NSW GOVERNMENT | Telco Authority

Guidelines for Telecommunications Structures

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Related Policies and Documents

Report Reference Number	Issuer	Reference	Document Name
[1]	SAI Global	AS/NZS 1170.0	Structural Design Actions, Part 0, General Principles
[2]	SAI Global	AS/NZS 1170.1	Structural Design Actions, Part 1, Permanent, Imposed and Other Actions
[3]	SAI Global	AS/NZS 1170.2	Structural Design Actions, Part 2, Wind Actions
[4]	SAI Global	AS/NZS 1170.3	Structural Design Actions, Part 3, Snow and Ice Actions
[5]	SAI Global	AS 1170.4	Structural Design Actions, Part 4, Earthquake Actions
[6]	SAI Global	AS 1657	Fixed platforms, walkways, stairways and ladders – design, construction and installation
[7]	SAI Global	AS 2312	Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings
[8]	SAI Global	AS 3600	Concrete Structures
[9]	SAI Global	AS 3995	Design of Steel Lattice Towers and Masts
[10]	SAI Global	AS 4100	Steel Structures
[11]	SAI Global	AS/NZS 4676	Structural Design Requirements for Utility Service Poles
[12]	NSW Rural Fire Service	NSW Rural Fire Service	Guidelines for Asset Protection Zones
[13]	NSW Rural Fire Service	NSW Rural Fire Service	Practice Note 1/11 - Telecommunications Towers in Bushfire Prone Areas
[14]	NSW Telco Authority	NSW TA Guideline 5	Structural Assessment Guideline for Towers, Masts and Antenna Mounts
[15]	NSW Telco Authority	NSW TA Guideline 6	Radio Site Electricals

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1. Executive summary

This standard is intended to provide performance specifications for the selection and design of appropriate radio equipment support structures for the NSW Government communications infrastructure. This document allows the NSW Government to ensure that the design and supply of structures on their sites will be of a standard that will ensure compliance with all relevant Australian Standards and reflect industry best practice.

This performance standard will seek to encompass as many cases as possible and, as such, will include lattice towers, monopoles, and guyed masts. For each of these cases, specifications will be provided for support structure footings, imposed actions, performance requirements, and lightning earthing requirements (note that this is for lightning suppression for the tower only as full site earthing would constitute a separate standard). These specifications will also relate to the site importance level as defined by the client, site designer and/or Customer.

2. Introduction

2.1 Purpose

The purpose of this specification is to provide the designer, supplier and the civil contractor (collectively referred to as the Service Provider) with detailed technical requirements which must be complied with in performing works for the NSW Government.

This performance specification is applicable for new primary and secondary support structures for telecommunications equipment and defines the whole-of-life requirements including planning, design, performance and construction requirements, operations and maintenance, and disposal. Due consideration shall be given to the durability, serviceability, strength, and quality of the structures to produce a finished product that is fit for its intended purpose.

Variance from this standard is considered acceptable where the alternative solution meets the objectives of the supported services and facilities in a more cost effective manner, taking total cost of ownership in to account.

For convenience, the term 'Primary Support Structure' (PSS) is used in a generic sense to include lattice towers, guyed masts, monopoles, head frames and their footings.

For convenience the term 'Secondary Support Structure' (SSS) is used in a generic sense to include structural supports for Telco equipment such as antennas, aerials, microwave dishes, RRUs, splitters, converters, and feeder cables mounted on the PSS.

2.2 Scope

The requirements specified in this document apply to all new support structures designed and constructed for the NSW Government.

This document must be used in conjunction with normal practice in the telecommunications industry.

In the event that a conflict arises between the requirements of this document and relevant Australian Standard, the mandatory obligations of the Australian Standards shall prevail as follows:

- Commonwealth and State Acts
- Australian Standards, Codes and Regulations and BCA
- NSW Government standards
- Industry standards

It shall be the Service Providers' responsibility to use appropriate standards and codes and to follow normally accepted practice in the industry where any areas are not covered by this document.

2.3 Documentation

The PSS and SSS service provider shall submit all technical documentation and drawings to the Customer including revisions. The design documentation shall include all designs, assumptions, reports, method statements, dimensions, member sizes, calculations, and construction drawings in AutoCAD compatible format for the PSS and footing and the SSS.

All assumptions must be clarified prior to commencement of works.

2.4 Certification

The Service Provider shall submit engineering certification signed by a Chartered Professional Engineer registered on the National Professional Engineers' Register having adequate experience in the given area of practice.

The certification shall include any assumptions and exclusions considered in the design and an executive summary of the results.

2.5 Safety in design

The design process represents the conceptualisation of ideas and implementation of strategies, by a professional design team that enable minimising hazards at source.

Safety in design is the recognition that a design decision can lead to hazards being built into a product, building, or structure that may manifest itself during construction, operation, maintenance, disposal or demolition.

The design team and Service Provider are bound by WHS legislation to record and demonstrate that hazards are eliminated or risk-mitigated for all designs. It should be noted that the Commonwealth WHS Regulations 2011, Chapter 6, Regulation 291 identifies construction work in this field is a high risk activity.

