that allows operators to monitor, diagnose, control, alarm and manage equipment and engineering systems locally and remotely through TfNSW operational critical data network using approved IP-enabled protocols.

BMCS devices and subsystems shall be compatible with the building automation and controls network in accordance with ASHRAE 135.

System vendor-offering package, configuration, and BMCS detailed design shall be subject to operator and maintainer approval during initial design stage.

7 Engineering outcomes

7.1 General

Services, systems and equipment engineering requirements aim at ensuring that processes related to a service or system conception, design, construction, operation, maintenance and eventual disposal at the end of its life result in the following, without compromising on functional performance or engineering outcomes:

- appropriate technical solutions
- optimum performance of services and systems during operation
- conscientious use of resources, all measured and optimised against predicted life cycle costs.

The desired outcomes are expressed through a mix of performance and prescriptive requirements.

7.2 Safety-critical and operation-critical systems

Incoming power supply to safety services shall be arranged in accordance with AS/NZS 3000.

Incoming power supply to operation-critical services and systems shall be derived from part of the transport facility installation that provides power to safety services, using appropriately labelled, dedicated switching.

For all safety-critical and operation-critical systems, their equipment, wiring (power, control, telecommunications), piping, containment and supporting infrastructure shall be routed to minimise the risk of vandalism and accidental or intentional damage SFAIRP.

7.3 Service and infrastructure routes

Service and infrastructure routes shall be selected and coordinated during the design and construction phases.

Security requirements for cabling and routes shall comply with TS 04992. Secure connections, crossovers and junctions with major trunk services shall be achieved. Where necessary, service and infrastructure routes shall be redundant, segregated and separated from each other to decrease the risk of multiple systems failures. These services routes shall be defined early in the design process in order that the structures and walls required to support loads and accommodate fixings are established sufficiently early to allow adequate capability. Support systems used shall have been fire tested to the requirements of the NCC. Duct systems and

tray systems shall be arranged so as to not prevent services below from being supported by the structure above or adjacent walls.

Pipes, ducts, cables, containment systems such as trays, trunking and conduit for all services shall be run within designated service routes, segregated and separated from each other to decrease the risk of multiple failures.

Cabled services and piped services shall comply with the following requirements:

- Cabled services – All wiring shall be installed in an approved wiring containment. Refer to TS 00008 (all parts) for fire life safety requirements related to mechanical and environmental protection, containment type and cabling including specific fire rating, low smoke zero halogen and flame-retardant properties.
- Piped services – Piped services shall be routed to facilitate easy access for inspection and maintenance. Cleaning and rodding points shall be provided in locations enabling maintenance access and servicing.

  Piped services running above equipment susceptible to water damage and cabled services shall be avoided.

7.4 Equipment considerations

Space economy shall be achieved while maintaining room for future system expansion, and ease of access for maintenance and renewal.

Equipment shall be fixed in a way that mounting brackets and building structure adequately support the weight and withstand the vertical and lateral forces generated during operation including meeting the seismic importance levels determined for the building.

Brackets and supports shall be secured to concrete/blockwork walls and utilise tested solutions for those services and systems required to perform during fire condition. The coordination of the services shall not remove the ability for any single discipline to obtain support from the primary structure.

Locations of floor-mounted fixings and supports shall be coordinated with the facility structural grid and planning modules. Fixing arrangements for freestanding equipment shall be located within the floor screed zone and be fully concealed beneath the floor finishes.

Appropriate steps shall be taken to support equipment, piping and ductwork to prevent vibration transfer. Vibration isolators shall be selected for each application to provide required attenuation and follow recommendations of equipment manufacturer. All pipework and conduit connections to equipment shall be arranged so that distortion, vibration or fatigue does not occur.

The placement of services and systems components shall ensure a 2.5 m clearance from any metal structure that can become electrified.

Suspended equipment shall be mounted for its lowest part to be at least 2.4 m above finished floor level. Where appropriate, equipment shall be protected against bird nesting.

Exposed containment in public areas installed between the floor level and 2.4 m above the finished floor level shall be vandal proof, with minimum level of protection against mechanical impact in accordance with AS/NZS 3013.

Equipment and their enclosures shall provide adequate environmental protection appropriate to the location, as well as rodent and vermin proofing. Equipment and their enclosures shall be protected against corrosion. Protection against galvanic (dissimilar metals) corrosion shall be provided where necessary.

7.5 Heating, ventilation and air conditioning

7.5.1 General

The purpose of HVAC is to provide a controlled, comfortable indoor environment for equipment, customers and staff by maintaining environmental conditions within specified ranges.

HVAC installations shall comply with AS 1668 (all parts) and all other relevant AS/NZS standards. Refer to *NCC, Volume One* for additional requirements. Air-conditioning systems comprising cooling towers shall be in accordance with AS/NZS 3666 (all parts).

7.5.2 HVAC design

7.5.2.1 General

HVAC design shall comply with relevant Australian standards. The HVAC design process shall comply with AIRAH, ASHRAE and CIBSE approved methodologies.

Energy efficiency shall meet the requirements of TfNSW *Sustainable Design Guidelines* with specific reference to compulsory requirements. All indoor transient spaces within publicly accessible areas shall be designed, constructed and operated to provide acceptable levels of indoor comfort (temperature, humidity, drafts and air quality).

The choice of the HVAC system shall depend on specific design criteria to be met including indoor temperature, humidity, air change rate and outside air supply, and required air quality. Spare space allowance or strategy shall be documented for future expansion for the installation of additional plant, to minimise disruption to operations. The HVAC/ECS shall have a minimum of 15% spare capacity, including heating, cooling, and ventilation capacity for all systems except stair pressurisation systems, stair pressurisation relief systems, smoke exhaust systems, and public area cooling and ventilation systems as measured against HVAC/ECS peak hours operations (coincident rooms operating) and the respective design conditions.

Where included as part of fire response strategy, ventilation and air conditioning shall interface and integrate with fire services systems for smoke management.

Thermal zoning and design load calculations shall be based on accurate information regarding external and internal loads, full- and part-load performance requirements, fresh air requirements, and air-conditioning duct system efficiency.

Thermal zoning and load calculations shall take the following into account:

- space size
- layout and function
- number of occupants
- variables such as passenger flow rates
- solar load, equipment loads
- structural materials and their heat transmission properties
- building envelope properties and performance including insulation levels, fenestration, envelope tightness, and so on
- air volume movements caused by trains moving through the spaces.

The HVAC design shall be aided by industry-recognised software and performed by competent personnel The HVAC design shall be appropriately documented for review, audit and stakeholders' approval.

7.5.2.2 Occupied spaces

Air-conditioning systems shall be provided to permanently occupied spaces. Air-conditioning systems shall be designed to provide comfort internal conditions of 22.5ºC DB ±2ºC DB for summer and 21.5ºC DB ±2ºC DB for winter.

The summer design ambient temperature and humidity conditions shall be based on the values that equal or exceed the top 0.4% of total hours in a year at that location, based on a 30-year average. In addition, an allowance of 1ºC shall be added to the ambient summer DB and wet bulb temperatures used in air-conditioning cooling load calculations for the probable effects of climate change.

The winter design ambient conditions shall be based on 10th percentile winter DB temperature based on observations for the last 30 years applicable to the location.

Air-conditioning systems shall be designed to maintain space humidity below 60% by virtue of the cooling coil. Humidity control shall be maintained when air-conditioning systems operate at part-load or when variable air volume systems operate at a turn-down flow rate.

Demand control ventilation should be used in areas that have varying and high occupancy loads during the occupied periods.

In transient public spaces, ventilation or air-conditioning systems, or both, shall mitigate elevated temperatures and provide the sensation of improved thermal comfort. Thermal comfort shall be assessed using the methodology in ANSI/ASHRAE Standard 55. Internal temperatures shall be within 80% acceptability limits of ANSI/ASHRAE Standard 55.

Heating of transport facility public spaces is normally not necessary. The TAO or service provider shall evaluate the need for heating of public spaces in areas where low temperatures persist in winter, such as the Blue Mountains. The evaluation result and resulting recommendation shall be approved by the operator and maintainer and stakeholders.

7.5.2.3 Technical spaces

Air conditioning shall be provided to all spaces where controlled environmental conditions are required for correct operation of equipment, typically within partially enclosed and fully enclosed structures.

Plant rooms, critical plant and equipment rooms (including mechanical plant and electronic and communication rooms), air conditioning and ventilation systems shall be designed to meet environmental conditions specified by equipment manufacturers.

Air conditioning shall be provided in plant rooms if ventilation alone is not sufficient to maintain the space temperature within equipment manufacturers' recommendations. Ventilation and air-conditioning systems for these spaces shall be provided with a backup system. Such systems shall be monitored and operate on a lead-lag arrangement.

For critical equipment rooms, the summer design ambient conditions shall be based on 98th percentile DB temperatures from data of the hottest months for the last 30 years.

TS 03947 contains environmental requirements for equipment rooms or cubicles.

The following technical spaces are typically provided with mechanical ventilation:

- mechanical plant rooms including pump rooms
- electrical switch rooms, transformer rooms, battery rooms
- lift shafts and lift motor rooms.

