Structured Cabling System Specification

Information Technology Directorate

NSW Department of Education

LEVEL 11, 8 CENTRAL AVENUE, SOUTH EVELEIGH, NSW 2015

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NSW GOVERNMENT

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Document details:

Glossary of terms:

Term	Meaning
“Shall”	The term "SHALL" means that the item is an absolute requirement of the standard. Omission of this item from the deployment would mean that the desired objectives would not be met. Objectives include availability, specific functions or technical requirements, and dependent features.
“Shall Not”	The phrase "SHALL NOT", means that the item is absolutely prohibited in the standard.
“May”	“MAY” means that an item is truly optional. For example, you may choose to include the item because a particular objective or application/protocol requires it or because it enhances the deployment.

Revision history:

Date	Version	Summary of changes	Author
01/07/2020	1.2	▪ Change from F/UTP to U/FTP for horizontal cabling. ▪ Racks in the MCR/BCR changed from 42RU to 45RU and also changed from 900mm to 800mm deep for the BCR racks ▪ Rack layout in MCR changed with the BD/School Server and Security/Telephone cabinets swapping locations ▪ Added a section on exceptions ▪ FOBOT in MCR changed from minimum 72 to 48 port capacity ▪ Modified wording for WAP outlets in ceilings i.e. not permitted ▪ Added/Updated diagrams ▪ Updated standards reference where applicable	Ibrahim Chehab - Network Design

Abbreviations and acronyms:

Acronym	Meaning
8P8C	8 Position 8 Conductor modular plug
ACMA	Australian Communications and Media Authority
AMS	Asset Management System

Acronym	Meaning
AS/NZS	Australian and New Zealand Standard
AXT	Alien Crosstalk
AWG	American Wire Gauge, Imperial unit used to specify electrical conductor size
BCA	Building Code of Australia
BCR	Building Communications Room
BD	Building Distributor
BEP	Building Entry Point
BMS	Building Management System
CCTV	Closed Circuit Television
CD	Campus Distributor
CP	Consolidation Point
DAC	Direct Attached Cable
DGPO	Dual General Purpose Outlet
DoE	Department of Education - NSW
DTO	Double Telecommunications Outlet
EFSG	Educational Facilities Standards and Guidelines - NSW
EMS	Environmental Monitoring System
EPR	Earth Potential Rise
FD	Floor Distributor
FFL	Finished Floor Level
FOBOT	FOBOT Fibre Optic Break Out Termination enclosure
F/UTP	Foil over Unshielded Twisted Pair, where the twisted pairs are encased in an overall foil shield
Gbps	Gigabits per second
GPO	General Purpose Outlet
HV	High Voltage, greater than 1000V AC
ICT	Information and Communications Technology
IDC	Insulation Displacement Connector
IEEE	Institute of Electrical and Electronics Engineers

Acronym	Meaning
IoT	Internet of Things
IP	Internet Protocol
ITD	Information Technology Directorate
LAN	Local Area Network
LC	Lucent Connector - a small form factor optic fibre connector
LSZH	Low Smoke Zero Halogen
LV	Low Voltage, exceeding 50V AC and below 1000V AC
MCR	Main Communications Room (also referred to as the CD)
MDF	Main Distribution Frame
MMOF	Multi-Mode Optical Fibre
MUTO	Multi-User Telecommunications Outlet
OTDR	Optical Time Domain Reflectometer
PABX	Private Automatic Branch Exchange
PIR	Power Insertion Loss
PM	Project Manager
POE	Power Over Ethernet
PVC	Polyvinyl chloride
RJ-45	Refer to 8P8C
RU	RU Rack Unit, the unit of measurement is 44.25mm
SCSS	Structured Cabling System Specification
SFP	Small Form Factor Pluggable
SMOF	Single Mode Optical Fibre
SNR	Signal to Noise Ratio
SNSDA	School Network Solution Design Authority
SPD	Surge Protection Device
STO	Single Telecommunications Outlet
STP	Shielded Twisted Pair
TO	Telecommunications Outlet
TRC	Telecommunications Reference Conductor

Acronym	Meaning
TTO	Triple Telecommunications Outlet
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair
U/FTP	Unshielded Foiled Twisted Pair, where each pair of cables is twisted and wrapped with metal foil
VoIP	Voice over IP
WAN	Wide Area Network
WAP	Wireless Access Point (also referred to as AP)
WLAN	Wireless Local Area Network

1. Introduction

The Structured Cabling System Specifications (SCSS) plays a critical role in providing the underlying platform for which ICT services are provisioned. It is essential that the cabling infrastructure installed in any NSW Department of Education (DoE) site supports current, as well as future requirements. Implementation of cabling infrastructure needs to be flexible to allow relocations, additions, and changes with minimal impact to existing services and users.

To provide consistency, it is essential that DoE stakeholders are engaged from the initial project concept planning as this may impact existing or new cabling infrastructure.

All cabling infrastructure supplied and installed shall comply with this SCS Specification as well as all relevant Australian standards, these include (but are not limited to) the following:

Standard:	**Applies to/for:**
AS/NZS11801: Current Edition	Part 1: General requirements Part 2: Office Premises Part3: Industrial Premises Part 6: Distributed building services
AS/NZS 3084: Current Edition	Telecommunications installations – Telecommunications pathways and spaces for commercial buildings
AS/NZS 3085.1: Current Edition	Telecommunications installations – Administration of communications cabling systems – Basic requirements
AS/NZS 2967: Current Edition	Optical fibre communication cabling systems safety
ISO/IEC 14763-2	Implementation and operation of customer premises cabling Part 2: Planning and installation
AS/NZS 14763.3: Current Edition	Telecommunications installations - Implementation and operation of customer premises cabling - Testing of optical fibre cabling
AS/NZS 61935.1: Current Edition	Testing of balanced communication cabling in accordance with ISO/IEC 11801
AS/NZS IEC 61935.2: Current Edition	Testing of balanced communication cabling in accordance with ISO/IEC 11801 Part 2: Patch cords and work area cords
AS/ACIF S008: Current Edition	Requirements for authorized cabling products
AS/ACIF S009: Current Edition	Installation requirements for customer cabling (wiring rules)

It is expected that any entity supplying and/or installing cabling infrastructure is expected to have access to and abide by the above mentioned standards. Only cabling systems offering the appropriate warranty/certification by the manufacturer shall be used. The minimum accepted period of certification is twenty (20) years.

The Information Technology Directorate's (ITD) Network Design team, a part of ITD's

Infrastructure Services division, is responsible for the maintenance and content of this document. Any proposed alteration to this document must be reported to the Network Design team for consideration.