Safety in design endeavours to identify, replace, substitute, or mitigate future WHS risks and hence provide a safer workplace environment for those personnel who will construct, manage, operate, work in, maintain, and ultimately demolish the product, structure, or building.

3. Design of Telecommunications Structures

3.1 General

The PSS and SSS design shall be governed by the current editions of relevant Australian Standards.

The design shall comply with all aspects of this specification and any additional requirements shall be stated on the design drawings.

The design team and the Service Provider shall take into consideration the aesthetic aspects of the design and ensure that the tower configuration and the configuration of all of its components address, as far as reasonable, any visual concerns.

Refer to NSW Telco Authority Guideline 5 (Guideline 5) for a comprehensive guideline on structure design. The following sections provide supporting information and clarification to Guideline 5.

3.2 Classification of services

NSW Government operates services with varying levels of importance. For the purpose of this specification, the following service classifications shall be considered:

Service classification	Description
Mission critical	Application is critical to emergency response and management. Unavailability of this application may impact on management of a life and death situation.
Operational	Application is critical to performing daily operational tasks; however unavailability will not impact on the ability to manage a life and death situation.
Business	Application is related to business or administrative activities.
Information	Application provides information that might be useful to a mobile unit, but is not critical to performing their daily tasks.

Table 1: Classification of service

3.3 Criticality of infrastructure

Importance or criticality is typically related to the consequence of failure or degradation of the infrastructure element under consideration. For the purpose of this document, the classification for criticality or importance of an infrastructure element is taken to be that of the highest importance level of all services supported.

The infrastructure owner or customer may elect to lower the criticality classification of an infrastructure element where redundancy of service is provided by other means in the event of failure the infrastructure element.

3.4 Importance level

The importance level of a structure shall be determined in accordance with AS/NZS 1170.0 Table F1 for concrete and steel monopoles and in accordance with AS 3995 for lattice towers and guyed masts. Unless advised otherwise by the Customer, the Service Provider should adopt importance levels based on classification of services as follows:

Service/structure classification	Importance Level in accordance with AS/NZS 1170.0	Type of Structure in accordance with AS 3995
Mission critical	4	Type I
Operational	2	Type II
Business	2	Type II *
Information	2	Type II *

Table 2: Structure importance level per service classification

3.5 Annual probability of exceedance

Design events for extreme wind, snow and earthquake shall be defined as per AS/NZS 1170.0.

In performing design assessments, the annual probability of exceedance of the design events for ultimate limit state design shall be in accordance with AS/NZS 1170.0 Table F2.

Unless advised otherwise by the Customer, the following probabilities shall be adopted:

Service classification	Importance Level in accordance with AS/NZS 1170.0	Annual probability of exceedance		
		Wind	Snow	Earthquake
Mission critical	4	1/2500	1/500	1/2500
Operational	2	1/500	1/150	1/500
Business	2	1/500	1/150	1/500
Information	2	1/500	1/150	1/500

Table 3: Event probability of exceedance per service classification

3.6 Design working life

The service life of a PSS should be designed to meet or exceed 40 years.

3.7 Design actions

3.7.1 Permanent, imposed, and other actions

The Service Provider shall be responsible for accounting for all permanent, imposed, and other actions including structure self-weight, platforms, access ladder and cages, headframes, cable ladders, etc. acting on the PSS and SSS in accordance with AS/NZS 1170.1 for concrete and steel monopoles and AS 3995 for lattice towers and guyed masts.

3.7.2 Wind actions

3.7.2.1 Site wind loading parameters

Wind region, terrain category and site exposure multipliers shall be determined by site-specific assessment using the relevant Australian Standard and topographic maps.

3.7.2.2 Wind region

Wind region (A1-5, B, C and D) for concrete and steel monopoles shall be determined in accordance with AS/NZS 1170.2.

Wind region (A1-4, B non-cyclonic and C, D cyclonic) for lattice towers and guyed masts shall be determined in accordance with AS 3995.

3.7.2.3 Terrain category

Terrain category for concrete and steel monopoles shall be determined in accordance with AS/NZS 1170.2.

Terrain category for lattice towers and guyed masts shall be determined in accordance with AS 3995.

Where applicable, directional terrain category values shall be provided for eight cardinal directions.

3.7.2.4 Topographic multiplier

The site specific topographic multiplier shall be calculated for the location of the PSS and SSS relative to the crest of the hill or escarpment. Where the local topography surrounding the site has a slope not greater than 0.05, the topographic multiplier of 1 shall be used.

For concrete, steel and timber monopoles, the site specific topographic multipliers shall be calculated in accordance with section 4.4 of AS/NZS 1170.2.

For lattice towers and guyed masts, the site-specific topographic multipliers shall be calculated in accordance with section 2 of AS 3995.

3.7.2.5 Shielding multiplier

Shielding from trees or vegetation is not permitted. A shielding multiplier of 1 shall be adopted for all PSS and SSS.

