NS203

Planning and Design Standards for Electrical Network Telecommunications Assets

November 2010

SUMMARY

Network Standard NS203 provides the design criteria for Ausgrid personnel associated with the planning, design, construction, maintenance and auditing of communication network assets used to support the electrical network. The document includes communication requirements for protection circuits, which being the most demanding in terms of availability, determine key aspects of the communications network.

ISSUE

Ausgrid staff: This Standard is for issue to all staff, Accredited Service Providers' and Alliance Partners' staff involved with the design of Ausgrid's major substations.

Where this standard is issued as a controlled document replacing an earlier edition; remove and destroy the superseded document.

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It is possible that conflict may exist between standard documents. In this event, the most recent standard is to prevail.

This document has been developed using information available from field and other sources and is suitable for most situations encountered in Ausgrid. Particular conditions, projects or localities may require special or different practices. It is the responsibility of the local manager, supervisor, assured quality contractor and the individuals involved to ensure that a safe system of work is employed and that statutory requirements are met.

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INTERPRETATION

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

Network Standard
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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to define the architecture of the Ausgrid communications network as used for electrical network purposes including protection circuits, categorise the protection links and provide a set of options from which a network can be designed and built. The aim is to establish ground rules for the development of the network.

The requirements identified in this document are based primarily on the requirements of the protection circuits. Protection circuits are assumed to be the most demanding in terms availability, therefore take precedence over other electricity Network applications such as SCADA. It is assumed that the bandwidth and latency requirements of other applications are met by the use of fibre planned and designed in accordance with the principles and detail shown in this document. The document will deal with the issues associated with the sharing of assets for protection and other functions.

While the concept of protection system redundancy is not unusual, the National Electricity Rules now firmly ties the communication system to the same requirements as the protection system for much of the 132 kV and some of the 66 kV network. In addition, NSW regulations now also specify redundancy which will affect the communications network

This document is not a fibre deployment plan, since it does not aim to be geographically specific. The role of fibre as the dominant component of the communications platform is assumed in this document and it does not aim to justify that aspect.

Equipment to be connected to the fibre network for specific applications such as protection is not covered by this document. Equipment required to establish a communications path is covered.

Since this document is designated as a Planning and Design Standard and recognising that it is difficult to lay down set rules for all situations, (particularly where equipment is to be installed on existing sites), some effort has gone into providing background material allowing a user to engineer the most appropriate solution for implementation. This document is intended to be used by competent and experienced staff to “engineer” a solution in keeping with the document. If the solution that is “engineered” does not meet the requirements of this document the designer shall obtain approval from the Manager responsible for design of communications systems for power system protection prior to release of the design.

2 REFERENCES

2.1 Network Standards and Engineering Guidelines

NEG TC01	All Dielectric Self Supporting (ADSS) Cable on Poles - Design Guidelines
NEG TC04	Bearer Availability Model
NEG SM04.7	Selection of Substation Batteries
NEG SM07	Active Fire System for Substations
NEG TC08.1.1	Telecommunications Dictionary
NS130	Specification for Laying of Underground Cables Up to 22 kV
NS168	Specification for the Design and Construction of Underground Subtransmission Lines
NS171	Fire Stopping in Substations
NS185	Major Substation Building Design Standard
NS187	Passive Fire Mitigation Design of Substations
NS191	Batteries and Battery Chargers
NS201	All Dielectric Self Supporting Fibre Optic Cabling for Installation on Distribution Assets
NS204.7.1	Communications Pits – Specifications and Installation Guidelines
NS206	Earthing Requirements for Communications Assets.
NS208.2.1	Telecommunications Communication Cabinet Architectural Design Work Instructions
NS208.2.2	Telecommunications Communication Cabinet Cable Interconnectivity Design Work Instructions
NS208.2.3	Telecommunications Substation Communication Cabinet Allocations Design Work Instructions
NS218	Telecommunications Protection Signalling Policy
NEG TC19	Allocation of Optical Fibre Tubes Design Work Instruction
NEG TC20	Protection Communication Links Construction Policy
NEG TC21	Requirements for Diversity Planning Policy
NS228	Telecommunications Interface to Third Party Assets Procedural Standard
NUS100	Field Recording of Network Assets
NUS174C	Ausgrid, Environmental Handbook for Construction and Maintenance

2.2 Australian Standards

AS/NZS 3084:2003

Australian Standard, Telecommunications installations - Telecommunications pathways and spaces for commercial buildings (ISO/IEC 18010:2002, MOD)

AS 61850.3-2005
: Communication networks and systems in substations - General requirements

AS 60870.2.1-1998
: Telecontrol equipment and systems - Operating conditions - Power supply and electromagnetic compatibility

ENA Doc 015-2006
: National guidelines for prevention of unauthorised access to electricity infrastructure