General inquiries can be made via:

Network Design Team, Infrastructure Services, ITD - email: ITInfraServNetworksArchitecture@det.nsw.edu.au

The School Network Solution Design Authority (SNSDA), is an ITD working group consisting of representatives from different ITD teams that evaluate and provide advice in relation to network related activities at school sites. Any requests for exceptions, must be made to the SNSDA for consideration. Please contact:

DoE School Network Solution Design Authority - email: SNSDA@det.nsw.edu.au

2. Exceptions

All cabling works are to comply with the requirements as set out in this specification, where this is not possible then an exception needs to be raised in order for it to be evaluated. This needs to be done prior to the commencement of the works in question.

Exceptions will only be approved if they are reasonable – i.e. a 45 RU rack will not fit in the proposed location and the request is to use a 27RU rack instead. Any requests to deviate from regulatory compliance will not be accepted.

It is recognised that some spaces have installation constraints such as heritage, hazard, or architectural aesthetic considerations – all such factors need to be evaluated and direction sought from ITD. All requests for exceptions shall be directed via the DoE School Network Solution Design Authority (SNSDA) - Email: SNSDA@det.nsw.edu.au (Please note, DoE staff can request an exception via the SNSDA SharePoint site. Requests for exemption will be considered at the next available SNSDA meeting).

3. General

All participants in infrastructure implementation must comply with the requirements of both the specific initiative and all government rules and regulations. Whilst all efforts will be made by NSW DoE to provide relevant requirements, it is the responsibility of the participants to make representation to the authorised persons and authorities to ensure they are informed of all requirements.

Requirements may include:

- Clothing and personal protective equipment (PPE) - for safety and identification.
- Licensing – for electrical and telecommunications cabling.
- Scheduling – co-ordination of works to suit business practices.
- Working in Schools – specific child protection rules and Work Health and Safety (WH & S) .
- Cleanliness – removal of packaging and building waste, and the use of drop sheets to protect DoE property.
- Working at heights – safety equipment as required by SafeWork NSW .
- Noise – coordinating building works to minimise noise impact during school hours
- Working with Asbestos – perform the actions required when working with asbestos.

It is necessary for all contractors engaged by DoE to carry out work in schools to obtain clearance for entering premises where children are located. All non-DoE staff are required to follow the department's requirements for work clearance as determined by the Principal before commencing work on a site.

Entities within DoE are Schedule 1 customers and are directed by the Department of Premier and Cabinet to use contractors on the current ICT Services Prequalification Scheme or its replacement. Contractors are required to be an approved registered supplier on the ICT Service Scheme 0020 for Category F02 – Network Management – Network Operations including delivery "as a service.

The contractor shall:

- ensure that during the entire period of works at least one cabler is onsite and hold an ACMA Open registration with endorsements for each cable plant being installed or worked on;
- Provide a copy of this standard to the sub-contractor, where cabling work is being sub-contracted by the primary contractor;
- remain responsible for ensuring that all installation works are fully compliant with this specification;
- be accredited with the manufacturer (of the cabling being used on site) as an approved installer prior to the works commencing;
- make all the necessary inquiries of all relevant authorities (including DoE) and perform all relevant testing to ensure that works being performed under their contract will not disrupt other services (Examples include contacting "Dial before you dig" to check if there are underground broadband, electrical, gas, water, waste and other services and performing traces of cables and conduits);
- check the latest school asbestos register and plan accordingly;
- ensure that their Public Liability insurance (or other) will cover the costs of reinstatement associated with any disruption of services.

Should the contractor disrupt any service during the course of works they shall make all efforts possible to rectify the service in the least amount of time possible. The contractor is responsible for the costs and coordination of the rectification of the service(s).

4. Horizontal cabling specifications

Important:

- **Greenfield sites** are defined as buildings, sites or floors where NSW DoE has no existing telecommunications infrastructure (cabling, LAN or WAN), e.g. Schools Infrastructure projects for new and expanded sites.
- **Brownfield sites** are defined as buildings, sites or floors where NSW DoE has existing telecommunications infrastructure in place (cabling, LAN or WAN), e.g. schools infrastructure refurbishment projects.

Where existing telecommunication infrastructure is being removed and replaced (i.e. communication rack and cabling as part of a capital works program) then this is to be classified as a Greenfield site.

The Category 6A (Cat6A) specified for installation at **Greenfield sites** shall be:

- Category 6A/ClassEA, U/FTP, LSZH, Indoor or Plenum grade for internal.
- Category 6A/ClassEA, U/FTP, Outdoor grade for external.

- submitted for approval, before installation using the form in Appendix I: Equipment Sample Approval (ESA) Form

This is a shielded cable system and all connected components (RJ45 jacks, patch leads etc.) shall be shielded. Refer to section 8. Earthing. Category 6A/Class EA, U/FTP may be substituted if F/FTP if U/FTP is not available.

The Category 6A (Cat6A) specified for installation at **Brownfield sites** shall be:

- Category 6A/ClassEA, U/UTP, LSZH, Indoor or Plenum grade for internal.
- Category 6A/ClassEA, U/UTP, Outdoor grade for external.
- submitted for approval, before installation using the form in Appendix I

The U/UTP cable **shall** have a metallic/aluminium foil that wraps around the outer cable or around the pairs of the cable.

All internal grade CAT6A cabling (regardless of the type) shall have a Low Smoke Zero Halogen sheath. All further references to Cat6A cabling in this document, refer to the above specifications.

For clarification about whether a site is classified as either Greenfield or Brownfield please send a request to the ITD SNSDA for determination. It is imperative that this is done before any works commence.

4.1 General

The horizontal data cabling system shall consist of:

- Only Category 6A horizontal cabling;
- Cable trays as the major cable support systems;
- Patch panels and cable management;
- Testing and commissioning;
- As built documentation;
- Manufacturer certification;
- Appropriate labelling.