3.7.2.6 Wind direction multipliers

For concrete, steel and timber monopoles, the site-specific wind direction multipliers shall be adopted in accordance with Table 3.2 of AS/NZS 1170.2.

For lattice towers and guyed masts, the site-specific wind direction multipliers shall be adopted in accordance with Table 2.2.5 of AS 3995.

3.7.2.7 Design wind speed

For concrete, steel, or timber monopoles, the site wind speed shall be calculated in accordance with figure 2.2 of AS/NZS 1170.2.

For lattice towers and masts, the gust wind speed shall be calculated in accordance with Figure 2.2 of AS 3995.

3.7.3 Snow and ice actions

Snow and ice actions shall be considered for support structures located:

- in sub-alpine and alpine regions of Australia in accordance with AS/NZS 1170.3
- in areas known to be ice/snow prone

Sub-alpine

Sub-alpine areas include:

- Central and Northern Tablelands of New South Wales above 600m AHD
- Southern Tablelands, New South Wales 600m and 1200m AHD

Alpine

Alpine areas include:

- Southern Tablelands, New South Wales and Victoria above 1200m AHD

3.7.3.1 Falling ice – protection measures

Support structures deployed in sub-alpine and alpine regions shall be manufactured to suit the conditions.

Antennas, ancillary equipment and maintenance personnel shall be adequately protected from falling ice and snow, i.e. bulk ice and snow shedded from the structure or attached ancillaries. Horizontal protective shields shall be provided for antennas and ground level equipment. Protective guards shall be provided for all exposed horizontal runs of feeder cables. Depending on the maintenance frequency, designers shall consider ground-level protective structures for personnel servicing or moving about the site, as well as adequate warning signs, beneath elements of the structure where ice or snow build-up can occur.

For protection from snow and ice build-up on the upper most antennas on the PSS, a horizontal frame with galvanised steel mesh infill or suitable alternative shall be provided above each antenna such that the protection does not affect the RF performance of the antenna.

For protection from falling ice, an angled frame with galvanised steel plate or mesh shall be provided above each antenna where there is a clear fall distance of five metres or greater, or where an overhead assembly (e.g. headframe) is present.

The feeder cable guard shall be galvanised steel mesh of sufficient strength to protect from falling ice from higher levels on the PSS.

3.7.4 Earthquake loads

3.7.4.1 General

Earthquake loads shall be determined in accordance with AS 1170.4. For steel lattice towers and masts, appendix C of AS 3995 should be used as additional guidance for earthquake design.

3.7.4.2 Probability factor

The probability factor (k_p) shall be taken from table 3.1 of AS 1170.4 for annual probability of exceedance corresponding with the relevant structure importance level.

3.7.4.3 Hazard factor

The hazard factor (Z) shall be taken from Table 3.2 of AS 1170.4. Where the location is not listed, be determined from figures 3.2(A) to 3.2(F).

3.7.4.4 Site sub-soil class

The site shall be assessed and assigned to the sub-soil class it most likely resembles in accordance with section 4 of AS1170.4 and the geotechnical investigation.

3.7.4.5 Earthquake design category

The earthquake design category (EDC) shall be determined in accordance with table 2.1 of AS 1170.4 for the corresponding importance level, sub-soil class and structure height.

3.7.4.6 Analysis and design

Earthquake loads for EDC II support structures shall be determined by static analysis in accordance with section 6 of AS 1170.4.

Earthquake loads for EDC III support structures shall be determined by dynamic analysis in accordance with section 7 of AS 1170.4.

Design of structural components for earthquake loads shall be in accordance with AS 3995 for steel lattice towers and guyed masts; AS 3600, AS 4100 and AS/NZS 4676 for concrete steel and timber monopoles respectively.

3.7.5 Flood loads

3.7.5.1 General

In declared flood zones the PSS design team and Service Provider shall take into account load actions caused by moving flood water and debris acting on the tower. Unless directed otherwise by the Customer, a flood study shall be provided to the tower Service Provider determining design flood levels, flow velocities, and scour depth as a minimum.

3.7.5.2 Scour protection

The PSS design team and Service Provider shall take into account the effects of scour on the PSS footings and shall provide scour protection where required.

3.7.6 Thermal effects

The support structure design team and Service Provider shall take into consideration thermal effects in the design of the structure resulting from the weather extremes particular to the region. Also refer clause 4.2.4, AS/NZ1170 .0.

For structures in bushfire prone regions, classified ‘mission critical’ or ‘operational’, the structure should be designed to withstand 40kWm^2 of radiant heat.

3.7.7 Mine subsidence

If applicable, design the structures to comply with the requirements of the Mine Subsidence Board and submit an application with plans to the board for approval. Submit work as executed plans to the board.

The effects of mining-induced ground movements must be added to those due to the normal building movements arising from footing settlement and seasonal moisture changes in the supporting soil.

3.7.8 Individual antenna physical and wind loading data

The Service Provider shall take into consideration the physical and wind loading characteristics of individual antennas in the design of the structure. The effective sail area shall be calculated from antenna physical dimensions multiplied by the appropriate drag coefficient. The calculation shall include the antenna mount and any ancillary attachments.