NER
: National Electricity Rules

3 HARDWARE

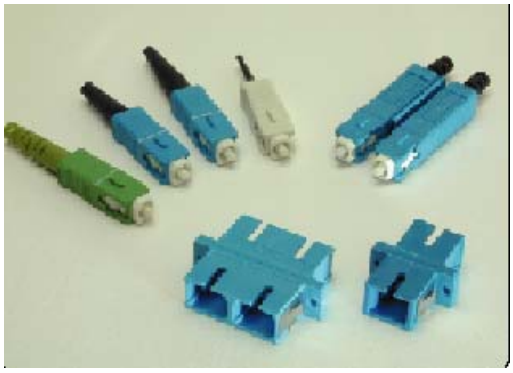
3.1 General

Equipment used for protection circuits must be designed for purpose. This applies to all assets. For example:

- If there is a need to place ADSS underground it must be water blocked and termite resistant cable.
- Patch cords in buildings must have the suitable bend radius protection as per manufacturer's specifications.
- Equipment enclosures must be bolted down.

3.2 Patch Cords

The quality of the optical fibre patch cords used in the network is a defining factor in making sure it performs predictably, consistently and reliably. Correct mode and core size patch cords shall be used in all instances.



SC Connectors

- Insertion loss must be better than 0.35 dB.
- Angle SC to be used for single mode fibre patch panel terminations.
- Flat SC to be used for multimode fibre patch panel terminations.
- Wherever feasible equipment is to be purchased with flat or angle SC connectors, to suit.

Legacy types previously in use in Ausgrid will be progressively phased out of service on the basis of capping existing usage and growing the network using the new standard.

Patch cords and patch cord label colours shall be used for ready identification of protection and other functions according to the table below:

Patch Cord Colours

Mode	Protection	Other Functions
Single Mode	• Red patch cord • Purple label	• Yellow patch cord • Green label
Multimode	• Orange patch cord • Purple label	• Pink patch cord • Green label

Patch cords shall be installed in lengths appropriate to the installation to reduce slack on the frame. Cords shall be installed such that the distribution frame does not become congested with excess lead lengths.

All patch cords are to be hung from one end for a period of 24 hours before use on the patch panel to reduce coiling of the patch leads when installed on the patch panel.

Patch cords will be run between cabinets only within the same room and only when held in suitable purpose build fibre guides. Outside the room fibre is to be run in ruggedised pre-terminated cable assemblies or as un-terminated fibre sheath.

3.3 Terminations

Copper cable terminations will be rare, however if required, all cores of copper cables shall terminate in one location i.e. cables shall not be split at their immediate end point. If cores of the cable are required for other purposes, the cable shall be aggregated in one location, and subsequent cables run to further locations.

For fibre terminations within the same rack it is a requirement to split the sheath into fibre tubes within the core network termination enclosure and separate protection and general access tubes. Individual tubes are not permitted to be subdivided into individual fibres in this manner and must be terminated first before being extended from the core partition to the access partition of the fibre termination box. Transferring tubes from one partition to another can ONLY be done within the same rack and they must be suitably protected from damage through the use of grommets, protective tubing and purpose made radius control mechanisms as supplied by the manufacturer.

Cabling carrying active protection circuits must be terminated on a dedicated core network enclosure and segregated using a physical barrier, such as a subrack or a separate splice enclosure. This includes intermediate splice locations using external splice enclosures. Protection fibres will be spliced to the equipment and not patched until the fibre reaches the dedicated protection panel.

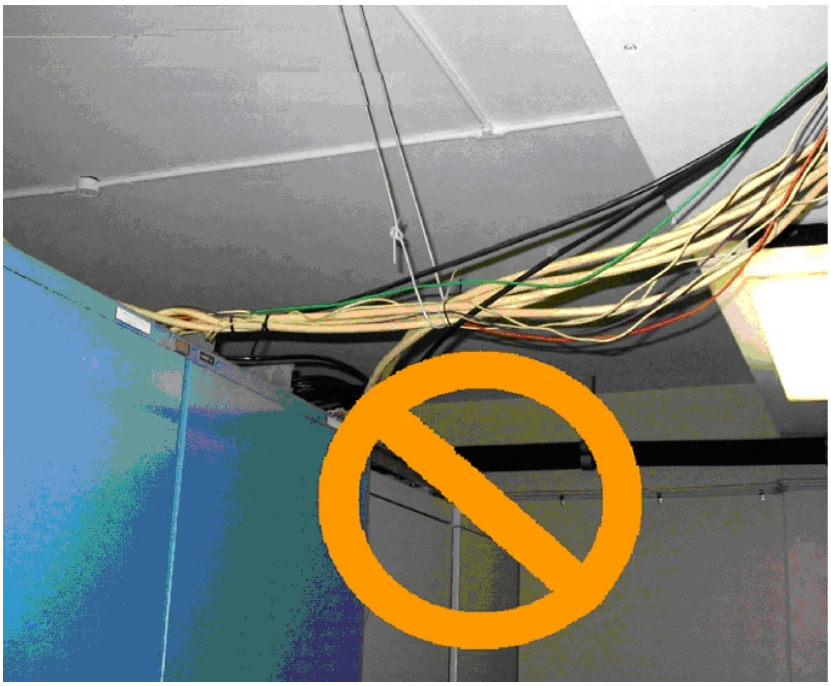
Stand-by and emergency fibre paths can be patched as required, taking note of optical budgets and ensuring that the dedicated standby path will actually perform the required function.