Ventilation systems serving technical spaces shall be separate to ventilation systems serving occupied spaces. The ventilation of technical spaces shall maintain consistent positive pressure to mitigate against dust ingress.

7.5.2.4 Mechanical equipment and accessories

HVAC equipment shall be positioned such that it does not interfere with any existing equipment or hinder safe access. Proposed locations of air-conditioning units shall be submitted for approval along with the methodology of proposed work prior to commencing any work on site.

Equipment installed at sites accessible to public shall be protected with high quality metal lockable robust and vandal resistant enclosures.

All mechanical equipment and accessories shall be of premium quality in relation to design, manufacture and installation, procured from reputable manufacturers and with assurance provided through product rating data and product certification.

All necessary equipment shall be furnished with safety devices. The safety devices shall include guards on belt drives, electrical interlocking of motor control circuits, motor overload protection warning lights and alarms.

All equipment and ancillaries shall be installed with sufficient clearance space around for maintenance, access, repairs, removal and reinstatement. Access systems for maintenance and inspection shall be addressed early during design. Where HVAC plant entails the planned movement of maintenance personnel and equipment but there is an inability to use portable access equipment, permanent access shall be provided, for example, permanent ladders, gantries, walkways, handrails and similar.

Air-conditioning units shall be located to limit mechanical noise in occupied spaces. Attenuation of the noise associated with the supply or return air, or both, may also be required. The impact on fan energy consumption shall be assessed and compensated for in duct or fan components.

Rigid ductwork in accordance with AS 4254.2 shall be used for main branches. Ductwork should be as direct as possible, minimising the number of elbows and transitions, with long-radius bends used wherever possible. All equipment and associated installation exposed to weather shall be selected, installed and connected to withstand the prevailing environmental conditions at the location, throughout the life of the installation. All air-conditioning ductwork and chilled water pipework shall be insulated in line with the location climate zone requirements. Additional protective covers may be required, subject to relevant manufacturer’s recommendations.

All equipment subject to wind exposure (for example, rooftop), shall be anchored securely onto load bearing structures with additional guy wires if necessary for secure fixing.

The equipment shall be provided with permanently fixed manufacturer’s identification plates. The identification plates shall contain details of machine capacity, model number and serial number. Identification plates shall be accessible for visual inspection after the equipment is installed in position.

7.5.3 Refrigerants

All HVAC and refrigeration equipment shall use no flame propagation, lower toxicity refrigerants designated as class A1 in accordance with AS/NZS ISO 817. The use of other refrigerants, for example flammable refrigerants (including pre-charge for delivery) or any other ozone depleting refrigerants, shall not be permitted. System refrigerant volumes shall not exceed the quantities detailed in AS/NZS ISO 817 as required for the volumes of the rooms they are serving.

Refrigerants shall be based on one of the following criteria:

1. the calculated TDEI of the refrigerant systems is less than 15, or
2. all refrigerants have an ozone depletion potential (ODP) of zero, and a global warming potential (GWP) of 10 or less, or
3. where it can be demonstrated that specific equipment (split systems) is only available on a market with refrigerant non-compliant with 1) or 2), then a calculated TDEI of the refrigerant systems of between 15 and 35 is permissible.

The system TDEI described in 1) and 2) above shall be calculated. Systems shall not use chlorofluorocarbon and hydrochlorofluorocarbon refrigerants, nor refrigerants which are toxic or explosive, other than as classified in accordance with AS/NZS ISO 817.

Ventilation shall be provided to mitigate refrigerant build up in rooms containing condensers or chillers in accordance with AS/NZS 5149.1, AS/NZS 5149.2 and AS/NZS 5149.3.

7.5.4 Air quality

7.5.4.1 Indoor air quality

The indoor pollutant levels while public spaces are occupied shall not exceed the values in Table 2 in the breathing zone (between 900 mm and 1800 mm above the floor level).

Table 2 – Indoor air pollutant levels

Air pollutant	Value
Carbon dioxide (CO_2)	700 ppm
Carbon monoxide (CO)	9 ppm
Nitrogen dioxide (NO_2)	0.053 ppm
Fine particulates PM2.5	15 ug/m^3
Coarse particulates PM10	150 ug/m^3
Ozone (O_3)	0.08 ppm

As conditions can vary, the TAO or service provider shall assess each public space and nominate specific design measures to alleviate indoor pollution, including elaboration of compliance and assurance methodology for the operator and maintainer to follow during operation of the facility.

7.5.4.2 Outside air

Outside air shall be provided for general ventilation of occupied spaces in accordance with AS 1668.2 and this document.

Air-conditioning systems serving occupied areas shall provide outside air to satisfy the area occupancy level. The outside air may mix with return air at the appropriate rate. Outside air supply shall have a means of modulation to account for unoccupied periods except during an economiser cycle.

In indoor transient spaces within area accessible to public, the provision of outside air shall be 50% more than the requirements in AS 1668.2.

Each ventilation system that supplies outside air to occupied spaces shall have particle filters with minimum efficiency reporting value (MERV) of 13 or higher in accordance with ANSI/ASHRAE Standard 52.2. The air filtration media shall be replaced after construction is completed and before building occupation commences.

In fire mode the ventilation system operation shall be automatic and tailored to the requirements of smoke management determined by a fire engineered solution for the transport facility.

7.5.4.3 Cross contamination prevention

The leakage of conditioned air and infiltration of unconditioned air into conditioned spaces should be minimised.

Spaces where hazardous gasses or chemicals might be present (for example, garbage room) shall be equipped with exhaust systems creating sufficient negative pressure with respect to adjacent spaces when the doors to the room are closed. Such rooms shall be equipped with self-closing doors, and solid ceiling and walls.

Smoking inside transport facilities is prohibited. Designated smoking areas shall not be located within 10 m from all entries, operable windows or outside air intakes.

7.5.4.4 Biological contamination prevention

All new and like-for-like replacement HVAC systems serving publicly accessible indoor spaces shall be designed to mitigate against the spread and circulation of pathogens, viruses and bacteria. The TAO or service provider shall select appropriate ventilation methods to provide directional airflow through the space to avoid stagnation. Sufficient provision of outside air flow rates shall be applied to ensure that the ventilation system is able to adequately dilute concentrations of air-borne viruses and bacteria.

Such ventilation methods shall require outside air quantities more than the minimum prescribed in Section 7.5.4.2. In addition, return air systems may be equipped with air-cleaning technologies, such as UV irradiation, electrostatic precipitation, high efficiency filters, and so on.

The TAO or service provider shall assess the application for such return air treatment on a case-by-case basis. Where water-cooled systems are used, the systems shall be designed to avoid the risk of Legionella bacteria contamination in accordance with AS/NZS 3666 (all parts).

7.5.5 Air pressurisation

Air pressurisation systems and air pressurisation relief systems shall be provided to emergency egress stairs, emergency corridors and fire isolated compartments in accordance with AS 1668.1 and or fire engineering design.

Technical spaces and lift shafts shall be equipped with air pressurisation systems designed to prevent ingress of dust.

7.5.6 Mechanical plant

7.5.6.1 General

The selection of mechanical services equipment shall take into account the environment in which it is installed (for example, rail, wharves, tunnels and so on) and be capable of 24/7 operation. Commercial or industrial grade air-conditioning systems shall be installed. Residential air-conditioning systems shall not be used.

All equipment and installations shall be covered by a manufacturer's warranty from the date of the practical completion. Any equipment which proves to be defective shall be renewed at no cost.

Mechanical plant equipment shall be provided with factory accepted tested certification.

7.5.6.2 Chillers

7.5.6.2.1 General

Chillers shall be of proven design, in current production, factory assembled and tested by approved specialist manufacturers. The performance shall be certified to meet the specified performance requirements under operating conditions. Equipment shall comply with relevant Australian standards.

Chillers shall include a centrifugal oil-free compressor (or approved equal) with magnetic levitation bearings, electric motors, drive trains, air-cooled condenser, flooded shell and tube evaporator, control panels and the necessary controls, auxiliary equipment and safety devices for unattended automatic operation. The compressor shall be of variable speed and capable of modulating to low load conditions while maintaining high efficiency.

Coils shall be treated with factory applied anti-corrosion coating to protect against sea air (where located within proximity of the sea) and other contaminants. Galvanised wire mesh guards or approved equal shall be fitted where necessary to prevent accidental contact with moving parts and to protect condenser coils.

Chiller frame, cabinet, joints and other metal parts shall be treated with anti-corrosion coating to protect against sea air (where located within proximity of the sea), other contaminants and wet weather.

Motors shall be of squirrel cage induction type with adequate power for operation at a saturated condensing pressure of 5°C above scheduled load conditions. Motors shall have six terminals to permit reduced voltage starting and connecting links for conversion to three wire connections. Thermistors shall be installed in each motor winding. Open compressor motor air intakes and outlets shall be fitted with attenuators.

All condenser fans shall be of variable speed and deliver the rated air quantity against the resistance of the air intake. The discharge system shall be constructed from corrosion resistant materials. The fans shall be balanced for vibration free operation. Fan motors shall be weatherproofed, have built-in thermal protection and be resiliently mounted. Bearings shall be of sealed ball bearings. Fans shall be of the propeller type or axial air-foil type.