3.7.9 Headframe, grouped antennas and other wind loading data

When calculating the effective sail area of a headframe and antenna configurations, the support structure design team and Service Provider shall take into account shielding of leeward antennas and headframe components.

Where explicit details for proposed and future feeder cables are unknown, an additional sail area of 0.3m^2 per linear metre (for lattice towers and guyed masts) and 0.15m^2 per linear metre (for monopoles) applied from the top of the PSS to three metres above ground shall be included for antenna feeder cables.

3.8 Serviceability limit states

3.8.1 Principal structural support

The PSS shall be designed for serviceability limit state by limiting tower rotations under the serviceability wind speed at the top of the tower to meet the antenna manufacturer's specification. This limit applies to the combined rotation of the PSS and its footing.

The serviceability wind speed is equal to the basic serviceability gust wind speed of 28 m/s multiplied by the site topographic multiplier.

3.8.2 Antennas

3.8.2.1 Coverage antennas

The allowable rotation limit of coverage antennas is to meet the antenna manufacturer's specification. The limit applies to the combined rotation of the PSS, its foundation, and the SSS.

3.8.2.2 Microwave dish and Yagi link antennas

Microwave link antennas have stringent rotation limits and these are critical for the PSS design. The rotation limits for specific link antennas may be more stringent than the general limit at the top of the tower.

The PSS designer shall ensure that rotation limits for link antennas intended to be supported on the PSS combined with the rotation of the SSS at the link antenna fall within the manufacturer's specified limits. Where rotational limits for operational performance are not specified by the Customer or antenna manufacturer, the rotational limit shall be 50% of the 3dB antenna beamwidth as measured from the nominal antenna azimuth angle.

4. Performance requirements

4.1 Principal structural support types

The PSS types required for the NSW Government are categorised into three groups:

- Monopoles
- Lattice towers
- Guyed masts

4.1.1 Monopoles

Monopoles shall be steel with hot dip galvanised finish or prestressed spun concrete. Monopoles shall have a capability to be provisioned with at least one headframe. The top of the monopole shall be detailed to allow for a future pole extension, headframe or turret.

The monopole Service Provider may elect to design and fabricate a range of standard monopoles suitable for the applicable generic loading subject to different wind conditions and monopole service classification.

The minimum wind loading conditions for standard monopoles shall be region A, terrain category 2 and topographic multiplier of 1.

4.1.2 Lattice towers

Steel lattice towers may be a triangular or square shape with equal sides in plan.

Where practical, self-supporting lattice towers shall be designed and fabricated as a modular system, such that the individual sections can be added or removed from towers of different height.

The minimum wind loading conditions for standard lattice towers shall be region A, terrain category 2 and topographic multiplier of 1.

Lattice towers shall be supplied with steelwork to support antennas, ancillary equipment, and cables. This steel shall be in the form of a headframe or individual mounts. All lattice towers shall have a hot dip galvanised finish.

For maintenance purposes hot rolled open steel sections are preferred for the PSS and SSS design and construction. Ensure the joint connections are detailed to prevent the build of debris and water and that all connections to footings are supported on reinforced concrete upstands 150mm minimum height above the finished ground level.

Where closed hollow steel sections are utilised as a structural elements, provide minimum 20mm diameter drain holes at opposite ends of the member. Hole positions should be selected such that member naturally drains in its installed position. Holes exposed to water or debris ingress should be sealed after galvanising and prior to final installation.

4.1.3 Guyed masts

Guyed masts shall be of hot dip galvanised steel construction and may be either triangular or square shape in plan with equal sides. Guyed masts shall be designed and fabricated as a modular system with sections that can be readily transported to site, added or removed to form masts of different heights.

4.2 Secondary structural support types

4.2.1 Headframes

Headframes shall be designed to accommodate all antennas, cabling and other ancillaries required.

Headframe design shall consider the technical performance objectives of the supported antennas including:

- required height
- spacing from other services, steelwork or obstructions
- azimuth and tilt
- rotational and lateral stability

Headframe design shall consider the operational performance objectives of the supported antennas and services including:

- personnel access to headframe and antennas (e.g. via PPE or mobile plant)
- ability to test, service and maintain antennas and ancillaries

Unless otherwise approved by the Customer, headframes should be of steel construction with a hot dip galvanised finish.

4.2.2 Ancillary mounts

Mounts or mounting arrangements shall be provided to support all ancillaries required including:

- PMR coverage antennas: omnis, panels, phased arrays
- link antennas: Yagi and microwave antennas
- junction devices and RF Equipment: combiners, filters, remote radio units

Mounts shall:

- be of steel construction with a hot dip galvanised finish unless otherwise approved by the Customer
- be circular section for antennas, installed within 1° of vertical
- provide sufficient space to fasten antenna / equipment brackets

- support equipment at required height, azimuth and tilt
- provide required lateral and rotational stability to ancillaries
- consider requirements for ongoing service, support and maintenance of ancillaries
- not compromise the integrity of the PSS
- shall consideration requirements and tolerances specified by ancillary manufacturers

For clarity, ancillary mounts may not include proprietary brackets, clamps and fixings to support the equipment, e.g. proprietary brackets provided with microwave antennas providing an interface between dish and vertical antenna mounting pipe.