Where specified, cabling to each outlet shall consist of pairs per outlet as outlined in the table below:

Outlet type:	**Number of 4 pair CAT6A cables to each RJ45 outlet:**
Single (STO)	1
Dual (DTO)	2
Triple (TTO)	3

- Cable installation shall be in accordance with Australian standards and manufacturers guidelines.
- All underground external grade cabling will require surge protection to be installed at the Distributor end of the cable.
- Outdoor rated gel filled cables are to be installed for any cable that exits the building (whether it be via under covered walkways or underground, in conduit or otherwise);

- The Cat6A System is to be fully grounded and bonded as per the relevant standards - AS/CA S009, TIA942, TIA/EIA J-STD-607-A and J-STD-607A. See section 8. Earthing.
- All Wireless Access Points are to be allocated dual outlets.
- All horizontal cabling shall be installed via dedicated communications cable trays and pathways at all times.
- Each run of cable from the Building or Floor Distributor to the Telecommunications Outlet shall be contiguous without any joints or splices.
- All horizontal cabling to connect to a Building Distributor on the same floor, unless explicit permission has been given by the DoE SNSDA team.
- Bundle sizes should be limited to a maximum of 24 cables per bundle and bundles shall not be stacked or packed tightly. This is to ensure efficient deployments and allow the potential for future services relocation.
- Cable bending radii are to be observed at all times, kinks, crushed and tight bends will not be accepted.

Please note:

- **The use of plastic cable ties for installations is strictly prohibited.**
- **The installation of Consolidation Points is strictly prohibited.**

4.2 Category 6A channel performance

The Category 6A UF/FUTP structured cabling solution shall be installed to class EA standards, ensuring a frequency of 500Mhz and is to comprise of category 6A components capable of providing 10 Gigabit Ethernet operations using full-duplex transmissions.

The total length of the horizontal cable must not exceed 100 meters (90 meters for the permanent link and 10 meters for the patch cordage).

4.3 Cat6A cabling construction for pathways

There are two (2) classifications of Cat6A cabling to be used, based on the cabling's installation pathways; External and Indoor.

4.3.1 External (Underground/Outdoor):

Cat6A cables that are installed with any portion of its cable:

- in underground conduits and/or;
- exposed to the elements and/or;
- in protected above ground outdoor and adverse internal pathways;

External cabling **MUST** be classified as "external" and external grade Cat6A is to be installed. Also, surge protection will be required. See section 4.11 Surge Protection Device (SPD).

4.3.2 Indoor:

Cat6A cables that are installed wholly within internal building spaces such as;

- Riser cupboards;
- Internal ceiling cavities;
- Internal wall cavities;

Indoor cabling **MUST** be classified as "indoor" or plenum grade as required. Indoor cabling **MUST**, in addtion, consist of low smoke zero halogen.

4.4. Installation

The following installation techniques shall apply:

- Pulling tension should not exceed the manufactures specifications for all cabling installed.
- In the event that the physical cable sheath is seen to be damaged or of inferior manufacture, e.g. cable twists, uneven sheath shape and the like, the reel shall be set aside and replaced.
- In the event that defects inspections reveal damaged or inferior manufactured cable, the complete run shall be replaced at no additional cost.
- Bending radii should not exceed the manufactures specifications for all cabling either during installation or in its final location.

Apart from the approved pathways listed in sections 6 and 7, all horizontal cabling shall be installed via dedicated communications cable trays at all times.

All cabling shall enter cavity walls from the ceiling space where appropriate for new buildings and where possible in existing buildings. Cables dropped from cable trays or other cable support systems shall be neatly loomed and secured with hook and loop, e.g. Velcro or approved cable support mechanisms which are to be utilized along the entire length of the cable pathway.

The use of plastic cable ties for installations is strictly prohibited.

4.5 Cabinet pathways

For all new installations, all horizontal cabling shall enter the cabinets from suspended cable trays above via designated entry points on the cabinet roof corner.

No cabling shall enter through the cabinet floor, front, rear or side panels. Variations will require approval from the DoE SNSDA Team.

A minimum 1.5M service loop is to be maintained for each cable installed. The service loop is to be stored in the cable tray, ceiling space or cabinet in a neat manageable manner.

4.6 Terminations

The telecommunications outlet pin assignment shall be identical to the existing methodology utilised on site. For installations where no existing horizontal cabling exists, the outlet pin assignment shall adhere to T586A.

A single consistent PIN assignment shall be adopted throughout the installation.

4.6.1 T568A Pin assignment:

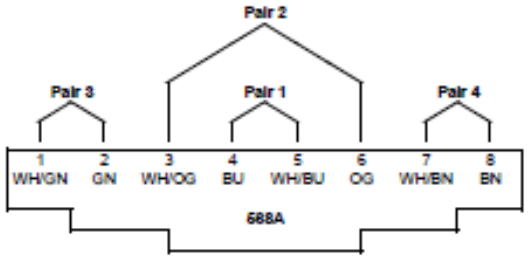


Figure 1 - T568A Pin assignment

4.6.2 Cabinets

- All patch panels are to be rack mounted RJ45 panels with 24 ports being 1RU in height. The ports shall be aligned with the mounting rails. If recessed or protruding panels are used then there must be enough clearance for the door to be closed when cables are installed. Angled V style patch panels are not to be installed. Patch panel categories shall be consistent throughout the whole site and are not to be mixed. The patch panels shall have a provision for labelling. See section 11. Labelling.
- Patch panels are to be installed and identified with a unique outlet numbering sequence that is continuous across the entire installation. See section 11. Labelling.
- Service loops or any excess cabling IS NOT to be stored in the cabinet unless it is done in a neat and manageable manner.
- Terminations and termination procedures shall comply with local and international standards as well as the manufacturer recommendations for certification compliance. Only the minimum length of the cable jacket required for termination shall be removed.
- The untwisted length in any cable element shall be as short as possible.
- Horizontal cables should be used with connecting hardware and patch cords, or jumpers, of the same performance category or higher to maintain a manufacturer certifiable channel performance.
- The overall system performance levels shall be classified by the least performing component in the link.

4.6.3 Telecommunications outlets

- Are reticulated from the ceiling space, floor space or in internal wall conduits, whichever is applicable;
- NSW DoE has strict requirements on the types of telecommunications outlets that are permitted to be installed. This covers the RJ-45 jack itself and also the wall plate/covers that houses the jack.

Each component shall be submitted for approval before installation using the Appendix I: Equipment Sample Approval (ESA) Form.

The RJ45 jack shall:

- Have a fixed mechanism that is self-closing and covers the contacts within the jack when not in use.
- be matched to the cabling being installed to provide full manufactures warranty
- be matched to the horizontal cabling type specified in 4. Horizontal cabling specifications
- be submitted for approval, before installation using the Appendix I: Equipment Sample Approval (ESA) Form.

The wall plate housing the RJ45 jack shall:

- Have a tamperproof wall plate that requires the use of a tool to remove. Any panel, facia or any component that is an integrated part of the jack and labelling shall not be removable without the use of a tool.
- Have adequate space for the required labelling to be installed as per section 11. Labelling. Where there is labelling on the surrounding edge plate or clip on cover then the use of a tool to remove this component is required i.e. clip on covers or components that can be removed by hand and have labelling on them are not permitted.