3.4 Fibre and Cable Guides

Cabling carrying protection circuits shall be supported on purpose built systems such as cable trays or conduits with suitable bend radius control. External optical fibre sheath is carried on regular cable tray systems, however caution is required with bend radius control and over tightened cable restraints.

Patch cords used for protection circuits must be carried on purpose built fibre guides or other product specific for use with patch cords, such as split conduits. Dedicated fibre guides are to be used for bundles of more than 20 patch cords. Access to fibre cables already installed in the fibre guide must ensure that any new fibre can be installed or existing optic fibre removed without inducing improper bends on adjacent fibre.

Note: Cables are to be adequately supported when interconnecting racks. The figure below shows cables incorrectly supported.



Incorrectly Supported Cables

The figure below shows a typical 2” fibre guide and split conduit. Note that the yellow fibre guide must be suitably supported according to manufacturer’s instructions.

Sample Use of 2” Fibre Guide

3.5 Radio Equipment

Radio installations requirements are as follows:

- Protection circuits over radio bearers shall only be on microwave systems using licensed frequencies.
- Interface to be a true 2 Mbit G703; in particular the protection equipment must have access to time slot 16.

- The equipment is to be air conditioned for reliability and longevity, however it must be rated in the temperature range -10^{o}C to +55^{o}C or better.
- Radio equipment mean time between failure (MTBF) must be a minimum of 5 years.

The level of detail available on remote interrogation is dependent on the action that could take place. i.e. If a transmitter fault is to be cleared by replacing a module, then that is the level of remote diagnostic required.

A “Radio fail summary” alarm must be provided.

Other points to be considered include:

- Antenna towers and masts must be purpose built and certified by a qualified structural engineer.
- All external steel work is to be hot dipped galvanised to the same standard as transmission towers (eg. with an expected life of forty years).
- Equipment is to be rack mounted on 19’’ racks with rail at the front of the cabinet; if required, the use of shelves is acceptable, but not preferred; if shelves are used, equipment must be secured and not left loose.
- Cabinets must have capacity for cross connection panels at 75 ohms coaxial connectors.
- Twisted pair connectivity for all purposes, i.e. 120 Ohms G.703 or alarms, must be done at insulation displacement Krone block for protection circuits; for other circuits it is also permissible to use RJ45 or RJ12 connectors.
- Maintain records of the Krone frame and any other cross connections as soft copies.
- All cable tray and supports to be galvanised 150mm wide as a minimum. This capacity is likely to be sufficient in the majority of cases.
- All external cabling to be UV stabilised, bird and rodent resistant and clearly marked as Ausgrid asset. Note that at times radio installations share towers and it is critical that our cabling be identifiable as being Ausgrid property.

When sharing Ausgrid infrastructure, the tower structure can be shared, however the hut shall be for exclusive Ausgrid use.

Battery minimum back up time for radio sites is to be the same as the back up time of the function and location being supported. At the time of writing this document a substation requires 5 hours of battery back up and must have the facility to connect a portable generator.

3.6 Labels

Patch cord labels must be a light weight adhesive type made for the purpose, using a wrap around, self laminating vinyl label, such as the Brady self laminating Vinyl product part number 62351, reference number PTL-104-427. This will provide an area of 38.1x9.53 mm on which to write. Smaller and larger options are available.

Sample Patch Cord Label

Purple labels shall be used for **protection** and **green** labels shall be used for **other** applications.

The label is to be installed such that the writing can be seen WITHOUT the need to twist the patch cord ie. fold around the cord then retain a “flag” with the writing on it not on the cord.

These labels are available from a number of suppliers and can be produced on a hand held, battery operated labelling machine or on a laser jet printer.

The label will state the following:

- Location of the distant end of the patch cord; this will be the equipment in the same room eg. “Cab A. RU x”, where x is the rack unit locating the patch cord. When the patch cord is only within the same cabinet, label the location as “Local”.
- Distant end circuit location eg. at HOB a patch cord may say “Wallsend” as the distant end of the circuit.

The colour of the cord and label will indicate if it is used for protection.

Fibre sheaths will be labelled at entry to a fibre splice enclosure or gland.

3.7 Communication Pits

Refer to NS204.7.1 *Communications Pits – Specifications and Installation Guidelines* for more detailed information on pits.

Pits will hold at least one splice enclosure plus up to 4x20 metres coil as well as having enough space to not compromise the bending radius of the fibre cable during installation and storage; note that rodent proof fibre cable has a larger diameter and has a significantly larger bending radius than normal fibre cable.