4.2.2.1 Link antennas

The following provides a guideline for link antennas design and should be qualified against structure and antennas manufacturer's requirements.

Unless otherwise specified by the antenna manufacturer, antenna mounts should incorporate a primary mounting pipe of 60-114mm outside diameter and secondary supports of suitable diameter for other elements including panning arm support, horizontal or vertical bracing and radio equipment.

Antennas mounted on towers or masts

Large diameter/aperture link antennas shall be face mounted with sufficient spacing for panning, e.g. link dish greater than 900mm in diameter or antenna with aperture greater than 0.75m².

Small diameter/aperture link antennas may be face mounted or leg mounted. The mounting pipe shall have a minimum 250mm stand-off from the exterior of the supporting structure.

Antennas mounted on monopoles

Antennas should be mounted using either Grade 316 stainless straps, hot dipped galvanised structural steel fabricated collar or galvanised steel chain. The mounting pipe for the link antenna is positioned 400mm from the monopole to allow for panning.

4.3 Footings

4.3.1 Design criteria

PSS footings shall be designed to match the ultimate capacity of the PSS. This shall allow for additional future equipment to be installed without being limited by the foundation capacity.

Where practical and cost effective, consideration should be given for minor over-dimensioning (e.g. 10-15%) of foundation to accommodate potential future structure upgrades.

4.3.2 Footing types

The following footing types are commonly used in for supporting the PSS:

- Direct embedment
- Bored pier
- Insitu reinforced concrete raft
- Insitu reinforced concrete raft on piles
- Insitu reinforced concrete raft and anchors*
- Rapid deployment precast reinforced concrete slab(s)
- Rapid deployment galvanised structural steel grillage with ballast**

*Anchors may be drilled rock anchor, screw pile or percussive driven earth anchor

** Service Provider to provide 50 year minimum service life warranty for foundations

The footing durability design shall consider effects of water table, moisture content and chemical constituents of the soil and shall include the allowance for reduction in the weight of materials due to buoyancy.

4.3.3 Geotechnical Site investigation and report

The site investigation information given in the geotechnical report provides information on the nature of the ground at each tested part. It is not a complete description of conditions existing below the surface.

The Service Provider shall make their own interpretations of the data presented in the geotechnical site investigation report, and their own assessment of any interpretations, deductions, conclusions or recommendations contained in that report.

The Service Provider shall determine fully and to their complete satisfaction all the foundation conditions and all the design parameters that are to be used in the design of the works. This shall be based on specialist professional advice. All geotechnical work is to be undertaken by a qualified geotechnical engineer.

4.4 Bulk earthworks

The Service Provider shall design the bulk earthworks to minimise impact on the environment and provide control measures during construction to this effect.

4.5 Compaction of earthworks

The Service Provider shall show requirements for compaction of earthworks on the civil works for construction drawings.

During construction of the earthworks the Service Provider shall progressively submit to the Customer, or their authorised representative, test certificates from a NATA-registered laboratory for compaction of earthworks.

4.6 Testing

An independent, approved, NATA-registered testing authority shall perform all the compaction testing of earthworks and insitu concrete strength testing and submit test certificates to the Customer or their authorised representative.

The Service Provider shall supply certification that aggregates are suitable for use in roadwork and concrete in accordance with the design specification.

The Service Provider shall not proceed with work subject to testing until tests are satisfactorily completed.

4.7 Erosion and sediment control

The Service Provider shall stage the works such that the agents of erosion are minimised. Plan, carry out and maintain the work to avoid erosion, contamination, and sedimentation of the site, surrounding areas and drainage systems.

4.8 Maximum slope

Limit the slope of embankments to a maximum of one in four unless specified otherwise elsewhere in the design documents. Do not exceed the grades recommended in the geotechnical report.

4.9 Excavations in public areas

Before excavating any public area including roads, footpaths, reserves, and the like, the Service Provider shall obtain the approval of the relevant authorities and comply with their requirements for public access and fall prevention barriers, alternative traffic arrangements, excavation methods, backfilling, and reinstatement.

The Service Provider shall restore areas outside the limits of the works which have been disturbed by the works to their original condition on completion of excavation. Reinstate surfaces to their original level without subsidence and without cracking at junctions with existing surfaces.

The Service Provider shall restore pavements to match existing and reinstate retained top soil and for the new/restored grassed areas.

4.10 Bad ground

Should unexpected and/ or unsuitable material be encountered in the excavation, or soft, wet and unstable areas develop during excavation, consult the geotechnical engineer who carried out the original and/ or undertake supplementary site investigation to determine appropriate remedial works. Submit to the Customer, or their authorised representative, details of any alterations to the submitted construction documents resulting from such advice, before undertaking any additional work.