- Be submitted for approval, before installation using the Appendix I: Equipment Sample Approval (ESA) Form.

Where the RJ45 jack does not have a fixed self-closing shuttered mechanism, then a shuttered bezel that is between the RJ45 jack and the wall plate may be used provided it has been approved by using the Appendix I: Equipment Sample Approval (ESA) Form. See Appendix H: Examples of complying TO components for examples of TO components that adhere to the above requirements.

4.7 Wireless Access Point (WAP) cabling

All Wireless Access Points (WAPs) are to be allocated with one dual outlet per WAP.

The amount of WAPs installed will be determined by a wireless survey that will be undertaken by DoE IT staff. The wireless survey will also determine the locations of where the WAPs will be installed.

The distance between the outlet and the final mounting place for the WAP shall not exceed 30cm for both wall mounted and ceiling mounted outlets. The outlets are to be visible at all times and are **NOT** to be concealed in the ceiling or wall cavities.

The WAP, regardless of being internal or external, is to be visible at all times. If required, a protective enclosure for internal WAPs can be considered in suitable locations (e.g., halls gymnasiums, indoor pools). All requests for enclosures are to be discussed with the DoE ITD representative.

If requested, a DoE ITD representative is to inspect proposed locations of the WAP cabling prior to sheeting.

4.7.1 Internal:

For new cabling and WAP installations, if the ceiling height is above 3m, or the ceiling surface is unsuitable (e.g. metal), the WAPs are to be wall mounted at 2.4m above finished floor level (FFL), nearest the center of the room with allowance given for a 1m clearance radius that is free from interference (from ceiling fans, lights, sensors, speakers etc.).

4.7.2 External:

External WAPs must include the provision of waterproof outlet covers. The associated patching cable is to be externally rated and protected by a UV and waterproof membrane that is securely connected and routed in a manner that encourages water to not pool on any of the related components. This water proofing should be consistent with the IP66 and IP67 protection of the access points. Refer to Appendix E: External WAP

External WAPs may be mounted up to a height of 4m. Please note that this does not apply to point to point wireless bridges. Where possible and practicable, the DTO for an external WAP may be installed on the inside wall, provided that is within 1 meter of the WAP, is accessible to DoE staff and does not hinder the aesthetics of the wall. All outlets, regardless whether they are on the internal or external wall, are to be terminated onto an approved wall plate and not left hanging.

See the example shown in Appendix E: External WAP.

4.8 Security cabling

All cabling for security devices (including, but not limited to, security cameras, alarms, intercoms, etc.) are to be discussed with the relevant project manager. Project Managers, in turn, are to liaise with the DoE School Security Unit to determine any specific security cabling requirements.

4.9 Leads/Patch cords

The contractor will be responsible for the supply and installation of the Category 6A patch leads. Two (2) patch cords/leads are required for every outlet installed, one at the device end and one at the patch panel end.

An additional lead will need to be supplied for each surge protection port installed (See section 4.11 Surge Protection Device (SPD)).

External WAP patch leads will require an external grade cable at the device end (See Appendix E: External WAP).

The length of the patch cords/leads shall be specified by the ITD representative, as well as the gauge of the patch leads supplied (i.e. 23AWG or 28AWG or a combination of both).

The colour of the patch cords/leads are to comply with the Patch Lead Colour Chart (refer to Appendix F: Patch cables). Where the environmental/aesthetics surroundings of a space are better suited to use a different patch cord colour (i.e. WAP mounted onto a black ceiling, a black patch cord is used) then it is suitable to use such coloured patch leads at the device end only.

Note for ITD representative:

- Be aware that installing larger gauge patch leads will reduce the overall permanent link performance length and may not meet PoE requirements for future devices. This needs to be taken into consideration when the ITD representative nominates the patch leads to supply.
- Example: 10M of 28AWG patch leads will reduce the capacity of the permanent link length from 90M to 82.5M

See the example shown in Appendix F: Patch cables.

If 28AWG cables are used, then refer to vendor specifications as to recommended bundle size.

4.10 Copper cabling between distributors

Copper cabling between distributors for data services is strongly discouraged, all data services that run over the DoE network are to use the fibre network. Any requests for copper cabling between distributors for data services are to be forwarded to DoE SNSDA Team.

Where an exception has been granted for copper cabling between distributors, all inter-building copper backbone cables shall:

- be of outdoor cable construction;
- be gel filled to prevent the ingress of moisture and impurities and;
- meet the specifications as outlined in AS/CA S008.

Where the distance between distributors is over 90 meters, no data services are to be utilised.

Any cabling for voice services (non-VoIP) shall be discussed with the ITD project manager. There may be a requirement for some Cat3 voice cabling between distributors (usually a 25 pair), but this needs to be confirmed with the ITD project manager before any works are to commence.

4.11 Surge Protection Device (SPD)

Where external twisted pair cabling is installed with any portion of it underground, a

surge protection device must be installed at the floor/building distributor ends only. No surge protection is required at the WAP (or similar) end. The appropriate standards, including AS 4262 and IEC 61643-21 amongst others, must be met in regards to surge protection devices.

One SPD circuit must be allocated for each external 4 pair twisted pair cable.

The SPD devices typically come in the arrangement of a single port inline device and in 8,12,24,48 port 1-3RU panels. Single inline devices can be used for up to 4 installations per cabinet and are to be installed so they are easily accessible but reduce interference with future cabinet installations. If there is more than 4 required per cabinet, then the larger panel type installation is to be used. All are to be installed as per manufactures instructions.

4.12 Labelling

See section 11. Labelling.

4.13 Testing

See section 12. Testing.

5. Optical fibre cabling specifications

5.1 General

The optical fibre component of the cabling work requires the establishment of an optical fibre backbone and patching network. In particular, this work involves, but is not limited to;

- provision of OS2 9/125 single-mode cable;
- termination of all optical fibres;
- provision of all connectors, breakout, enclosures, organizer trays, patch panels and connector couplers;
- provision of optical fibre patch cords;
- labelling of all patch panels and other equipment and;
- comprehensive testing of all optical fibres.

Optical fibres shall comply and meet the requirements of all national standards and guidelines where not defined below. Optical fibres;

- shall have a non-metallic central strength member for loose tube construction;
- shall have individually buffered fibres surrounded by strengthening components, e.g. aramid yarn, for internal riser use;
- where loose tube construction is used for internal building cabling, it must have low smoke zero halogen construction;
- shall be of a graded index type and;
- conform to the national manufacturing standard.