Evaporators shall be of the flooded shell and tube type using enhanced surface finned copper tubes. Evaporators shall be designed and constructed in accordance with either ASME or AS 1210 pressure vessel codes for a refrigerant side working pressure of 1320 kPa and a maximum waterside working pressure of 1000 kPa. The design shall be approved by the statutory authority and a licensed boiler inspector. The evaporator shall be insulated. The insulation shall be protected from damage by metal sheathing.

Chillers shall be provided with a rupture disc and automatically reseating pressure relief valve for relief of excess refrigerant pressure in flooded chillers. Chillers shall be provided with a pressure gauge in the pipe between the disc and the relief valve and a pressure switch wired to operate an audible alarm if the pressure rises significantly above atmospheric pressure. Chiller shall be provided with a means of relieving the pressure between the disc and the valve. The discharge of the pressure relief valve shall be piped to outdoors.

Each chiller shall be equipped with all necessary circuit breakers, starters, contactors, operating and safety controls to form a complete operating package. Controls and electrical equipment shall be factory wired and installed in a unit mounted control panel. The chiller shall operate automatically when it receives a signal to start through the closing of a chilled water flow switch.

Condensate drain lines shall run to the nearest sanitary point with airlock as specified in AS/NZS 3500.1. Traps not automatically recharged shall be provided with a trap priming device. Drain lines running to stormwater shall not be used.

7.5.6.2.2 Chiller and cooling equipment requirements

Chillers with capacities greater than 350 kW shall comply with the minimum energy performance standards (MEPS).

Chillers with capacities less than 350 kW shall comply with NCC requirements.

For water-cooled chillers:

- the minimum COP shall be 4.2 and
- the minimum IPLV shall be 5.2.

For air-cooled chillers:

- the minimum COP shall be 2.5 and
- the minimum IPLV shall be 3.4.

Dual water-cooled chillers shall be provided with circulation pumps and condenser water plant all arranged in a parallel configuration. Single point of failure impacts shall be mitigated with isolation valves.

Water-cooled chiller's heat rejection plant shall be open circuit type cooling towers. Hybrid cooling towers shall be used where the plant room space is constrained.

7.5.6.2.3 Open circuit cooling towers

Make-up water shall be provided to replace the water at evaporating rates. Three hours of make-up water storage tank shall be provided.

7.5.6.2.4 Air-cooled chillers

Dual air-cooled chillers shall be provided in parallel with dedicated pumps with heat rejection integrated into the chillers. Single point of failure impacts shall be mitigated with isolation valves.

7.5.6.2.5 Air-cooled chillers with evaporative pads

Chillers with evaporative pads used to pre-cool the air entering the air-cooled chillers, thus increasing chiller efficiency, shall be used where climates are favourable.

Where provided, three hours back-up water tank shall be incorporated where the chillers depend on the evaporative pads to maintain peak design cooling capacity during loss of water supply.

7.5.6.2.6 Variable refrigerant flow condensing units

Variable refrigerant flow (VRF) air-conditioning systems shall be used to serve smaller cooling loads where centralised systems are not available for use.

7.5.6.3 Air handling and fan coil units

AHU and FCU equipment shall be designed for horizontal or vertical air flow.

The panels shall be 50 mm thick double wall type with injected chlorofluorocarbon-free polyurethane foam insulation for a rigid non-vibrating construction. The outer panel wall shall be painted with baked polyester powder paint that is resistant to scratch and nicks and allows for easy cleaning.

The inner wall should be galvanised steel.

The paint shall be UV resistant and weather resistant for outdoor application.

Chilled and hot water coils shall be of the type suitable for the application. Each coil shall be constructed of copper tubes expanded into aluminium plate type fins to provide a firm mechanical bond between the fins and the tube. Each coil shall be factory tested to a pressure of 2000 kPa. Each coil shall be fixed and supported within the unit casing so as to be easily withdrawn from the casing. Coil fins shall be corrosion resistant (where located in coastal areas) using anti-corrosive material coatings such as Blygold or Blue Fin.

AHUs and FCUs shall be sized to accommodate filters and filtration requirements detailed in Section 7.5.4.2.

Access shall be provided to each section of the plant for inspection and maintenance purposes.

Units shall be constructed to eliminate the transmission of mechanical vibration.

Condensate drain lines shall run to the nearest sanitary point with airlock or trap as specified in AS/NZS 3500.1. Traps not automatically recharged shall be provided with a trap priming device Drain lines running to stormwater shall not be used.

7.5.6.4 Split air-conditioning units

7.5.6.4.1 General

DX split air-conditioning units shall be provided with indoor units, complete with decorative casing, replaceable filters, outdoor condensing sections, interconnecting refrigeration piping, insulation sufficient to prevent condensation, and electronic operating and safety controls. Indoor units shall be sufficiently sized to provide design outside air rates and filters sized to satisfy filtration requirements detailed in Section 7.5.4.2.

Ceiling cassette units are suitable only for small office-type spaces. Ceiling cassette units shall be provided with only the face plates visible within the rooms. The cassette units shall be sufficiently sized to incorporate outside air kits to satisfy occupancy of the space.

Condensing units shall consist of air-cooled refrigerant condenser, liquid receiver, compressor, hot gas muffler and associated piping, controls, and electrical connections, mounted within an acoustic casing on a fabricated steel base frame. The construction of condensing units shall be weatherproof and corrosion resistant.

Condensate drain lines shall run to the nearest sanitary point with airlock or trap as specified in AS/NZS 3500.1. Traps not automatically recharged shall be provided with a trap priming device. Drain lines running to stormwater shall not be used.

7.5.6.4.2 Packaged or split type direct expansion air-conditioning units

PAC units shall be provided as either a duty-only or duty-standby configuration as required to satisfy the criticality of the room.

PAC units shall be provided on the roof and serve rooms below via reticulated supply and return air ductwork.

Where rooms are not accessible to the roof plant (for example, below ground), standalone split-type DX air conditioning units shall be provided that comprise a separate air-cooled condenser unit located externally and an indoor FCU located with a plant connected by refrigeration pipework.

PAC units and split-type air conditioning units shall be used for sites with low total cooling load that do not warrant a full centralised chilled water plant or split system.

7.5.6.5 Packaged air-conditioning units

PAC units shall be provided with cooling coil, supply air fan, compressor, condenser, filter and prewired electrical panel with starters and electronic controls. If required, a separate labelled terminal strip for remote control and alarm shall be provided.

PAC units shall be sized to accommodate filters and filtration requirements detailed in Section 7.5.4.2.

Condensate drain lines shall run to the nearest sanitary point with airlock as specified in AS/NZS 3500.1. Drain lines running to stormwater shall not be used.

7.5.6.6 Control equipment

7.5.6.6.1 Motorised valves

All motorised valves shall be selected with sufficient torque to close off against system pressure. Valve motors shall be drive open and drive closed position with the feedback of open percentage.

All chilled water and condenser valves shall be modulating motorised valves with drive open and close with the feedback open percentage.

7.5.6.6.2 Temperature sensors

Temperature sensors shall be solid state controllers utilising an integral thermistor element to produce a 2 V to10 V output signal. Set point shall be adjustable and throttling range from 1ºC to 10ºC.

7.5.6.6.3 Water differential pressure sensors – pressure transducer

The differential pressure shall be of the strain gauge diaphragm type with solid state circuiting to produce a 4 mA to 20 mA output. Zero and span adjustments shall be provided at the sensor for calibration purposes. Water pump speeds shall be controlled with the pre-set pressure.

7.5.6.6.4 Pressure switches

Pressure switches shall be provided for proving operation of pumping systems. Positive movement of a diaphragm shall activate a micro switch and feedback to the control system for status.

7.5.6.6.5 Variable speed drives

Variable speed drives shall be of solid state adjustable frequency drive type controlled by a microprocessor and suitable for use on cube power absorption loads such as fans and pumps.

The controller shall be capable of adjusting the speed of any 415 V, 50-cycle, 3-phase motor of suitable power rating over a 5:1 speed range. The controller shall determine the optimum power supply to its connected motors to maintain the most efficient running characteristic of that motor.

The controller shall include the following features as a minimum:

- ventilated enclosure
- 4 mA to 20 mA dc or 0 V dc to 10 V dc signal
- separately adjustable ramps for soft start and soft stop
- manual speed control and external input facility from a control system
- manual reset button for all trip functions
- adjustment facility for maximum and minimum speed setting
- electronic overload motor protection
- faulty alarm relay
- speed indicating signal output to DDC/BMCS for smoke management.

7.5.7 Exhaust and extract systems

Smoke management shall comply with AS 1668.1 or fire engineering design.

A smoke extract system shall be provided where required by the system design to ensure tenable conditions for emergency evacuation of passengers and staff. The system shall be capable of extracting and sufficiently diluting smoke from a fire so that an adequate smoke-free height is maintained for sufficient time to allow evacuation of passengers, general public and staff to designated points of safety.

All enclosed toilets shall be fitted with a mechanical exhaust system.

Toilets within a space which has a high transient occupancy profile (for example, a larger station, and bus terminal or interchange public concourses) where there are more than three connected cubicles or two cubicles and urinals, shall be fitted with a fully redundant mechanical exhaust system (comprising at least two fans).