The coils are there to provide cable distance that can reach a nearby parked van; fibre splicing is done in vehicles which have the equipment, provide power, cover from the elements and reduce dust contamination in the splice.

3.7.1 Use of Electricity Pits

As a rule fibre cables should not be installed in electricity pits since they will provide a hindrance for electrical cable installations and a risk of damage to the fibre. If required communications assets that carry protection functions can transit electricity pits. This will require that any fibre be installed in conduit within the pit. The conduit must be diverted around the edges of the pit such that:

- it will not interfere with any current or future electrical cable work, be that new cables or recovery,
- meets the minimum bending radius,
- have access for construction purposes, and
- be protected from damage by galvanised steel structure where it is not attached directly to the side of the pit.

The above generally will result in small conduits being run around the pit, covered by galvanised steel protection (eg. Unistrut or similar) between the large conduit and the wall of the pit.

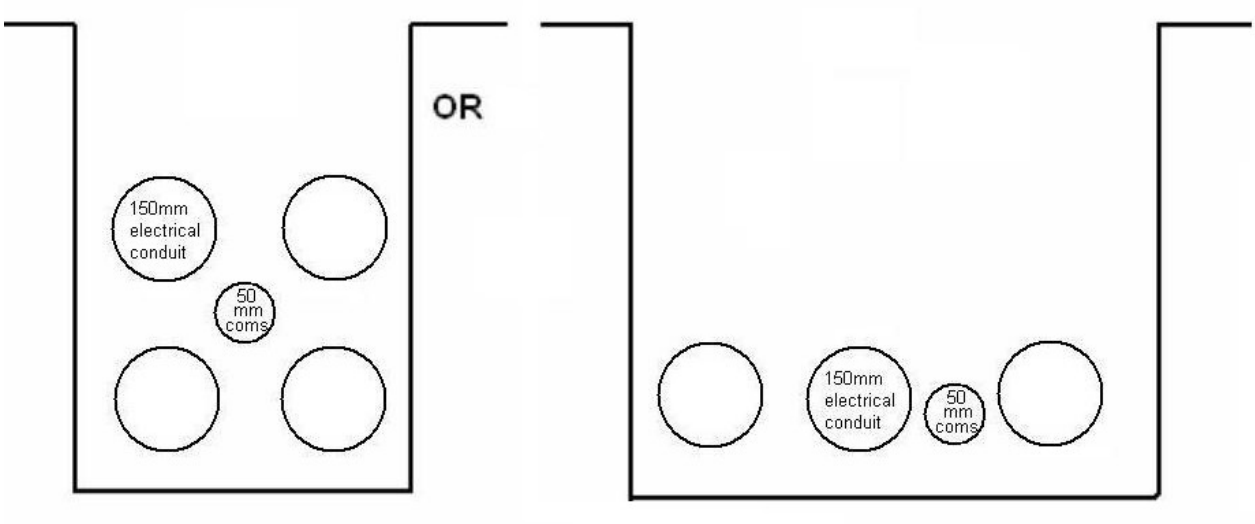
3.8 Conduits

Installation shall comply with the requirements of NS130 *Specification for Laying of Underground Cables up to 22kV* and NS168 *Specification for the Design And Construction of Underground Subtransmission Lines* as applicable.

Conduits holding protection fibre cable shall not be made available for third party access and must retain at all times sufficient spare capacity to install an additional fibre cable under fault conditions.

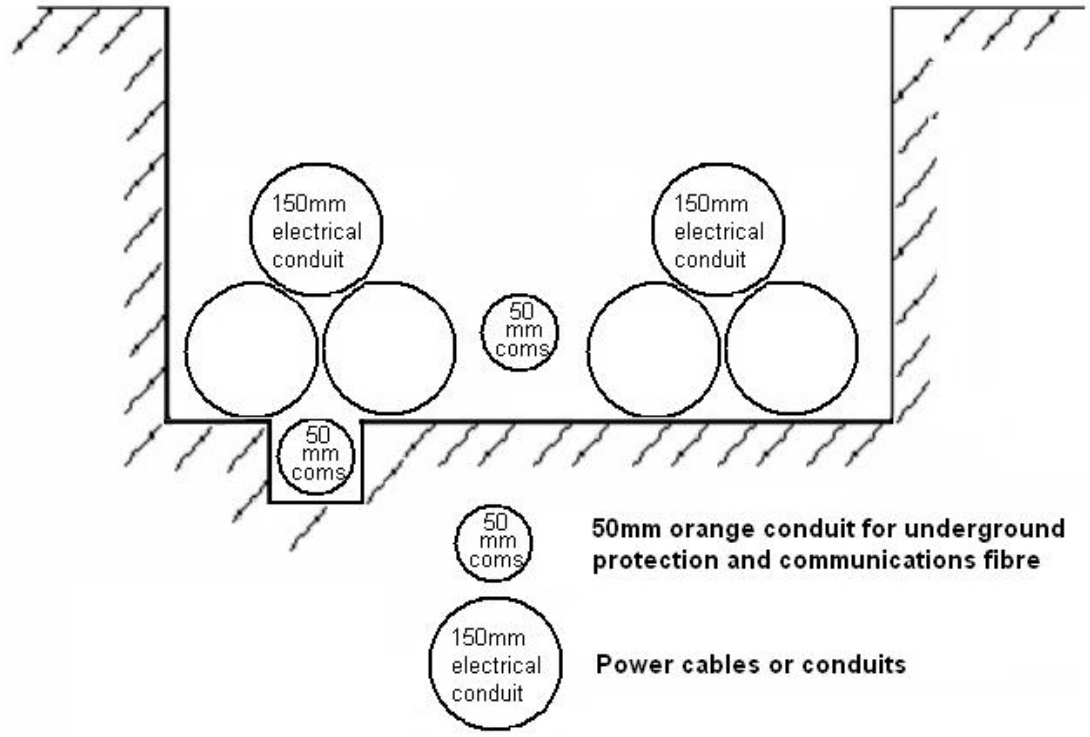
When selecting the conduit to be used for protection fibres from a nest of conduits, the planner or designer will need to consider the future possible electrical build activity, such that the fibre will not be affected by that work. Typically, select a conduit on the side of the nest and second from the top. Conduits holding protection fibres for category 1 and 2 protection circuits are not to be above the electrical conductors (ie. conductors or electrical conduits must offer a minimum of one layer of cover).