A minimum of one 12 core OS2 fibre cables will be installed at each location with the provision of a minimum of 100% spare capacity of the total number of utilised cores (e.g. if 4 cores are to be utilised and 8 remain unutilised the spare capacity provision has been met).

Any expansion of these fibre cables will be installed in multiples of 12 cores. Non-terminated "future capacity" cables are **NOT** permitted unless explicitly exempted by the DoE School Network Solution Design Authority Team.

All installed cables on DoE sites shall be terminated at each end and associated documentation, labelling and test results shall be provided.

5.2 Optical Fibre Performance

Optic fibre works shall comply with all standards of the Australian Communications Authority and the Standards Association of Australia. Specifically with the mandatory provisions of all applicable Australian Standards, and AS/CA S008 and AS/CA S009 current versions.

Where minimum specifications differ between Australian Standards AS/NZS 11801 and AS/NZS 3084:2017 then the greater requirements of Australian Standards shall apply. If a conflict of information arises consult the DoE SNSDA team for determination.

All installations shall be in accordance with the optical fibre manufacturer's specifications, including pulling tensions, support fixing distances and bend radius supports.

5.3 Optical Fibre Cabling Construction for Pathways

There are three (3) classifications of Fibre optical cabling to be used, based on the installation pathways of the Fibre Optic cabling; Underground, Outdoor and Indoor.

5.3.1 Underground:

Optical fibre cables installed with any portion of its cable in underground conduits **MUST** be classified as external or outdoor grade and be equipped with loose tubes with a moisture barrier, and a nylon jacketed polyethylene sheath.

5.3.2 Outdoor:

Optical fibre cables that are installed in protected above ground outdoor and adverse internal pathway such as;

- roof and external wall cavities
- sub floor spaces
- conduits in environmentally protected spaces

MUST contain a moisture barrier or blocking compound and be classified as external or indoor/outdoor grade and be low smoke zero halogen.

5.3.3 Indoor:

Optical fibre cables that are installed wholly within internal building spaces such as;

- Riser cupboards
- Internal ceiling cavities
- Internal wall cavities

MUST be classified as indoor, indoor/outdoor or plenum grade and be low smoke zero halogen.

5.4 Optical Fibre Installation

Optical fibre installation shall be performed by an installer properly trained and qualified in carrying out the required works. All installations shall be to a high standard and in accordance with the fibre manufacturer's specification.

All optical fibre cable shall be fixed at intervals of no more than 300 mm onto cable trays with Velcro cable ties or in conduit.

All optical fibre cable shall be installed such that it does not cause the cable to exceed their manufacturer's minimum bend radius or installation tensions.

Any coiled excess shall be fully protected from physical damage and supported in a way such that the specified bending radius can be sustained for the life of the optical fibre cable.

5.5 Optical Fibre Cabinet Pathways

All optical fibre cabling installations will enter the cabinets from the suspended cable trays above via designated entry points on the cabinet roof corner. No cabling is to enter through the floor, front, rear or side panels. Variations will require approval from the DoE School Network Solution Design Authority team.

A service loop of minimum 3M is to be maintained for each cable installed. The service loop shall be fully protected from physical damage and supported in a way such that the specified bending radius can be sustained for the life of the optical fibre cable.

The service loop or excess cabling is to be stored in the cable tray or cabinet in a neat manageable manner.

5.6 Optical Fibre Terminations

The termination method of all optical fibre cable will be fusion splicing only.

Direct termination or mechanical jointing of fibre and connectors of any type are **NOT** allowed. (Excluding temporary emergency repairs).

All connectors are to be of type LC and shall be;

- single fibre 1.25 mm zirconia ceramic ferrule;
- secure, anti-snag latching mechanism;
- polarized connector to ensure proper insertion;
- be manufactured under ISO 9001 and 9002 guidelines.

Colour coding of fibre terminations in FOBOTS is to be allocated as per AS/NZS 11801: Current Version.

Single-mode (OS1/OS2) Couplers/Duplex Adapters for fibre terminations in FOBOT will be identifiable by the colour "BLUE".

See Examples in Appendix D: Fibre examples for current fibre installations.

5.7 Optical Fibre Patch Panels (FOBOTS)

Optical fibre shall be terminated onto an approved FOBOT. Each patch panel shall be provided with patch cord support offering full protection of patch leads and connectors. Patch panels shall be in the designated equipment rack in the locations specified in the Rack layout diagrams in Appendix B. Rack layout.

- Connectors are to be aligned with the mounting rails.
- Fibre terminations to the same building/floor distributor are to be grouped together in the same enclosure and not installed across different enclosures.
- Existing fibre enclosures with blank panels or slots are to be utilised before new enclosures are installed, provided that the enclosure meets current specifications and capacity requirements.

- The fibre entry to the patch panels shall be through a correctly sized and compression cable gland to prevent any movement of the fibre internal to the panel from occurring should the panel be moved.
- Patch panels shall incorporate the following features:
    - Allow for the termination of at least 36 LC connectors using the designated connectors while occupying no more than 1 rack units (RU)
    - New enclosures being installed in an MCR (Main Communications Room/CD) should be of a high-density model, capable of supporting a minimum of 48 LC connectors per 1RU. (See sample in Appendix D: Fibre examples)
    - Be installed such that the front doors of the equipment rack shall be fully closed and lockable without any interference of equipment, cabling or patch cords within the enclosure whilst complying with specified bend radii.
    - Have either a slide or swing tray to improve access (only required for Greenfield sites).
    - Grommets/compression cable glands shall be provided for all cables entering and exiting the enclosure.
    - A cable strain relief bracket.
    - Internal cable management rings and securing devices.
    - Hinged and stacked splice trays.
    - Cable entry points from the rear, top, and bottom.
    - Patch panels shall utilise the designated connector couplings mounted on a pre-punched blank plate.

Spare connector ports/panels are to be fitted with blanking panels or inserts to ensure the entire enclosure is sealed and is not accessible by contaminates or vermin.

5.8 Optical Fibre Leads/Patch Cords

The contractor will be responsible for the supply and installation of the Optical patch leads.

The number, length, and type of optical patch leads will need to be specified by the ITD representative, as well as any legacy fibre patch leads configurations that may be required.

A guide to current Fibre patch leads can be found in Appendix D: Fibre examples.

5.9 Optical Fibre Labelling

See section 11. Labelling.

5.10 Optical Fibre Testing

See section 12. Testing.

6. Distributor design

The size, location, and provisioning of services and facilities shall be in accordance with AS/NZS 3084 in conjunction with this document. Site distributor design includes three of the four tiers, these being:

- Campus Distributor (CD)
- Building Distributor (BD)

- Floor Distributor (FD)
- Consolidation Points (CP)

The NSW Department of Education does not support the installation of consolidation points in its network design. Any requests for Consolidation Points can only be approved by the DoE School Network Solution Design Authority team.