Toilets shall have exhaust flow rates of 50% more than those prescribed in Australian standards or a minimum of 15 air changes per hour, whichever is greatest, for the entire toilet room volume.

Bin rooms, storerooms, cleaners' storeroom and cleaning machine storeroom shall be ventilated with duty only mechanical exhaust air ventilation systems. Passive make-up air shall be provided to the room from the common corridor via transfer air grilles or door undercuts.

These rooms may be connected to the toilet exhaust system.

Garbage rooms, boundary trap rooms, grease arrestor rooms, sewer and water sumps and the like shall be served by dedicated duty/standby mechanical exhaust air ventilation systems. Passive make-up air shall be provided to the room from the common corridor via transfer air grilles.

Spaces containing potentially obnoxious substances or wet areas shall be maintained under negative pressure to contain odours and contaminants.

General exhaust systems shall be provided in staff areas such as tea rooms, kitchenettes, breakout spaces, and so on.

7.5.8 Gaseous fire suppression extract system

Areas equipped with gaseous fire suppression shall be provided with passive relief to atmosphere and a mechanical purge extract system. The system fan shall be sized to achieve an extraction rate of not less than six air changes per hour. The system fan shall be ducted to atmosphere.

The extract system fresh air and extract air ductwork shall incorporate motorised fire dampers which will automatically open on activation of the gas extraction fan to facilitate make-up air and gas evacuation. The vent discharge from the space being purged shall discharge directly to a safe outside location. The vent discharge shall not be less than 6 m from any intake air opening. The extract system shall consist of high and low level exhaust points.

7.6 Natural gas

Due to public safety considerations, unless special permission is obtained from the operator and maintainer, natural gas shall not be used at underground transport facilities.

7.7 Hydraulic

7.7.1 General

Hydraulic services include cold and hot water, rain and stormwater and sanitary drainage. These services are necessary to achieve acceptable standards of transport facility operation, staff and passenger amenity, and fire life safety. A hydraulic service is dependent on

site-specific requirements, primarily the facility spatial configuration. For example, the requirements for elevated, open facilities will be different to the requirements for underground or enclosed facilities.

Hydraulic systems shall be designed, installed and operated in accordance with AS/NZS 3500 (all parts). Refer to *NCC, Volume Three* for additional requirements.

The hydraulic services shall include:

- water services systems
- potable domestic cold water
- potable domestic heated water
- groundwater, track drainage and treatment system(s)
- sewer drainage
- trade wastewater capture, treatment and drainage
- rainwater capture, treatment and re-use
- recycled water, and
- stormwater drainage.

The hydraulic services shall be standalone systems.

The complete and integrated hydraulic service systems shall be provided with all necessary components.

Only water efficient appliances shall be used as specified in TfNSW *Sustainable Design Guidelines*.

Pipe material and all components shall be chosen based on life cycle cost without compromising on functional performance or engineering outcomes, and with regard to corrosion, ease of access and protection against vandalism. Pipework (unless it specifically services the room) shall be located external to rooms containing equipment susceptible to water damage, such as electrical, communications, signalling, and so on.

Pipework, valves and fitting shall be arranged in a neat and orderly manner so that these elements are conveniently accessible and easy to replace. Access for cleaning shall be provided so that all sections of the installation can be rodded or otherwise cleaned without cutting into the pipe or damaging wall or ceiling linings, or other building elements.

The hydraulic services shall, as a minimum:

- provide safe water supplies to the public, staff and other facility occupants
- provide potable cold water, and heated water as required, to potable water consuming fixtures and fittings

- provide wastewater capture and drainage
- provide trade wastewater capture, treatment and drainage (where applicable)
- provide rainwater capture and re-use as required, to sanitary fixtures, fittings and equipment prevent mixing of groundwater with stormwater within the hydraulic services systems, and
- capture, store, treat and dispose groundwater and fire water captured.

Pipework (unless it specifically services the room) shall be located external to rooms containing equipment susceptible to water damage, including:

- control and communications equipment
- signalling and train control system (STCS) equipment
- motor control cabinets or drives
- servers and other such computer equipment
- switchboards
- switch gear, and
- transformers.

Water pipes or drainage shall not be routed directly above any equipment or devices susceptible to water damage.

Screwed, flanged or mechanical joints shall not be made in pipes concealed behind wall linings or inaccessible spaces.

Permanently installed automatic air release vents shall only be fitted in plant rooms and service areas.

7.7.2 Water

Water supply shall be provided at facilities requiring potable water or requiring water for firefighting purposes. A separate grey water supply or storage (where available) system may be provided for toilets or cleaning points, or both.

Water for firefighting purposes shall be independently valved from water for domestic purposes.

Water connection can be either from a TfNSW infrastructure or a local service provider, for example Sydney Water.

In either case, a permanent water meter shall be installed at the point of entry to the facility in a location approved by the operator and maintainer to measure the total potable water use for a facility. Meter data shall be compiled into monthly and annual summaries. Meter readings may be manual or automated.

Metering arrangements shall be in accordance with the operator and maintainer and water service provider (for example, Sydney Water) requirements.

The water system shall be constructed to provide full design flow and pressure at all fixture outlets. Where this cannot be achieved by direct connection to service provider's main, the water main shall be pumped to achieve the necessary requirements.

Water supply systems shall be provided with the minimum discharge pressure at the most disadvantaged outlet and maximum discharge pressure at the most advantaged outlet as stipulated in AS/NZS 3500.1.

Water supply system infrastructure, including authority connections, meters, valves, pipework, pumps, and associated components, shall be provided with a minimum spare flow capacity of 20% at first passenger service, above the calculated probable simultaneous flow rate, in accordance with AS/NZS 3500.1.

A water system at a public transport facility shall be designed such that a single failure does not necessitate shutting the entire system down; this can be achieved by utilising a suitably configured and appropriately valved ring main. Sectional isolation valves shall be provided to each ring main at a maximum of two branch pipe intervals.

Local isolation valves at each fixture shall be provided. Stop valves shall be installed to isolate outlet groups, such as bathroom or amenities, individual serviced plant rooms, inlets to water heating units and any other discrete equipment requiring water supply.

The service provider shall include specific design measures, such as backflow prevention devices, to protect potable supplies from potential contamination sources. The water supply connections shall be provided with backflow control, isolation, separation provisions, and metering arrangements to meet the requirements of local water supply authorities for all potable and fire water connections.

Flexible, non-metallic connections for the incoming water supply replacement shall be provided to accommodate differential settlement.

All metal pipe work shall be electrically isolated by means of an insulation pipe section at the site boundary.

Water saving devices, such as rainwater harvesting and water recycling, shall be used wherever practicable. Vermin protection shall be provided where risk of vermin contamination exists, such as at rainwater inlets.

Water efficient appliances shall be used as specified in *TfNSW Sustainable Design Guidelines*.

7.7.3 Hot water

Sanitary fixtures (both staff and customer areas including disabled access facilities) shall deliver temperatures not exceeding 45ºC. Heated water shall be available at all times.

Potable domestic heated water shall be provided to, as a minimum:

- basins in disabled amenities
- non-public basins
- sinks and
- showers.

Hot water supply for different purposes should be as follows:

- Hot water supplied for domestic type use to customer accessible amenity area of the facility may be provided by an electric mains pressure hot water service located within the services cupboard.
- Hot water supply to the staff amenity area of the facility may be provided by an electric mains pressure hot water service located below the tea sink bench.
- Instant boil type hot water service units may be provided within facility staff kitchen areas.

Thermostatic mixing valves shall be provided to limit the water temperature at sanitary fixtures used primarily for personal hygiene.

All domestic heated water supply and return pipework, including valves, shall be thermally insulated to a minimum of 0.04 W/mK.

Dead legs in hot water pipework shall be kept to a minimum length between the hot water system ring main to the fixture outlet.

Water shall not be heated by gas fired systems.

Heated water shall be available during hours of occupancy.

7.7.4 Recycled non-potable

Recycled non-potable cold water shall be provided from the utilities recycled water network, where available.

Where provided, recycled non-potable cold water, shall be used for, as a minimum:

- fire hose reels
- toilet flushing
- backup supply to the rainwater re-use service
- supply to the vehicle wash plant
- internal vehicle washing, and hose taps for cleaning and washdown
- workshop equipment washing

- make-up water supply to mechanical cooling systems, and
- landscape irrigation.

Where the offsite utility recycled water infrastructure is not available, spatial provision shall be provided for future recycled water infrastructure to facilitate connection to the systems in the future.

7.7.5 Rainwater and stormwater

The rainwater system shall be designed in accordance with AS/NZS 3500.3.

Rainwater and stormwater shall be captured and controlled, by adequately designed gutter and downpipe systems, surface falls and drainage, to facilitate public convenience, safety and efficient operation.

External downpipes shall collect all rainwater and discharge to the stormwater drainage system in accordance with local codes, the NCC and Australian standards and discharge to the nearest civil stormwater system. The system should drain downpipes and paved areas before connecting to the trunk drainage system.