4.11 Site clearing

Clear only the site areas occupied by the works and areas shown on the design drawings or specified as areas to be landscaped or cleared.

Remove everything on or above the site surface, including rubbish, scrap, vegetation matter, organic debris, scrub, timber, stumps, boulders, rubble, and the like.

Grub out stumps and roots over 75mm in diameter to a minimum depth of 300 mm below finished surface.

Strip and separately store topsoil on site for later reinstatement landscape works.

4.12 Spoil – ground works

Remove surplus excavated material or site clearance material from the site unless otherwise specified.

4.13 Site restorations

Upon completion of the works, restore the natural ground surfaces of the site (i.e. the surfaces which the contract does not require to be altered) to the condition existing at the commencement of the work under the contract.

4.14 Filling

Provide filling free from perishable matter, imported onto the site from an approved source unless the specified filling type can be provided from spoil recovered from the excavations.

Filling types:

Type	Description
General filling	Graded material, maximum particle size 75mm
Hardcore	Inorganic hard material capable of being compacted to an even stable surface
Granular material	Maximum particle size 75mm; percentage passing, 0.075mm sieve – 25 minimum; plasticity index not greater than 15% and not less than 2%

Table 4: Site fill materials

4.15 Placing filling

Suitably prepare the ground surface to receive filling. Place and compact filling in layers, to the required dimensions, levels, grades, and cross section.

Under bearing surfaces such as footings, slabs and paving, compact the filling, and where necessary the subgrade, to AS2870 Residential slabs and footings - construction, clause 6.4.2 or to the recommendations of the geotechnical report, whichever is more critical.

Supply satisfactory evidence in the form of test reports from a NATA registered laboratory to demonstrate that the required compaction has been achieved.

4.16 Service trenches

Backfill and adequately compact service trenches under footings, slabs and pavements to prevent loss of support to and settlement of any new or existing structure above.

4.17 Authorities conditions

Structure design and implementation shall satisfy all the conditions of all relevant authorities such as the relevant consenting authority's including the land and site owner, local council, water board, Roads and Maritime Service, Environmental Protection Authority and the Civil Aviation Safety Authority.

5. Documentation requirements

5.1 Design and construction documentation

Design and construction document provided to the customer should be in the formats listed below or as otherwise agreed with the Customer:

Type	Description
Reports and Specifications	MS Word 2010; or Portable Document Format
Calculations other than structural assessments	MS Excel 2010; or Portable Document Format
Sketches	MS Visio 2010; or Portable Document Format
Drawings	AutoCAD 2010; and Portable Document Format
Tower/Mast structural assessment models	MS Tower

Table 5: Documentation formats

5.2 Structural assessment and certification

The Service Provider shall provide as a deliverable all of the calculations including the MS Tower model (or equivalent model) for all supplied components. These deliverables shall be verified before delivery to the Customer by a qualified Engineer (see section 2.4).

To satisfy the safety in design requirements of the WHS Act and Regulations 2011, all designers shall provide dimensional data and member schedules in their design documentation. This shall be in the following forms:

- CAD drawings: general arrangement drawings

- Bill of materials: schedule of member details

This will inform the Customer, other Service Providers, and users of the design intent and will enable them to carry out risk assessments for construction, future maintenance, and demolition works that may affect the structure. Intellectual property claims shall not be accepted as a reason for withholding essential information.

6. Primary structural support access provisions

6.1 General

All Primary Structural Support (PSS) shall be have provisions for safe access to all antennas, equipment, and cabling. Unless instructed otherwise by the Customer, it is preferred that all PSS should satisfy this requirement without the need for external elevated devices.

All PSS shall be provided with an access ladder in accordance with AS 1657 and a fall arrest device/ system in accordance with AS/NZS 1891 and the pertinent structure type code.

6.2 Monopoles

For monopoles, access should be provided using horizontally opposed step bolts or step pegs in combination with a flexible fall arrest device.

6.3 Lattice towers and guyed masts

Access to steel lattice towers and guyed masts shall be in accordance with appendix D of AS 3995.

Access arrangements for self-supporting lattice towers shall be designed as for class B structures, guyed masts shall be designed as for class C.

The structures access provisions must satisfy the requirements of AS 1657.

6.4 Headframe and platforms

The platform and headframe structure shall have sufficient capacity to support the anticipated maintenance loads. If a fall arrest system or fall arrest anchor points are provided they shall be provided in accordance with AS 1891.

Where fall arrest systems are provided they shall be designed such that personnel can remain permanently attached whilst arriving, departing and working on the platform.

Where an access hatch is required on the platform, a ‘hold open’ device or latch shall be provided. The hatch shall be able to be closed and support the same loading as the surrounding platform.

6.5 Anti-climb devices

An anti-climb device shall be provided to prevent unauthorised climbing of the PSS with an access point located three metres above ground.

The anti-climb device shall be designed, supplied and certified by the PSS manufacturer.

The Service Provider shall provide a basic handbook or instruction sheet detailing the safe operating and loading limits of the device. All elements of the device shall comply with the applicable Australian Standards.