Provisioning Principles:

- Only one CD per campus
- Minimum of one BD per building
- Only one BD between FD and a CD
- Multi-level buildings will require, at minimum one (1) BD/FD per floor.

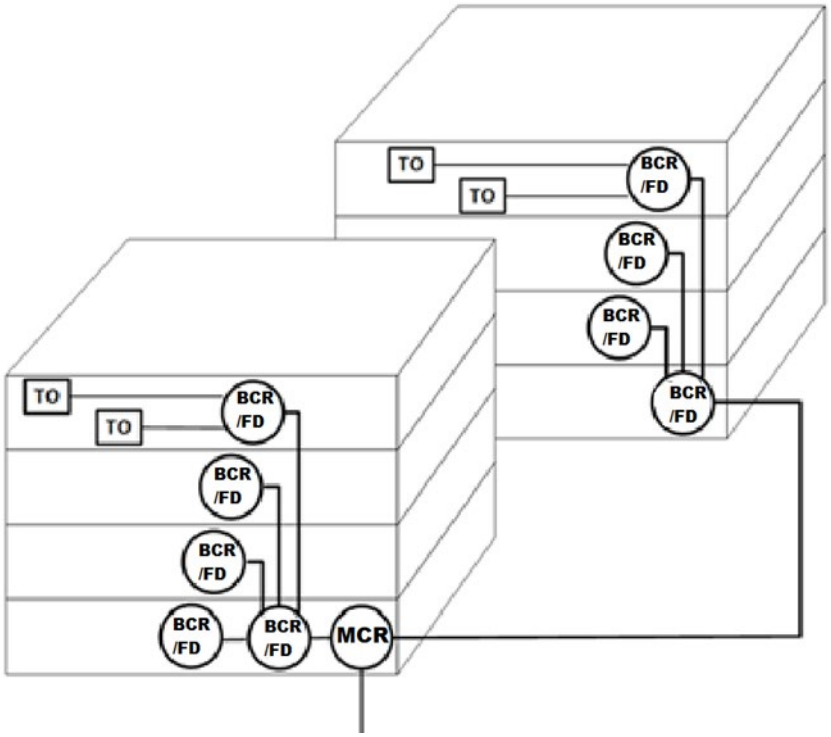


Figure 2 - Distributor design diagram

6.1 Communications rooms – definitions

6.1.1 Main Communications Room (MCR contains CD and BD)

(See AS/NZS 3084:2017 – Section 4: Equipment Room).

The CD is located in the Main Communications Room housing WAN link, servers, security, telephony, main communications, and network equipment in a restricted, secure, air-conditioned environment. This room will also contain a BD to support any horizontal cabling terminated to this location.

6.1.2 Building Communications Room (BCR contains BD/FD)

(AS/NZS 3084:2017 – Section 3: Telecommunications Room).

BD/FD installations, in this and other buildings, are to be located in dedicated Building Communications rooms. These are a restricted, secure, ventilation controlled environments that contain network, security and telephony equipment that service a designated area of a building. In Greenfield sites, closets/cupboards of any kind is **NOT** an

acceptable location for a BCR.

6.2 Communication Rooms – Design Principles

- All CD/BD/FD's are to be installed only in dedicated, purpose designed rooms.
- Cabinets, with side panels intact, are to be located centrally in the room.
- Cable pathways into cabinets are to be through cabinet top entry points via ceiling mounted cable trays from side walls or ceiling, installed above 2200mm, to provide full access to all sides of the cabinet row.
- No cabling or services will connect to the cabinets below the 2200mm level so as to allow 360-degree access to the cabinet installation row.
- The minimum dimensions of the Communications rooms must be internal and free of columns, ducts or other intrusions into the space. The communications riser, and other services risers or equipment must be outside the required minimum cabinet clearances.
- Inter-cabinet pathways are to be through cabinet top entry points.
- Communications rooms are to house only communications, network, security, telephony equipment, building monitoring systems and IT related equipment with restricted access and must not be used as storerooms.
- No other services e.g. electrical risers/boards/cupboards, water, mechanical are to travel through or be installed in these rooms.
- All main communications rooms are to have the capacity for an additional cabinet (with power sockets pre-provisioned) marked as "Future Expansion" in the room specifications. This is not to be utilized during installation and if additional cabinet capacity is required, then the room is to be expanded to accommodate the additional cabinets while retaining expansion capacity.

6.3 Communication Rooms – Locations

6.3.1 Main Communications room (MCR contains CD and BD)

The Main communications room is to be located in the school Library building. If this building is not centrally located on the site, the MCR may, with DoE School Network Solution Design Authority Team approval, be installed in the Administration building or other building in a central and secure location, as long as all the minimum room requirements are met.

All site communication services such as WAN links, servers, security, telephony, main communications and network equipment are to be located in the main communications room. Under no circumstances should these services be installed in separate locations.

6.3.2 Building Communications Rooms (BCR contains BD/FD)

For a building that contains multiple BCR's, one will be defined by the DoE School Network Solution Design Authority team as the primary BCR (containing Building Distributor) that is connected to the Campus Backbone cabling and will service other BCR's (containing Floor Distributors) located in the same structure using the buildings backbone cabling.

6.3.4 Single level buildings:

The building communications rooms should be located centrally to reduce cable pathways and assist with future expansion. In high outlet density areas or larger buildings, it will be required to install further building communications rooms to reduce cable congestion and/or meet security/horizontal cabling requirements.

6.3.5 Multi-level buildings:

Multi-level buildings will require, at minimum, one (1) building communications room per floor. These should be located centrally to service the largest floor area and close to the inter-floor cable risers.

In high outlet density areas or larger buildings, it will be required to install further building communications rooms per floor to reduce cable congestion and/or meet security/horizontal cabling requirements.

The DoE SNSDA team may approve a building communications room to service an adjacent floor that is not heavily populated and if all the requirements for security/horizontal cabling can be met. This will be at the DoE SNSDA Team's discretion.

See Appendix A. Room distributors for MCR and BCR layout designs.