The facility onsite part of the system shall be designed for a 1-in-100-year storm event. The system design shall minimise the amount of pollutants entering a stormwater system to obviate downstream pollution, blockages and adverse health effects. Open points shall be eliminated where possible. Where this is not possible, the number of open points shall be minimised. All gutters and downpipe entry points shall be protected with metal mesh gutter protection system. Cleanout shall be facilitated with appropriate removable cleaning eyes.

Where exposed in public areas:

- solid formed downpipe enclosures shall be used
- non-climbable and vandal resistant downpipes shall be used.

Runoff shall be filtered through onsite traps to capture litter, organic waste matter, paper, plastics, glass, metal, and other materials. Such traps shall be accessible by lockable removable covers.

Onsite detention systems should be used where collected water is used for irrigation and cleaning purposes.

The facility stormwater system shall be connected to a local government stormwater system or the local service provider (such as Sydney Water) stormwater system, through terminal manholes. Onsite detention systems should not be used due to likely spatial constraints and maintenance costs. For sites that can experience large run-off, liaise with the appropriate authority to facilitate adequate design and connection.

Any stormwater drainage that is not capable of being gravitated to the stormwater system shall be transferred through retention and pumped to the gravity system.

A feasibility assessment should be undertaken to inform whether a water sensitive urban design should be implemented, taking into account, but not limited to, the following factors:

- sensitivity of adjacent environments (for example, drinking water catchments)
- physical space available and its topography
- environmental constraints (for example, national parks)
- safety
- maintainability
- cost.

7.7.6 Sanitary drainage

Sanitary drainage shall be connected to a local public service and provided with a gravity system where levels permit.

Sanitary waste from facility fixtures shall be drained to a sewer pumping station in underground or in locations below the level of adjacent gravity fed sewer main. Pumped discharges shall be interconnected and extended through a rising main to the local service provider (for example, Sydney Water) gravity sewer drainage system. The pump arrangement and system control shall include redundant equipment configured to prevent system malfunction and include automatic local and remote alarms. Pump out systems shall not exceed the local authority's pumping flowrate guidelines.

Where sewer pump stations with a pumped rising main connect directly to a utility water asset, the flow shall be limited to the specified limit of the authority. All pressurised discharge flow rates above this limit shall be agreed with the local water authority.

Sewer drainage system infrastructure shall be provided with a minimum spare flow capacity of 20% at completion above the calculated fixture unit ratings, in accordance with AS/NZS 3500.2.

All vent pipes shall be extended throughout the system, to freely discharge to the atmosphere and discharge vertically in accordance with AS/NZS 3500.2. Vents and drainage pipes shall be constructed to provide flexibility for fixture reconfigurations.

Any water sources which fall into the category of trade waste shall be in accordance with the utilities discharge licences, and shall include any water treatment necessary in order to satisfy the utilities requirements.

Grease traps shall be provided in technically and environmentally appropriate locations approved by operator and maintainer.

7.8 Electrical

7.8.1 General

LV electrical installation includes all LV equipment and installation parts within a transport facility including the main switchboard and its supply cable. Installation upstream of the main switchboard is classified as part of an electrical distribution system and is not covered in this document.

All electrical installations shall comply with AS/NZS 3000 and *Service and Installation Rules of New South Wales*. Electrical installations in heavy rail and metro environments shall additionally comply with TS 03954.

The following are covered in TS 03954 and standards referenced therein*;* though TS 03954 is rail and metro specific, non-rail-related aspects and principles described therein apply to all modes:

- distribution supply to an electrical installation
- electrical protection
- switchboards
- power factor correction
- motor control centres
- wiring and containment systems
- energy metering
- earthing, bonding and electrolysis
- lightning and surge protection
- identification of assets and labelling.

All cabling and exposed cable containment systems in buildings shall be low smoke zero halogen.

7.8.2 Lighting

Transport facility lighting shall be designed in accordance with AS/NZS 1158 (all parts) and AS/NZS 1680 (all parts), as applicable, and AS/NZS 4282. In addition, lighting requirements of AS 1428.1 and AS 1428.2 shall apply.

The following are covered in TS 04935:

- technical requirements
- specific applications of lighting

- illumination levels
- lighting control systems.

7.8.3 Emergency lighting

Emergency lighting shall be designed in accordance with AS/NZS 2293 (all parts).

The following topics are covered in TS 04936:

- technical requirements
- additional requirements for specific applications.

  Note: Though TS 04936 is heavy rail specific, non-rail-related aspects and requirements described therein apply to all modes.

7.9 Fire engineering

Fire engineering aims to protect people, property, and the environment from the dangers of fire and smoke through the application of deemed-to-satisfy or performance-based solutions.

The risk of injury or fatality due to a fire event shall be eliminated or minimised. Public transport facilities including buildings and developments integrated with a transport facility and adjacent areas, shall identify and manage fire related risks and include appropriate fire safety measures and risk mitigation controls.

In addition, the principles in TS 00008.1 shall apply to all transport facilities.

For stations, the principles in TS 00008.1 and TS 00008.2 shall apply.

Particular fire system elements forming part of an overall fire strategy for a transport facility should only be employed if indicated by an overall analysis of compliance or risk, in conjunction with passive and operational measures.

7.10 Fire services

Fire services in transport facilities shall be provided in accordance with TS 00008 suite of standards. Additional requirements related to fire services are contained in the applicable legislated standards and the NCC.

7.11 Lifts, escalators and moving walks

7.11.1 General

Lifts, escalators and moving walks are vital services in transport facilities to facilitate easy and equitable access to various parts of a facility.

Lifts, escalators and moving walks shall be positioned to facilitate continuity of designated access paths within the facility and promoting wayfinding while supporting and enhancing ease of circulation.

Lifts shall comply with TS 04955.3. Escalators and moving walks shall comply with TS 04955.4.

7.11.2 Normal operation and emergency evacuation

The operator and maintainer shall develop facility-specific and location-specific plans for the use of lifts, escalators and moving walks during a normal situation. The use of lifts, escalators and moving walks during an emergency evacuation is subject to inclusion of these services in the facility emergency evacuation plans by the operator and maintainer. Documented evidence of such plans shall be submitted for future reference and audit.

7.12 Telecommunications

7.12.1 General

As part of building services, telecommunications cabling supports all known and anticipated future systems and applications conveying different kinds of information like voice, text, data, image and video. These may include the following service sectors:

- asset management (for example building wellbeing, energy monitoring)
- environmental management and control (for example lighting management, environmental comfort sensing)
- electronic security (for example CCTV, access control, duress alarms)
- building information systems (for example central clock, electronic signage)
- audio visual systems (for example customer information systems such as PA, PIDs, help points)
- information technology services that facilitate the use of electronic devices for work and personal purposes (for example computers and phones)
- government radio network (GRN)
- other transport-specific applications (for example ticketing, train communications systems, emergency telephone system)
- distributed antenna system
- PSDs.

7.12.2 Transport network

Building telecommunications cabling in transport facilities shall be designed and constructed in accordance with AS/NZS 11801.1 and AS 11801.6 although some specific applications may require additional, non-standard cabling.

Telecommunications cabling and installation shall comply with AS/CA S009, TS 06210 and TS 05164. Telecommunication cabling may follow a similar route to the LV power cables. The required separation distances shall be maintained. All communications cabling and exposed cabling containment systems in buildings shall be low smoke zero halogen.

Equipment rooms and cubicles that serve facility services and systems shall comply with TS 03947. However, the minimum requirements in this document may not be sufficient for housing specific, safety-related equipment. Additional measures shall be adopted as required based on thorough, location-specific risk analysis that takes into account all relevant factors.

7.12.3 Public carrier network

A public carrier provider shall install a separate MDF to facilitate connection of public telecommunications services. From the MDF, conduits and cables shall be installed to public telephone points around the facility. A power supply shall be provided for use of the public carrier provider.

The design shall include spare space needed for future mobile network operator equipment to provide or enhance their own coverage for existing and future services, for example Public Safety Mobile Broadband.

7.13 Building management and control system

7.13.1 General

A BMCS shall be provided to manage services and equipment operation.

7.13.2 System configuration

Building services assets shall be managed through a local DDC/BMCS, and a network-wide BMCS, or a SCADA system. The BMCS shall provide overall monitoring and control of the building services assets, enable appropriate interfaces between the different services and subsystems and be able to operate automatically without manual intervention.

The system shall utilise local field HMI stations complete with memory and necessary operating programs to accomplish control functions at the point of utilisation. All local HMI shall be connected to the main control centre via a network backbone.

Detailed control diagrams for each subsystem shall be configured to suit the manufacturer's equipment and be approved by the operator and maintainer before commencing installation of the BMCS.

Instruments shall not be located where they interfere with the operation or removal of equipment. Conduits or piping shall not interfere with access to any equipment.

7.13.3 Functionality

Facility services assets and systems shall be periodically assessed, and an annual report provided year-on-year to compare the level of performance and energy usage of major system components.

BMCS shall facilitate detailed performance analysis and integration of the collected data with operation and maintenance response.

BMCS shall have a means of setting operational parameters, controlling respective equipment and monitoring the operation and status of the connected equipment through intuitive user interfaces.