7. Lightning protection earthing

7.1 General

A lightning protection system is an important element of the overall communications site design and as such is covered in other more specialised documents. A risk assessment shall be carried out for each site as outlined in AS/NZS1768 Lightning Protection. The spreadsheet assessment tool provided with AS/NZS 1768 shall be used for the assessment parameters as required.

7.2 Earthing

The structure shall be earthed as part of the overall communications site earth design. This section provides guidance on earthing in relation to structures only. For details of overall communications site earth design please refer to the any published earthing guidelines.

The structure shall have a lightning finial(s) fitted at the highest point on the structure with a minimum length of 500mm. The maximum length allowed by AS/NZS1768 is six metres. Exclusion for lightning finial(s) may be considered where:

- antennas are mounted at the top of the structure
- antennas are DC grounded provide structure protection similar to that of a lightning finial (e.g. binary array antenna)
- Customer accepts risk of antenna failure in the event of a direct lightning strike.

If the PSS is of steel construction the structure shall form the down conductor which is to be bonded into the lightning protection system at ground level. Structures of non-metallic construction shall utilise either reinforcing steelwork or be provisioned with dedicated down conductors which are then bonded into the lightning protection system at ground level.

Should the PSS be constructed on an existing structure/ facility (e.g. rooftop), the PSS shall be connected to the existing structure/ facility earthing system.

The earthing point(s) of steel or concrete monopoles shall be at steel or cast in earth tags provided with the PSS. No drilling of the PSS to provide earth points shall be acceptable.

The earthing point(s) of steel lattice towers or guyed masts shall be at existing bolts. No drilling of the structure to provide earth points shall be acceptable.

7.3 Resistance to earth

In consideration of AS3015 Table 4.1, the site earth system supporting protection of the structure levels should adopted the following resistance to earth objectives:

Type of facility	Resistance to earth objectives*
Core network facility or data centre	1Ohm minimum 0.5 Ohms preferred
Major radio repeater site (e.g. hilltop PMR site, cable transmission site)	5 Ohms minimum 2 Ohms preferred
Minor radio / transmission site (e.g. depot / workshop facility)	10 Ohms minimum 5 Ohms preferred
Other facilities	10 Ohms minimum 5 Ohms preferred
Core network facility or data centre	1.0 Ohms minimum 0.5 Ohms preferred

Table 6: Resistance to earth objectives

* - the minimum objectives may be relaxed by a factor of 2.5 times in cases where ground condition or site layout is prohibitive in accommodating a satisfactory ground earth system, e.g. rocky ground.

7.4 Testing

Testing of the structure's earthing shall be undertaken as part of the overall communications site earth testing.

Further information on the requirements and methodology for lightning protection earthing systems can be found in:

- AS/NZS1768 Lightning Protection
- NSW TA Radio Site Electricals guideline (Guideline 6)
- AS/NZS 3015 Electrical Installations

8. Aircraft obstacle lighting

8.1 General

Under the Civil Aviation Regulations the Civil Aviation Safety Authority (CASA) has the ability to determine that an object which intrudes in navigable airspace requires obstacle lighting to be installed.

Obstacle lighting can also be mandated by local councils where they are responsible for the operation of an aerodrome. This will normally be communicated as a condition of the Development Application.

Additionally the Royal Australian Air Force Aeronautical Information Service (RAAF AIS) has responsibility for maintaining a tall structure database. This database is for all structures 30m or more above ground level within 30km of an aerodrome civil or military and 45m greater above ground level elsewhere.

Where required, the tower shall be painted, marked or otherwise identified as an aviation obstacle in accordance with CASA's Manual of Operational Standards and the Civil Aviation Regulations.

8.2 Obstacle lighting

Obstacle lighting shall be provided on structures as required by any of the authorities listed in section 8.1 including the following cases:

- on all structures 110m or greater above ground level
- for structures within 30km of an aerodrome or airport
- for structures / ancillaries that penetrates a published Obstacle Limitation Surface Plan

Where obstacle lighting is required the following shall be provided:

- high intensity flashing white lighting for structures in excess of 150m above ground level
- low intensity steady red lighting for structures 45m or less above ground level
- medium intensity lighting shall be provided for extensive structures (e.g. buildings), structures 45m or greater above ground level, or if determined by CASA. The lighting may be steady red, flashing red, or flashing white dependent on specific circumstances.

Lighting may be supplied from the available A.C. or D.C. power system.

All cabling on the structure shall be adequately mechanically protected against the elements and fauna.

Obstacle lighting shall be as detailed in CASA manual of standards part 139 section 9.4.

8.3 References

Refer also to:

- CASA manual of Standards part 139 Section 9.4
  http://www.casa.gov.au/scripts/nc.dll?WCMS:PWA::pc=PARTS139
- RAAF AIS, Aeronautical Data Officer, (03) 9282 5750, ais.charting@defence.gov.au

9. Corrosion protection of the primary and secondary structural support

9.1 General

The Customer requires the Service Provider to provide a performance guarantee of 15 years before first maintenance is required for the as installed corrosion protection system PSS and SSS structural steelwork.