Communications conduits will also be provided by default with HV buried cable or conduit installations. The typical configuration is as shown below:



Communications Conduit Location

When installing communications conduits for critical protection that requires diversity and is to be installed in the **one** trench, use two 50 mm orange conduits in the arrangement indicated in the figure below.



Diverse Communications Conduit Location in a Single Trench

The key feature of the arrangements is that one is below the feeder and the other is between the feeders. In this way we can mitigate the risk from vertical excavation damaging only one or a horizontal excavation damaging only one, without first coming into contact with the HV cables.

Communications conduits and subducts must be labelled as Ausgrid assets.

Ausgrid communications conduits shall be:

- orange in colour,
- 50mm as standard, with the use of 32 mm if required, but not preferred,
- installed below or between HV cables, as shown above, **OR** with 900mm cover outside Ausgrid substation fence and 500 mm cover inside the fence, and
- have a bend radius as large as feasible, but not less than 1200mm as per NS130.

4 SPECIFIC EQUIPMENT ISSUES

4.1 Optic Fibre Equipment

4.1.1 Fibre Cable

Critical to having improved fibre availability will be three aspects of fibre termination:

1. Physical Separation

This aspect will be achieved through the use of separate core and access terminations, as shown in the various diagrams below.

2. Access Control

A key aspect to the sharing of fibre sheath is the physical separation between the core network and general access to fibres.

3. The Use of "ring barking".

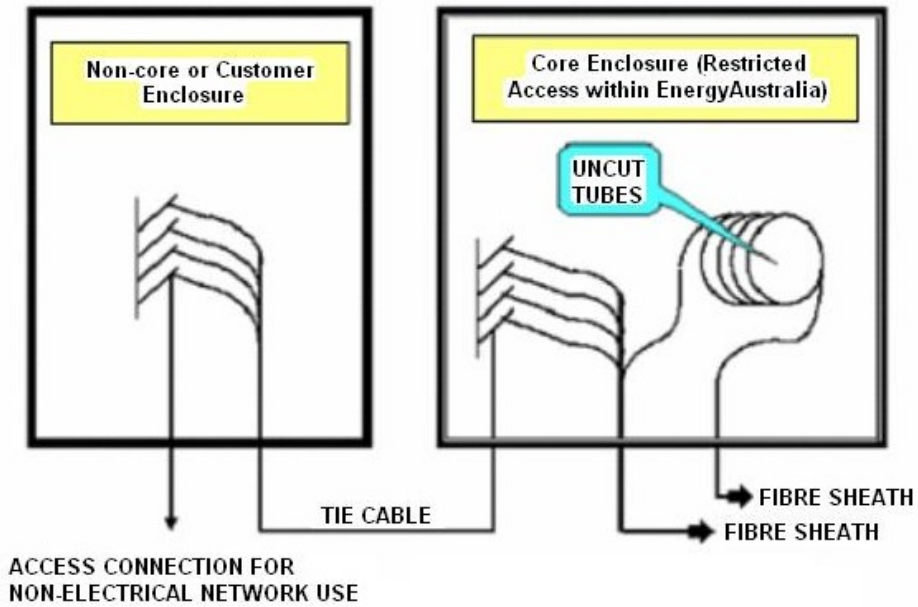
This refers to a fibre termination whereby the fibre sheath is removed without cutting the tubes within. These uncut tubes are stored and pass through the fibre enclosure without a splice. This technique has the advantages of reduced risk of failure from physical damage through handling or water ingress, reduced losses on the fibre path and reduced cost.