All necessary control functions, access to relevant data and alarms shall be available to enable management of normal and emergency operation from a single point (location) or from multiple points (local and remote locations) on the transport network by a supervising entity, for example Rail Operations Centre (ROC) for rail operations and operational control centre (OCC) for metro operations.

Failure of a local field station or the control processing unit shall not render the control system inoperable; however, it can result in local loss, or degraded performance of the particular function. Any such failure shall be reported at the BMCS head end. BMCS shall provide for periodic testing of designated equipment, alarms, reporting, time stamping and recording configured to help facilitate maintenance planning.

7.13.4 Technical support

BMCS controlling devices shall be calibrated and their sequence of operation adjusted to ensure uninterrupted continuous operation and satisfactory automatic control.

The manufacturer shall maintain a maintenance support facility complete with system technicians, diagnostic and test equipment and routines, and new spare digital controllers and control components. Emergency service shall be available on a 24/7 basis.

The manufacturer shall issue a report on construction completion stating that the system configuration is complete, has been adjusted, has had all hardware and software functions verified, and is operating in accordance with the specifications. Any deviations from specified settings or operations necessitated during system adjustment shall be specifically noted.

The manufacturer shall prepare the functional specification, fully describing in both written and graphical form, of all functions to be controlled by the system and submitted for approval of the operator and maintainer.

7.14 Information systems

7.14.1 Information technology

7.14.1.1 General

A telecommunication system provides a unified means for a facility system's data and voice transmission requirements utilising wired and wireless packet switching networks for the purpose of data communication between ethernet and internet protocol enabled systems, across local, metropolitan, and wide area networks.

Facility telecommunication systems are integrated across local, metropolitan, and wide area networks in compliance with TS 06218.

For wireless networks requirements, refer to TS 06219 and TS 06220.

Programmable electronic equipment shall comply with TS 03948.

7.14.1.2 Facility LAN and staff telephone system

Facility LAN and a telephone system shall be provided at transport facilities to allow data and voice communication within a facility and between facilities in different locations.

7.14.1.3 Public telephone system

Public telephones may be installed within transport facilities in locations approved by operator and maintainer. The public telephones shall be provided in accordance with Industry Guideline G630:2020. Public telephones shall be connected directly to a carrier provider's system such as Telstra. Public telephones shall be independent of the TfNSW system.

7.14.2 Customer information systems

Various customer information systems operate throughout the transport network. Local requirements at a facility are based on the transport mode served and are location specific. Customer information provided at a transport facility may include static signs, visual displays, PA system, help points, and synchronised LED clocks.

PA system, electronic visual displays and hearing augmentation requirements are specified in TS 06206.

Help points requirements are specified in TS 06207.

Customer information systems are deemed to be an essential service that shall continue to remain operational for the duration specified in TS 00008 (all parts) and TS 03954. Dedicated incoming power supply compliant with Section 7.2 of this document shall be provided.

Individual elements of the customer information system (for example PIDs) shall be equipped with power supply arrangements equivalent to the system central equipment, so that entire systems are operational for as long as required during a power outage.

Clear sightlines to visual display units shall be assured. Visual displays and clocks shall be located to avoid interference (glare) from lighting and to avoid glare from sunlight. Where this is not possible, sun control hoods shall be fitted to control glare.

Synchronised LED clocks shall be provided with dedicated power supply circuit and data wiring to a synchronising device.

7.14.3 Other systems

Where required by facility operation, other systems such as government radio network (GRN), digital train radio system (DTRS), and public mobile carrier networks shall be installed within transport facilities. Any external system installations shall not impact the current and future operational needs of TfNSW.

7.15 Electronic security system

7.15.1 General

Electronic security systems operate network wide. The systems shall be capable of being locally and remotely managed and monitored, for example by security control centre.

The following electronic security systems are in use on transport network:

- CCTV
- access control
- intruder detection
- duress alarm.

These systems shall be designed, installed, operated and maintained in accordance with TS 04992. Wiring and containment shall be provided in accordance with AS/NZS 3000 and TS 03954.

Dedicated incoming power supply shall be provided in accordance with Section 7.2.

7.15.2 CCTV

Refer to TS 04989 and TS 00050 for CCTV requirements.

Transport facility CCTV shall monitor strategic locations in accordance with TS 04989. The monitoring arrangements depend on the transport facility configuration and layout and can include the entrances, access ways and circulation spaces, ticketing machines, self-service machines, top-up machines, paid area access points, lift cars, lifts and escalator landings, entrances to public toilets and help point areas.

For effective image capture, CCTV requires appropriate lighting. For CCTV lighting requirements refer to TS 04935 and TS 04992. Glare from artificial lighting or interference from direct sunlight shall not deter CCTV operation. The minimum illumination level to support CCTV operations shall not be less than 0.5 lux vertical illuminance at 1.5 m above finished floor level in the direction of the camera.

The CCTV network is deemed to be an essential service and shall continue to remain operational during a power outage for a duration equal to or longer than the operation of emergency lighting within the facility as specified in TS 04936.

New installations shall be IP based, compatible and fully integrated with the existing IP based CCTV system; any hybrid systems currently in operation may remain for some time.

The CCTV system LAN switches, network attached storage, video encoders, digital recorders and relevant auxiliary equipment shall be housed in CCTV-dedicated rooms. Where security systems equipment is co-located in a transport facility equipment room, secure locking of individual sections within the rack shall be provided. The room shall be equipped with the following:

- A dedicated UPS sized for150% of the sum of the manufacturer-specified individual equipment power needs, and the required autonomy time.
- A separate UPS room shall be provided for larger systems. NCC specifies requirements for separation of battery systems within buildings.
- Secure door, frame and locking mechanism with electronic access control, in accordance with TS 04992.
- Dust free and climate-controlled environment within the room. For larger rooms CCTV equipment, duty and standby air conditioners shall be provided.
- A ventilation or extraction system able to operate during a power outage.

CCTV cameras viewing ticketing equipment shall be located in accordance with TS 04989.

7.15.3 Access control

Physical access to security-sensitive areas and equipment such as digital video processing, control and monitoring facilities shall be restricted, and the access points equipped with an electronic access control system.

For requirements applicable to areas equipped with electronic access control systems, and any other areas where zone 3 (restricted access) in accordance with the *Protective Security Policy Framework* applies, refer to TS 04992.

The system shall interface with the fire alarm system for automatic unlocking of emergency exit doors in case of a fire.

7.15.4 Intruder detection

An intruder alarm system shall be installed if determined through the security risk assessment in accordance with TS 04992. The system can cover staff occupied areas, detection of building perimeter ingress or egress doors, main storage, plant, and electronic equipment rooms.

7.15.5 Duress alarm

A duress alarm can be used to request emergency assistance from local security, police or emergency services. Duress alarms shall be configured as part of the access control system.

Hard-wired duress alarm points shall be installed in locations determined by the security risk assessment. In addition, a wireless mobile duress alarm system shall be provided for staff as required.

7.16 Electronic ticketing system

7.16.1 General

Smart cards (as well as debit and credit cards) are used by all transport modes.

Smartcard readers are installed in electronic ticket gates or located in fixed locations at transport facilities without ticket gates.

The following components are usually installed at transport facilities:

- ticket self-service machine
- electronic gates, and gate attendant controller and station computer
- fixed location readers
- the ticketing system common equipment, system cabling (power, UTP copper, optical fibre), and cabling containment.

All these can be integrated over fixed LAN or wide area network.

The ticketing system components and its coverage extent shall be determined by the transport facility specific needs and the availability of suitable spaces.

Fixed-location readers, electronic gates and ticket self-service machines are interlinked to common system equipment. This equipment can interface and integrate with the ticketing systems at other transport facilities to form a transport-wide system.

The TAO or service provider shall locate and integrate ticketing system elements; for example, fixed location readers, self-service machines, electronic gates, wiring containments, and so on, in accordance with TfNSW ETS specification requirements within their design. Operators requiring remote device management shall additionally develop and integrate a software solution to interface with ticketing system product. As ticketing system requirements are subject to change, transport facility designers shall check with TfNSW ticketing team for latest requirements at the installation planning stage.

Any upgrades to existing gatelines currently in service, shall have the supporting equipment upgraded at the same time. All work shall comply with the TfNSW ticketing team most recent installation requirements and hardware specifications and interface.

7.16.2 Fixed location readers positioning

Fixed location readers are installed at all ungated transport facilities. Some fixed location readers may also be required at gated transport facilities. Fixed location readers are available in the following configurations:

- short single reader
- short double reader
- tall single reader
- tall double reader.

The readers shall be orientated so that the device is visible to passengers, under cover where possible, and in coverage of CCTV in accordance with TS 04989.

7.16.3 Self-service machines

Self-service machines and top up machines are provided for customers to purchase or reload smart cards using cash or cards.

The following legacy self-service machine designs are no longer used at new stations but currently deployed at transport facilities:

- Astreo Cash self-service machines – top up of the Opal card and vending of single trip tickets. Accepts credit and debit cards and cash.

- Astreo Cashless self-service machines – top up of the Opal card and vending of single trip tickets. Accepts credit and debit cards only.
- Galaxeo self-service machines – top up of the Opal card and vending of single trip tickets. Accepts credit and debit card only.