Design all concrete work to the requirements of AS3600 concrete structures with 50 years minimum lifetime durability.

9.2 Minimum requirements for structural steelwork

Structures shall be provided with a corrosion protection for all structural steelwork to the requirements of AS2312. Determine atmospheric environment/ classification for the site from section 2 of AS2312.

A galvanised system should be adopted for all exposed external structural steelwork and those elements that are not easily accessible for future maintenance. Based on this system, use a further coating mass in terms of galvanising and/ or painting to comply with the 15 years guarantee requirement, as necessary.

Galvanised coating shall comply with Australian Standard AS/NZS 4680 and AS 1214. Member sizes and fabrication details shall be adopted to safeguard against warping and distortion during the galvanising process.

When selecting the protection system, ensure compatibility of the primer and top coats. Do not use products containing lead or chrome bases.

Notwithstanding any other requirements, all cold-formed steel used as a SSS shall be zinc coated with a minimum coating mass of 300g/sqm in accordance with AS1397 steel sheet and strip – hot-dipped zinc-coated. Provide additional protection as the design requires.

Avoid steel work directly in contact with ground.

9.3 Concrete durability

Design external structural concrete elements to comply with a minimum 50 year lifetime durability complying with Section 4 Design for Durability of AS3600 Concrete structures. Refer also to Technical Note TN57 Durable Concrete Structures from the Cement and Concrete Association of Australia

10. Operation and maintenance

10.1 General

To assist the operation and maintenance of the all systems supplied including the structure throughout the equipment lifecycle the following documentation shall be provided in a form acceptable to NSW Government, including where relevant:

- structure operating handbook including all design drawings and member schedules, also includes the structural model and all assumptions and parameters used to arrive at the final calculated loading in the structure and footing
- key Customer contacts in an emergency
- maintenance manual
- trouble shooting manual
- detailed list of recommended spares holdings
- as-built Installation drawings prepared in accordance with Customer guidelines
- design and as-built details of the earthing system. Earthing system maintenance specifications
- test certificates for concrete integrity, soil compaction, resistance to earth tests, commissioning sheets
- recommended maintenance schedule
- guidance on safe and sustainable disposal

11. Disposal

11.1 General

The support structure shall be designed to enable demolition using contemporary techniques. The Service Provider shall provide information so that potential demolisher can understand the structure, load paths, and any features incorporated to assist demolition, as well as features that require unusual demolition techniques or sequencing.

All demolition work shall comply with the AS 2601-2001 the demolition of structures and the demolition work code of practice dated 2014 as issued by Safe Work Australia.

11.2 Engineering considerations

The demolisher shall carry out or arrange the carrying out of any calculations, analysis, testing or examination necessary, prior to the demolition, to minimise the health and safety risks to the demolisher and the public.

11.3 Risk management

The demolisher shall manage risks in accordance with the WHS Act and Regulations 2011.

11.4 Demolition works plan

Demolition work shall be carefully planned before the work commencement. Planning involves identifying hazards, assessing risks, and determining appropriate control measures in consultation with all relevant persons involved in the work.

11.5 Waste recycling and disposal

Materials and finishes specified for the original structure may require special attention at the time of demolition and any special requirements for the disposal and/or recycling of those materials or finishes should be advised to the demolisher through the risk assessment documentation provided by the tower Service Provider.

11.6 Hazardous materials

All hazardous materials and waste that has the potential to exert a detrimental effect on people or the environment shall be correctly identified on site and safely disposed of in an environmentally and socially acceptable manner.

12. Terms and Definitions

Acronym	Definition
AHD	Australian height datum
Ancillary	For radio structures an ancillary may be considered to be any elements installed on a structure other than primary and secondary structural members. Ancillaries may include antennas, cables, cable support, lighting, fall arrest systems, signage, lightning protection systems and radio equipment.
BCA	Volumes 1 & 2 of the NCC
BTS	Base transceiver station
Coverage antenna	Telecommunications antenna that transmits/receives radio signals to provide cover to the surrounding areas
Customer	NSW Telco Authority or other NSW government agency representative
EME	Electromagnetic energy
EWP	Elevated work platform
Guyed mast	Steel framed truss reliant on the mast footing for vertical and horizontal ground support and on steel cables connecting the mast to footings for overturning stability
Lattice tower	Steel framed cantilever truss reliant on the support footing for overturning stability
Link antenna	Antenna that supports wireless backhaul to another telecommunications site
Monopole	Monolithic cantilever structure constructed in either steel, reinforced or prestressed concrete or timber reliant on the support footing or direct ground embedment for overturning stability
MS Tower	Specialty software tool by Bentley Systems Inc. for engineering and assessment of lattice structures
NCC	National construction code of Australia
NSWTA	New South Wales Telco Authority
ODU	Outdoor unit
PPE	Personal Protective Equipment
PSS	Primary support structure
RF	Radio frequency
SSS	Secondary support structure
WHS	Work health and safety

Table 7: Terms and definitions

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