6.4 Cabinet specifications

The table below shows the required cabinet specifications:

Item	**Specification**		**Additional Information**
	Main Communications Room	**Building Communications Room**	
Height	45RU		
Depth	1000mm	800mm	
Width	800mm		
Maximum External Height	Less than 2200mm		
Construction Type	All Metal construction. Welded construction		
Doors, front & back	Metal construction, reversible and removable. Perforated front and rear metal doors with a minimum of 60% open surface for ventilation. Key lockable and latched. The rear door is to be split door arrangement (French Doors)		No Glass or Perspex
Side Panels	Metal construction. Solid metal removable panels. External key lockable		
Front Rails	Standard 19 inch as IEC 60297-2 or later		Adjustable through the full depth of the cabinet. Set back minimum 150 mm from front door "L" Shape profile
Rear Rails	Standard 19 inch as IEC 60297-2 or later		Adjustable through the full depth of the cabinet. "L" Shape profile Depth will be set after installation.
Shelves	Full depth, Metal perforated		Minimum 1 per cabinet
RU markings	On both front and rear rails		
Security	Doors & sides external key lockable		L & F 92380 key code. Three (3) point locking handle
Mounting	Floor mounted with adjustable feet.		Floor mounts must be squarely located using adjustable feet to the floor. Castor

Item	Specification		Additional Information
	Main Communications Room	**Building Communications Room**	
			wheels are **NOT** to be used.
Vertical cable management	2 per cabinet located outside of each front rail. Running full height of the cabinet. D-ring cable manager. Capacity for minimum of 150 Cat6A 28AWG Cables per vertical cable manager		The managers that are supplied by the racking manufacturer are preferred as the mounting methods are predesigned.
2RU Horizontal Cable Managers	1 Per cabinet, installed at the top of the front rail of the cabinet		D-ring cable manager. Capacity for minimum of 100 Cat6A 28AWG Cables. To be fitted with Cat6A bend radius compliant guides spaced at one rack unit or similar.
1 RU Horizontal Cable Managers	1RU cable manager per 2RU of distributor panels		D-ring cable manager. Capacity for minimum 50 Cat6A 28AWG Cables
External power	2 per cabinet. Dedicated 20A circuit per outlet, including Future Expansion cabinet		15A captive pendant socket outlet. RCD and surge protected. Not to be installed in or on the cabinet.
Earthing	All racks are to be bonded to Protective Earth		
Top Panel ventilation	1 per cabinet for non-air conditioned rooms. Dual fans fitted internal to cabinet ceiling.		Not required for air conditioned rooms.
Power Distribution Units	1 per cabinet. 10 way vertical. 15A captive plug. Mounted at cabinet rear, right side.		Connected to 15A captive pendant socket outlet above the cabinet. 12 way vertical PDU may be required in MCR racks.

Cabinet Layouts can be found in Appendix B. Rack layout.

6.5 Cabinet Layouts

6.5.1 Cable pathways:

- Cable pathway to cabinets will be via suspended cable trays, to be installed at a minimum of 2200mm from the FFL, above the cabinet.
- Cabling of any type must not be run across floors or at a height less than 2200mm to cable trays.
- Cable pathways consist of two components, Cable trays and Optical Fibre Trunking (Raceway).
- Cable trays and Optical Fibre Trunking (Raceway) may be installed on the same suspension framework and will extend the full length above the cabinet installation row including the future expansion area.

6.5.2 Cable trays:

- Are for data communications including fixed fibre and security cabling only, not for power installation.
- Are to be either pre-galvanized, hot dipped galvanised, stainless steel or of powder coated material. Zinc plated steel cable trays are not to be used.

- Fibre and copper types of fixed communications cabling are to be secured separately in cable trays and separated from inter-cabinet cabling (which may be added or removed).
- Pathways to cable trays will be run vertically on external walls and then horizontally across to the cable trays.
- Are **NOT** be attached to cabinets but suspended from ceiling, walls or installed support beams.
- Must allow for 50% capacity when installed to allow for future expansion.
- Will not to be used for inter-cabinet fibre or copper patch leads.
- Entry and exit points to have approved bend radius support for the installed cabling.

6.5.3 Optical Fibre Trunking (raceway):

- For optical fibre and copper patch leads between cabinets, not fixed fibre or fixed copper.
- To be installed towards the front side of cabinets.
- Contains two drops into each cabinet, front left and front right through the cabinet ceiling.
- Is to be of a manufactured construction type designed for the purpose of fibre run installations with appropriate bend radius and supports installed.
- Must allow for 50% capacity when installed to allow for future expansion.
- Are **NOT** be attached to cabinets but suspended from ceiling, wall or installed support beams and to be the same supports used for the cable tray system.

7. Pathways

7.1 General

The implementation of appropriate pathways within DoE campuses is essential for longevity and serviceability of the cable plants. The pathways used in DoE are categorized in to three systems, Campus Backbone, Building Backbone and Horizontal.

Campus Backbone pathways are those that provide support and security of cabling between buildings.

Building pathways are those that provide support and security of cabling within buildings between distributors and Horizontal pathways provides support for cabling between the distributor and the work area. The choice of materials used in the pathway should consider environmental factors such as highly corrosive environments, e.g. hot dipped galvanized steel cable trays in locations close to salt water.

All pathways are to comply with AS/CA S009 and AS/NZS 3084.

7.1.1 Campus Backbone Pathways

All campus backbone pathways and cabling are to be Optical Fibre cabling, as specified in section 5. Optical fibre cabling specifications and installed as an underground conduit and pit system. Above ground conduit, direct buried and/or aerial catenaries are strictly prohibited for campus backbone cabling.

This connects the MCR to the buildings primary BCR that contains the building distributor. The primary BCR will be nominated by the DoE SNSDA team and will then service other BCRs that may be located in the same building using building backbone

cabling.

Due to the varying school designs and works at brownfield sites, the DoE SNSDA may require individual BCRs to be cabled directly back to the MCR and will advise during the design phase if this is required.

Low capacity buildings with less than 10 TOs (5 DTOs) with no possibility of future expansion, may not require a Campus Backbone pathway and TOs can be cabling back to nearest BCR using underground external grade horizontal cabling installed in underground conduits and pits. This is at the DoE SNSDA team's discretion and will be identified at the design stage.

7.1.1.1 Installation

Campus backbone pathways are to be installed completely underground to fixed buildings only. No part or any portion of the pathway is to be installed on awnings, verandas, walkways or any structure that is not part of the main building. The underground pathways should begin underneath the building where possible or enter the ground directly at the building's footprint edge.

7.1.1.2 Underground Conduit and Pit

The minimum underground conduit pathway is (2) X 100mm conduits between pits and also between building entry pits and the MCR or primary BCR location. Existing buildings may utilize (4) X 50mm from the building entry pit to the MCR or primary BCR if pathway cannot support (2) X 100mm. See Appendix G – Pit and Conduit.