7.16.4 Electronic gates

The electronic gate array shall achieve the following:

- facilitate passenger flow
- clearly delineate the threshold between unpaid and paid areas of the transport facility
- provide for both regular access lane widths and a single, wide access lane for access by people with disabilities.

The type of gate installed is facility specific.

The following generic types are currently installed:

- E2 ramp-less, the only type supported for new installations
- E2 ramped
- legacy gates.

Each gate aisle operates in a single (entry or exit) direction only. The E2 wide access gates are set to bidirectional mode where they will continually alternate between entry and exit modes.

To permit access for customers with special needs a wide access gate shall be provided. The wide access gate shall be controlled remotely or from the gate attendant controller, or both.

7.16.5 Gate attendant controller

The gate attendant controller is a touchscreen device used to locally control the function of the gate array or gate line. The gate attendant controller shall be installed on the paid side of the gate array only, in line of site of the entire gate array or gate line and in a secure enclosure. The gate attendant controller should be situated adjacent to the wide access gate at manned station.

The gate attendant controller shall perform the following functions:

- display the mode of each gate aisle
- change the direction and mode of each aisle to suit customer flow conditions
- display fault information.

A dedicated EGOP shall be provided for each gate array or gate line or as determined by the ticketing system. The EGOP panel for E2 gates shall not be incorporated or form part of any distribution power panel or board.

The EGOP shall integrate the emergency gate release button fire system and remote device management (where applicable) systems with the gate array or gate line emergency open function. After receiving a valid signal from the EGOP, the gate array or gate line shall enter into an emergency open state, where all gates will remain open until the EGOP is reset.

Gate array shall be captured by CCTV in accordance with TS 04989.

7.16.6 Emergency gate release button

Each gated transport facility shall be equipped with a means to open the gates from a nominated local or remote control location.

Locally installed emergency gate release button locations and layout shall be consulted with TfNSW ticketing team and coordinated with CCTV design to ensure that the CCTV camera can capture the image of a person operating the emergency gate release button with adequate detail for face recognition.

An emergency gate release button with red indication when activated and a duress alarm button shall be installed adjacent to the gate attendant controller screen at manned stations (this is typically found in a gate attendant controller hub type installation).

The emergency gate release button shall be as follows:

- Latching type with adequate number of contacts to facilitate gate opening, remote notification and alarm.
- Mounted in a box constructed of 1.5 mm thick grade 316 stainless steel, equipped with top-hinged accidental operation cover that forms part of the box or is affixed to the front of the box. The front face shall be permanently labelled as ‘EMERGENCY GATE OPEN – LIFT AND PRESS’ with white lettering in Helvetica font of 6 mm height on red background. Covers that shield the operating part (the press button itself) only shall not be permitted.

Electronic gates shall be integrated with facility fire detection and alarm system to automatically open the gates in case of a fire emergency.

7.16.7 Electronic ticketing system common equipment

The ETS common equipment shall be housed in an ETS-dedicated enclosure. The common equipment may include copper patch panels, LAN switches, auxiliary equipment, and fibre terminations.

Where required the cabinet shall also accommodate dual SELV 24V dc power supply unit arranged through a redundancy module to supply a common 24 V dc distribution section. Where possible, the power supply unit and redundancy modules should be remotely monitored by the operator.

The ETS cabinet installation location shall be done in consultation with the operator. The ETS enclosures should be installed in the transport facility equipment room compliant with TS 03947.

UTP data cables shall not exceed 90 m. Where UTP data cable runs exceed 90 m, a fibre optic cable shall be used. Otherwise, a second set of common equipment (secondary ETS enclosure) shall be provided in an approved location.

7.16.8 Electronic ticketing system telecommunications cabling

CAT6 UTP copper cables shall link field equipment to the system common equipment. Where more than one LAN switch is employed, these shall be connected by redundant optical fibre cable links for integration with the network-wide system.

Cable joints or additional terminations shall not be permitted in the ticketing system. Cables should be whole from source to device.

7.16.9 230 V ac power supplies to electronic ticketing system equipment

Power supply boards, circuits and typology shall be in accordance with TfNSW ticketing team requirements. ETS power supply circuits shall be fed from a dedicated electrical distribution board with circuits dedicated to ETS only.

The circuits shall be fitted with surge diverters mounted within the distribution board. The circuits shall comply with the following:

- For ETS cabinet, two dedicated circuits shall provide power supplies to each power supply unit, one from the normal supply and one from the UPS supply. Separate dedicated circuits shall supply two double power outlets to power any LAN switch and test equipment used by system maintenance staff.
- For self-service machines or top-up machines, a separate circuit shall supply from a 20A RCD. The circuit shall supply each self-service machine through a 2.5 mm^2 2C + E cable as well as being additionally earthed by a separate dedicated 6 mm^2 earthing cable.
- For E2 gates, a separate circuit shall supply from a 20A RCD. The circuit shall supply a bank of three gate aisles through a 4 mm^2 2C + E cable as well as each stanchion being additionally earthed by a separate dedicated 6 mm^2 earthing cable.
- For gate attendant controller, a separate circuit with a double power outlet shall be provided. The additional power outlet is for the ETS maintenance technician use only.

Power and control cabling shall comply with TS 03954. Cable joint or joints or additional terminations shall not be permitted in the ETS system. Cables should be whole from source to device.

All power and data cables shall be installed in suitable ducting or conduits with appropriate segregation. The conduits and trunking for connection of fare collection equipment and ticketing machines shall be installed within floor screeds. Cable containment type, location and design shall be in accordance with TS 03954. The designers shall consult with TfNSW ticketing team on specific cable containment requirements.

7.16.10 Cable containment

All power and data cables shall be installed in two-compartment metal ducting or separate metal conduits in accordance with TS 03954. The conduits and trunking for connection of fare collection equipment and ticketing machines shall be installed within floor screeds.

7.17 Noise and vibration

7.17.1 General

All systems, equipment, pipe work and ductwork shall be selected, manufactured and installed for quiet and vibration-free operation, in accordance with the noise and vibration criteria as specified for individual items of equipment, acoustic linings and vibration isolation. Any plant or equipment noise or vibration that can be heard or felt, and that exceeds the specified room design criteria, shall be rectified.

The following precautions shall be taken to ensure that minimum noise and vibration emanate from the plant installed:

- All rotating machinery shall be accurately balanced statically and dynamically.
- Centrifugal and reciprocating rotating equipment such as fans, pumps, compressors and chiller sets shall be mounted on vibration-absorbing mountings. Inertia bases shall be provided.
- All connections to rotating machinery, or assemblies containing machinery, shall be rendered flexible by anti-vibration hangers supporting ducting and piping systems, and flexible connections between ductwork and fans.
- Adequate provision shall be made to take up vibration in bends and pipe runs.
- Acoustic lining shall be applied to all critical lengths of ducts and air-handling units. Acoustic seals shall be provided where all pipes, ducts, air terminals and conduits penetrate plant rooms, acoustic walls, airtight enclosures, ceilings and bulkhead.

7.17.2 Vibration-isolating mounts and hangers

All vibration isolation mounts and hangers required for reciprocating rotating equipment, pipe work, cable trays and ductwork shall be manufactured by experienced and approved

manufacturers. They shall be manufactured from the best quality materials and selected to last the full life cycle of the building.

When selecting vibration-isolating mounts and hangers with respect to minimum installed vibration efficiencies and recommended static deflections, due allowance shall be made for the design floor deflection for suspended floors. Accordingly, the floor deflection shall be added to the required spring static deflection.

All spring mounts and hangers shall include neoprene or rubber pads or inserts for high frequency noise isolation. Spring diameter shall not be less than 0.8 of the compressed spring length.

Anti-vibration hangers shall be used to support equipment, piping and ductwork. Spring hangers shall be used adjacent to, and for not less than 5 m from, spring-mounted equipment. Hangers beyond 5 m from spring-mounted equipment shall incorporate neoprene or rubber insertion washers as a noise break, or springs if required to meet this specification.

All pipe work connected to reciprocating equipment shall be arranged such that it does not suffer undue distortion, vibration or fatigue.

Rubber-in-shear mounts may only be used for mounting of light equipment such as fractional kW fans in non-critical areas. If used, the mounts shall be adequately protected from oil and sunlight.

Electrical connections to all motors shall be made with flexible conduit.

All steps shall be taken to prevent vibration from being in any occupied space in the building. Vibration isolators shall be carefully selected for each application to provide attenuation of transmission of vibration.

7.18 Corrosion protection, painting and labelling

7.18.1 General

All surfaces shall be protected against corrosion immediately after fabrication or erection, or both.

All ferrous surfaces of equipment and other parts, such as steel fabricated brackets, fire dampers, flanges and so on, shall be galvanised or otherwise protected with suitable primer and painted with a suitable protective coating after any welding has been completed. All ferrous brackets and stands located externally shall be hot-dip galvanised.

Prior to painting, existing services and building surfaces shall be cleaned to remove dirt and ensure satisfactory adhesion of new paintwork.

All painting shall be performed by professional painters.

Paint materials and preparations and application practice shall result in a finish guaranteed not to fade, tarnish, peel or otherwise deteriorate for a minimum of three years under operating conditions.