Fibre tubes carrying protection circuits shall not be cut unless required for access to the fibres, repairs or for construction requirements (typically joints at the end of the fibre cable drum).

Please note that ring barking is a technique best suited to splice enclosures in the street or to terminations in buildings that are "close" to the final termination point. "Close" is a matter of judgement. The basic issue is that it is impractical to run any significant length of fibre in, through and then out of a building without cutting it.

4.1.2 Optical Splice Enclosures

In keeping with the philosophy that only core network functions shall be accessed through core network enclosures, the following shall apply to external splice points:



Fibre Termination Point for External Enclosures

The key features of this arrangement are as follows:

- The control of the backbone sheath rests with the core splice; the access splice receives only a sheath as a fibre tail
- Core and access functions are physically separated. In an external plant environment this arrangement is achieved using two separate splice enclosures, where the core splice receives the fibre sheath, then extends to the access splice using a short tail; they have separate locking arrangements and will be labelled differently.
- The core splice can have tubes that have been ring barked from the sheath and stored uncut. Typically, this will be all tubes other than the tube being accessed.

5 BROWNFIELD SITES

5.1 Connectivity to Older Architecture

When connecting to fibres that have not followed the above rules, connect fibres carrying protection, SCADA and other functions that directly support the electrical network directly to a core splice. All other connections are to be done via the non-core enclosure.

5.2 Existing Substation Sites

It is recognised that the bulk of the communication installations in the near to medium term will be undertaken in existing site, not all of which will be ideally suited. At these sites exceptions can be made to the use of the standard rack if space does not permit it. All the other aspect of this document apply and the use of non standard racks will require the same performance, in particular the use of clean filtered air, heat dissipation and compliance with the relevant standards.

Appendix A - Fibre

A.1 Functions Carried Over the Fibre Network

The fibre network carries both protection and general communications traffic. As a result, the architecture described below allows for protection circuits to be carried in the same fibre sheath. Due to build standards and physical security, some general communication links may not be suitable for protection circuits.

The current Ausgrid fibre network has as its most critical function the connectivity of protection circuits and the control and monitoring functions in sub-transmission and zone substations to control centres. Other applications may include security, LAN connectivity, load control and in some cases telephony.

It is envisaged that in the near future fibre connectivity to lower parts of the electricity network may be required and will be used when an opportunity arises. These are considered here in terms of establishing the fibre architecture to allow for future connectivity, hence maximising the fibre asset value.

In a logical form the fibre connectivity is shown in diagram A.1.1 below. The schematic of a possible physical arrangement follows in figure A.1.2.

The purpose of the illustration is to highlight that logical and physical connectivity are not the same. In the use of fibre technology for protection circuits this is further highlighted by the fact that the physical path of the high voltage transmission cables will at times be separate from the fibre that provides the protection. Typically the fibre will follow a path that will allow multiple uses of the one fibre sheath, such as connectivity to multiple zone substations as well as sub-transmission substations.