7.18.2 Painting

All visible parts shall be painted. In addition, all parts of the installation subject to corrosion or weather deterioration shall be painted with a suitable protective coating in a finish colour in accordance with AS 1345.

Finish painting of all visible (external and internal) services shall be provided where factory-applied finish is not included, including the following items as a minimum:

- all pipe work, sheathing and fittings
- all plant and equipment
- minor sundry items
- brackets and supports.

8 Infrastructure

8.1 General

Systems and services should be integrated through appropriate infrastructure to ensure correct operation and full functionality.

The infrastructure categories are as follows:

- TfNSW owned infrastructure

  TfNSW owned infrastructure systems extend network wide and facilitate transport operation and customer service. The following are examples of TfNSW infrastructure that can integrate facility services and systems:

  - electrical power distribution system for heavy rail in electrified areas
  - communications system inter-facility network.

- Public service provider infrastructure

  Additionally, to accommodate facility requirements, services can be connected to public service provider infrastructure.

  The following are examples of public service provider infrastructure that can relate to facility services and systems:

  - water for domestic purposes and fire protection
  - wastewater and stormwater

- electricity
- telecommunications.

8.2 Requirements

Services and systems design shall coordinate and accommodate the following:

- Interfaces and integration with relevant network-wide infrastructure systems and services.
- Water, wastewater and stormwater provisions.
- In addition to normal power provisions, UPSs with sufficiently long autonomy time shall be employed where required by the system design.
- Telecommunications cabling provisions.
- Where required by the system design, redundant routes between the infrastructure's interface points and services or system equipment room and common equipment; separate, secure and concealed wiring containment for each service or system power and telecommunications cabling.
- Equipment rooms that have adequate space provisions within. These rooms shall have a pressurised, dust-free, climate-controlled environment. Where necessary, equipment rooms shall be equipped with redundant air conditioning.

9 Assurance

9.1 General

A documented process to demonstrate assurance at project milestones and continuously throughout the asset life cycle shall be applied in accordance with TS 01504.

TS 01452 provides guidance on the requirements of TS 01504.

The assurance process shall demonstrate that all relevant factors were taken into account, and conclusions documented for all new works. The following applies:

- Documented evidence of compliance with legislation, including standards and codes mandated by legislation, shall be provided for all work related to TfNSW assets.
- Documented evidence of compliance to all relevant TfNSW standards shall be provided for all work related to TfNSW assets.
- Documented evidence of risk management to demonstrate that risk is managed SFAIRP.
- Documented evidence of works being performed only by competent personnel who are suitably qualified, experienced and licensed.

- Documented evidence that assets have been periodically assessed throughout the asset life cycle to indicate any pertinent risks and relevant actions have been carried out to mitigate the risks.
- Documented evidence that throughout the asset life cycle, the actual life cycle costs have been compared against the life cycle cost forecast and that the gaps in expenditure are identified and lessons learned are reported to AMB.
- Documented evidence of consideration of intra-project and intra-program works where there may be interdependencies between projects and programs or opportunities for bringing forward future asset upgrades into project and program works.

9.2 Risk management

The assurance processes, techniques, tools, roles and responsibilities shall be proportionate to the risk.

The risk management processes shall identify and assess the risk and take appropriate steps to eliminate risk where possible or, mitigate (minimise) risk to an acceptable level, SFAIRP.

The risk assessment shall be undertaken in accordance with TS 04982.

The more complex is the site, the more specific consideration shall be given to all aspects of risk management and assurance.

9.3 Assurance processes and artefacts

In the context of new and upgraded assets, assurance shall be provided for fitness for purpose, safety assurance, and technical assurance of appropriate depth specific to each engineering service and system.

Processes shall be applied by the relevant asset steward at each stage of the asset life cycle to enable assurance evidence to be generated. The processes and corresponding evidence shall be documented in the assurance and governance plan. Refer to TS 01504 for additional requirements on assurance and governance plans.

Assurance shall be supported by data and evidence. Assurance shall include the following:

- Correct and relevant input data.
- Relevant aspects of site-specific environment and considerations included in the design.
- Evidence of compliance with relevant acts, regulations, Australian standards and TfNSW standards, suitable proof of certification.
- Identification of hazards related to design, documentation of impact on installers, maintainers and the public. Demonstration that the design has eliminated all risks.

- Demonstration of risk mitigation to SFAIRP levels.
- Clear delineation of responsibilities of each party, including those beyond TfNSW.
- Compliance with approved testing and commissioning methodology and detailed requirements.
- Demonstration that controls from concessions have been accepted by the asset steward and incorporated into their management systems.
- Final design drawings, specifications, design reports and other items required by contract (marked for tender or for construction). These documents shall be clear and unambiguous and require no further elaboration in order to build the project.
- Industry best practices. These shall be employed while designing, installing, testing and operating all components.
- Compliance with manufacturers' recommendations.

AMB reserves the right to audit any evidence produced as part of the assurance process.

9.4 Concept solution selection

9.4.1 General

The design of new and upgraded systems shall reflect a whole-of-life cycle approach that holistically considers the particular solution's fitness for purpose. The fitness for purpose shall be weighed against the design, installation, operation and maintenance requirements.

Refer to TS 01471, TS 01472 and TS 01516 for more information.

9.4.2 Optioneering

Where alternative solutions are considered, alternative solutions shall only be deemed viable where the functional performance and engineering outcomes are not compromised. Once identified, alternative solutions shall not be rejected without stakeholders' consultation. Rejection of any alternative solutions shall be subject to agreement by the asset steward – operate or maintain. Alternative options shall be evaluated using multi-criteria analysis followed by risk assessment. The criteria and weighting used for the multi-criteria analysis shall be agreed with the asset steward. The designer shall evaluate different available options to ensure that the most optimal solution is selected.

There is often a need for system design to ensure uniformity of services and systems across the transport network in terms of function, connectivity, operational standardisation, dependability of maintenance and consistency of presentation, with some arrangements being the subject of existing supply, installation and maintenance contracts. The system designer shall investigate available options for stakeholders' approval.

9.5 Design

Service loads shall be calculated and verified. All design and operation aspects of services and systems equipment, and necessary components should be taken into account prior to or as part of design phase.

The services and systems design shall be checked for correctness and assured by a competent person who has demonstrated an in-depth knowledge and experience in the relevant discipline, has a minimum of 10 years of experience in the respective field, and is a registered engineer certified by a relevant professional body.

Drawings and specifications of the proposed installations shall be prepared and submitted prior to commencing any work for approval. As-built drawings, compliant with TS 01547.1, shall be provided on completion of work. Drawings shall include, but not be limited to, the following:

- Pipe work layouts, showing existing and new pipe work, equipment, insulation and including construction details and materials.
- Plans and sections of all plant areas at 1:50 scale and larger, showing relationships and clearances to plant rooms and other equipment, including details of mounting, and so on. The drawing shall indicate equipment model numbers and performance data.
- Wiring diagrams and control circuits.
- Schematic drawings of all automatic controls describing operation of control system and nominating set points, differential band, and so on.
- Details of all penetrations and building fabric requirements.

Full coordination of trades shall be carried out.

Construction work shall not commence until approval to proceed has been obtained.

9.6 Construction, testing and commissioning

Newly constructed assets shall be assured as part of the construction process.

The testing and commissioning process shall demonstrate that all relevant requirements have been achieved. Services, systems and equipment shall be factory (where applicable) and field verified, as part of the delivery.

The technical assurance process shall, as a minimum, demonstrate the following:

- that the installation including all associated equipment has been appropriately constructed and tested
- any deficiencies that affect safety have been remedied before the installation is handed over for operation

- that all identified defects and discrepancies have been rectified
- that as-built documentation has been handed over including the following:
    - layout plans that include placement of equipment, block or single line diagrams, relevant technical and operational information
    - test reports confirming installation safety, technical correctness and operational readiness in accordance with the design intent
    - commissioning certificates confirming that the entire installation has been certified, compliant with relevant legislation
    - operation and maintenance manuals
    - any other information necessary for safe and efficient operation of the asset.

Handover of transport assets shall comply with TS 01508 and TS 01515.1.

9.7 Operation and maintenance

The operator and maintainer shall establish and implement an inspection program for all services and systems to confirm continued performance.

The information handed over on completion of the construction shall be used to help formulate operation and maintenance strategies. Specific technical maintenance plans shall be developed and implemented in accordance with the requirements of TS 01506.1.

Periodic inspections shall be carried out at predetermined intervals by competent persons to assure that each system operates as intended. The inspection frequency shall be determined through risk-based approach, and in any case the maximum time between inspections of services and systems assets shall not exceed 12 months. At the completion of an audit or an inspection, any deficiencies found shall be recorded and rectified as soon as is practicable.

9.8 Asset identification

The operator and maintainer shall employ an asset identification system in accordance with TS 01515.1.

All piped and wired services shall be colour coded and labelled in accordance with AS 1345.

9.9 Record keeping and reporting

Periodic reporting of services and systems condition shall be carried out throughout the operational life of the assets at agreed predetermined intervals.

Up-to-date records of all maintenance activities and any other work affecting services and systems shall be stored in an electronic database. All records shall be readily available for inspection and audit.