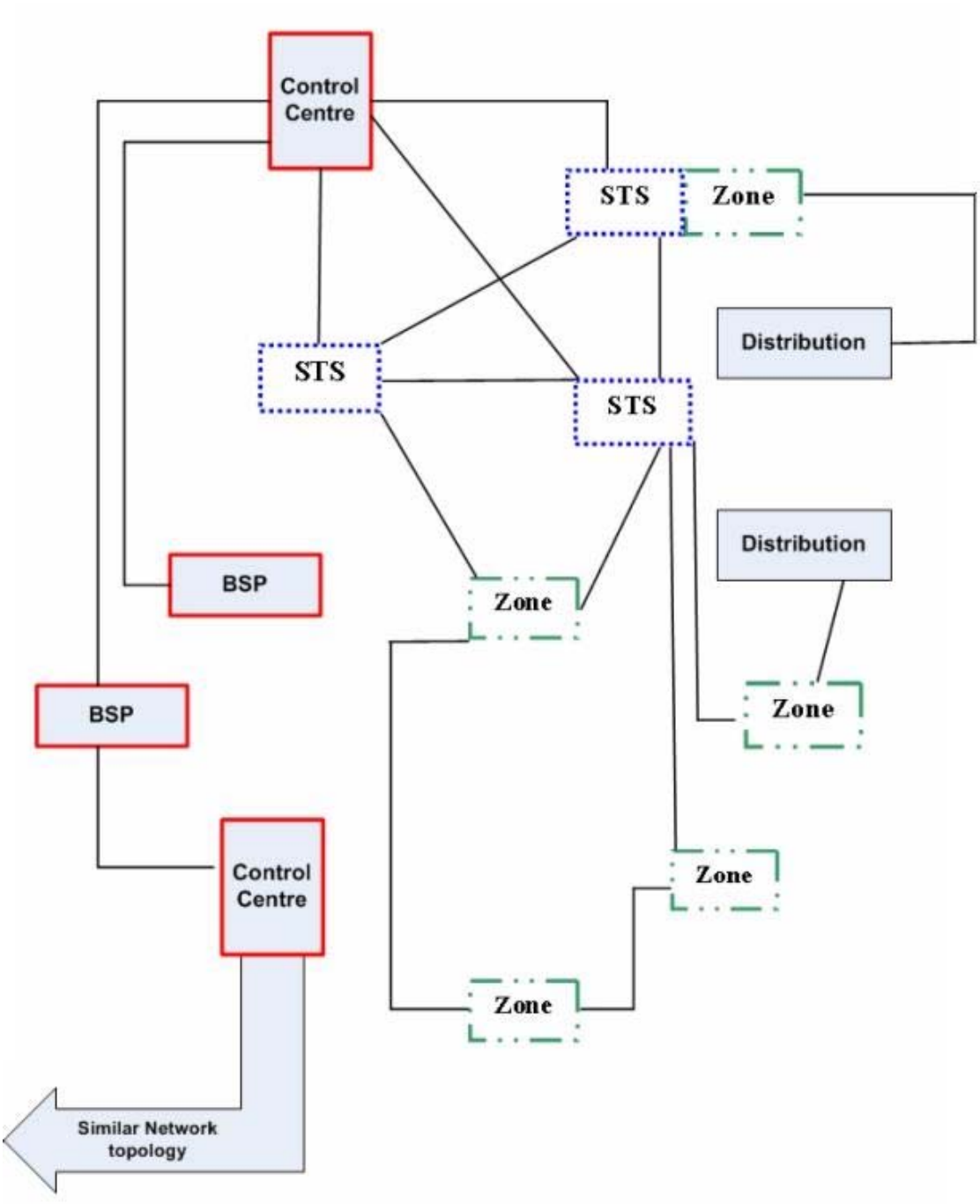


Figure A.1.1 – Fibre Logical Connectivity

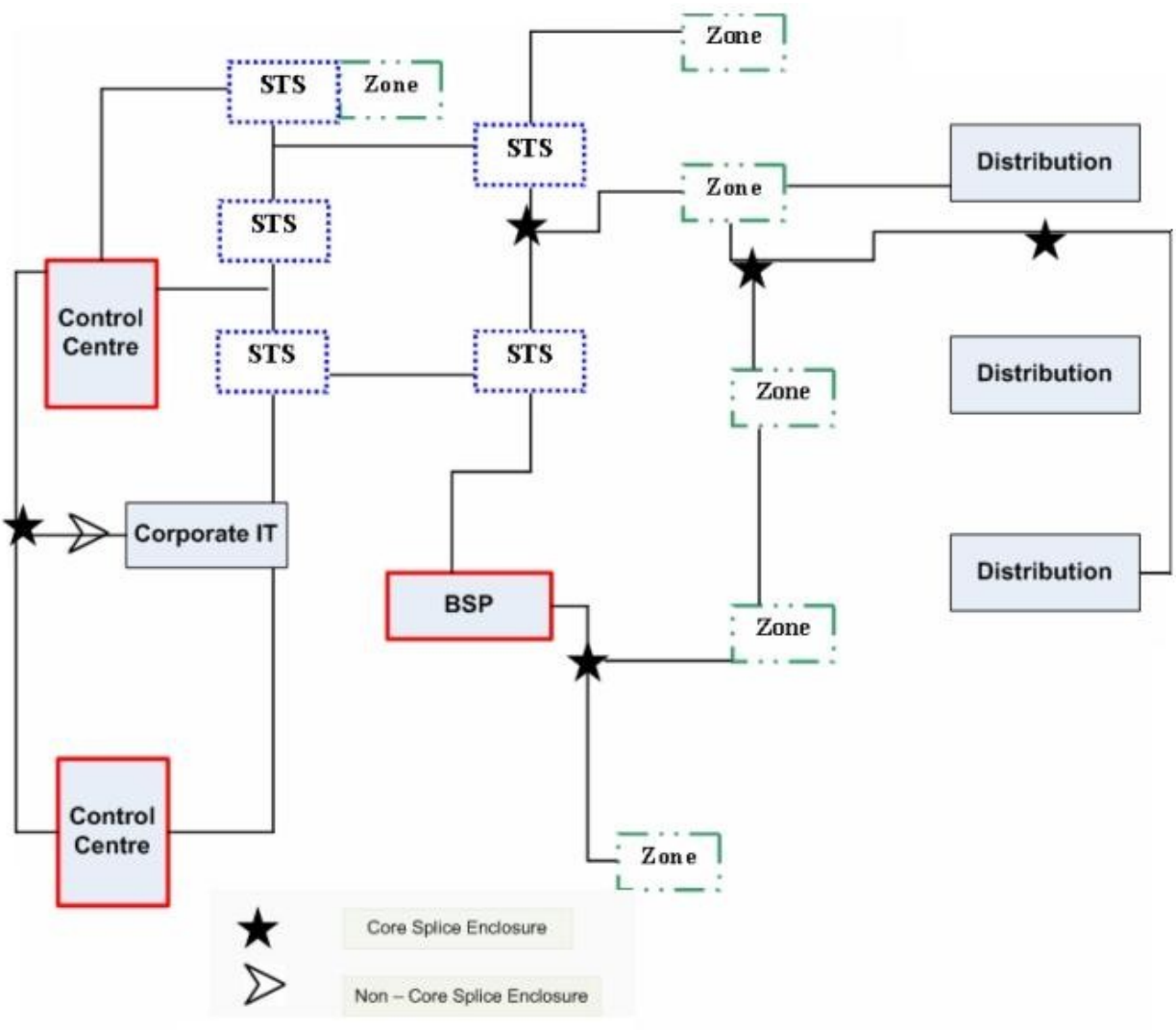
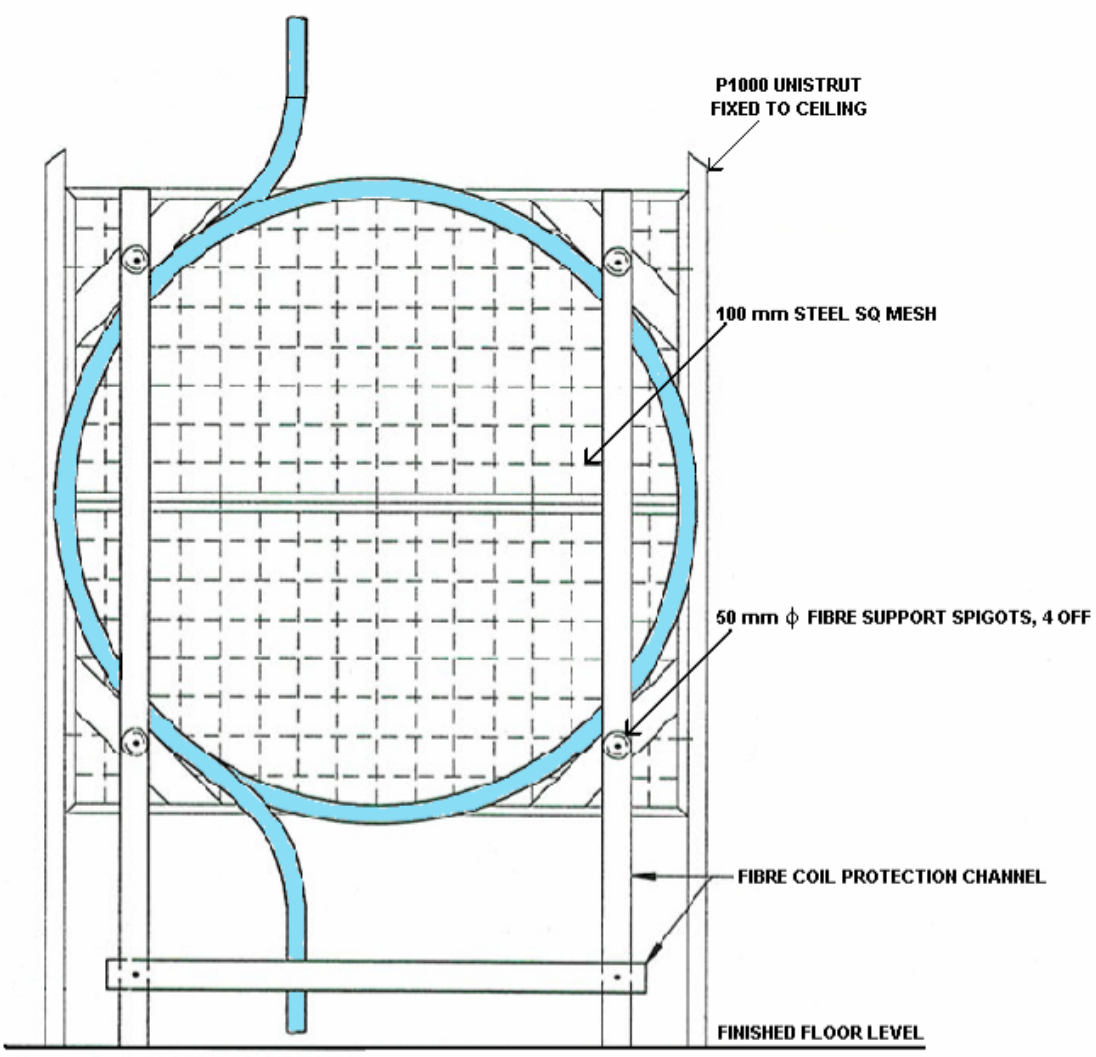


Figure A.1.2 – Schematic of Physical Fibre Connectivity

Appendix B - Optical Fibre Storage Rack



FRONT ELEVATION
SHOWING FIBRE COIL

This design has been used in the Australian Telecommunications industry in the past at a number of sites to store loops of excess optical fibre cable. The frame can be mounted vertically or horizontally.

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