For installations where only an optical fibre cable is installed in an underground conduit, a 4 square millimetre copper wire is also to be installed as a locator/trace wire. The locator cable is not to be coloured red, black, blue, purple or white.

All conduits shall be installed with the appropriate draw cord. White marking tape is to be installed at least 100mm above the conduit. The ends of conduits are to be sealed at the building entry point and within the pit. Drainage holes and drains must be provided in all pits. The pits are to be positioned such that conduits do not drain into buildings.

The conduit numbers and pits must be sized appropriately for the number of cables in a conduit with expansion capacity. Conduits should be considered as "full" when the cross-sectional area of the planned/installed cables reaches 40% of the conduit cross-sectional area.

Conduit fill factor comprising **[the sum of cable cross-sectional areas] / [conduit inner cross-sectional area]** shall not exceed the requirements of AS/NZS ISO/IEC 14763.2 for straight conduit runs. For new installations, this should be 24% (comprising 40% ultimate fill less 40% of this as spare capacity).

The location of the building entry pit is to be as close as is practical to the room housing the primary BCR or MCR.

All pits must use concrete lids. The minimum rating of the lid/cover is to be of type Class B.

Pits used in roadways and traffic areas may require a higher rated lid and hence the appropriate weight carrying capacity lid is to be used. Pit lids are to be labelled as "Communications" or "Comms".

Additionally:

- Pits used as the building entry to the MCR is to be a minimum size of Pit Type P8.

- Pits used to extend the main campus pathway are to be a minimum size of Pit Type P6.
- Pits used for building entry are to be a minimum size of Pit Type P5.
- The use of existing carrier conduits and pits for DoE cabling is **strictly prohibited.**

All conduits and pits are to be documented with the following details to be included:

- conduit pathways
- depths of all conduits and pits
- pit sizes and locations including GPS coordinates

See 13. Documentation for detailed information.

7.1.2 Building Backbone Pathways

If a building contains more than one BCR then a primary BCR (containing the building distributor) will be nominated by the DoE SNSDA team to connect to the Campus Backbone cabling and this will then service other BCRs that will be located in the same building using building backbone pathways.

Each BCR in a building will be connected on its own cabling back to the primary BCR.

All building backbone pathways and cabling are to be Optical Fibre cabling, as specified in section 5. Optical fibre cabling specifications.

7.1.2.1 Installation

All pathways are to have a minimum 50% spare capacity at the time of installation.

Vertical pathways between floors are to be a minimum of (2) X 100mm conduit sleeves or slots.

The building backbone pathways must be accessible throughout their length. The pathways must use the cable lay-in method for installation of cabling.

The building backbone pathways are to be a fully enclosed system consisting of metal trays or trunking with lids/covers or a combination of both and may utilize horizontal cabling trays or trunking as long as spare capacity is maintained.

Metal pathways are to be bonded to protective earth. Conduits are acceptable for installation in concealed spaces only.

7.1.2.2 Fibre capacity

The minimum installation is 12 core of Single-mode fibre for all building backbone cabling. The DoE SNSDA team will advise during the design phase if an increase is required.

7.1.3 Horizontal Cabling Pathways

The horizontal pathways connect the BCR's to the work area Telecommunications outlets.

All horizontal pathways and cabling are to be Cat6A, as specified in section 4. Horizontal cabling specifications.

7.1.3.1 Installation

The primary method for installing horizontal cabling is to be metal trays or trunking that is to be installed throughout the building to reach all cabled areas.

This is to be incorporated into the building planning at the design phase to allow capacity for these pathways and access to them for future expansion works.

The building distribution pathways must be accessible throughout their length, with

access/service hatches strategically placed ensuring that this is the case. The pathways must use the cable lay-in method for installation of cabling.

Where retrofitting existing buildings, proposed pathways need to be approved by the DoE ITD Representative.

The horizontal cabling pathways are to be a fully enclosed system consisting of metal trays or trunking with lids/covers or a combination of both.

- The minimum width of the tray or trunking is 75mm
- The minimum depth of the tray or trunking sides is 50mm

Metal pathways are to be bonded to protective earth. Conduits are acceptable for installation in concealed spaces only. Conduits entering the underneath of buildings are to extend to the underfloor surface and be affixed to the floor structures. Cable runs that contain ten (10) or more cables must use either a tray or trunking, for runs of less than ten (10) cables, the catenary wire may be used. Cable runs are not to be separated into ten (10) or fewer cables to avoid installing cable trays or trunking.

The size of the pathway must be increased if the cabling to be installed exceeds the maximum fill space. The pathway must allow for 100% expansion of cable carry capability based on the number of cables being installed at the time the pathway is installed. If the number of cables to be installed plus the 100% expansion exceeds the minimum dimensions (75mm x 50mm) then the pathway must be increased in size accordingly.

In all cases where the pathway is exposed the cabling is to be fully enclosed in a metal material that is securely fixed with removable screws throughout its entire length. This applies to pathways used for vertical and horizontal reticulation of cables. An exposed pathway is defined as being visible and accessible to the general pedestrian. This is regardless of the level of supervision present at any time. The exposed pathway is to be aesthetically matched to the surrounds of the room.

Where appropriate, multi-channel PVC ducts can be used for the reticulation of cables to the final outlet location. There need to be a minimum of two (2) channels, one for telecommunication cables, and another for power cables. No excess cables are to be stored in the ducts and all ducting shall be securely fixed to the surface using the appropriate method. The duct is to be clear of any burrs and other sharp spikes or edges.

Cables installed in cavities (wall partitions, columns, etc.) shall meet the mandatory separation from power cables as specified in AS/NZ 11801: Current Version. The area shall also be free from sharp edges, ensuring no strain is placed on the cable.

Appendix C. Pathway materials and fixings contains a list of acceptable products and materials/fixings used in pathways.

In summary, the following table lists what is acceptable and what is not:	
Campus Backbone Pathways	Underground conduit (and pit system) is required for campus backbone pathways.
	Above ground conduits of any size are not to be used for Campus backbone cabling.
	Conduit is an acceptable pathway to demountables.
	Existing carrier conduits and pits are not to be used for DoE cabling.
Building Backbone Pathways	Transition from Campus to Building Pathway - Conduits entering the underneath of buildings are to extend to the underfloor surface and be affixed to the floor structures. Is to consist of Fibre Optic cabling only, unless exemption for any other type of cabling (i.e. Copper) has been approved by the SNSDA.
	Building Backbone pathways are to be a fully enclosed system consisting of metal trays or trunking with screw fixed lids/covers or a combination of both
	Vertical pathways between floors are to be a minimum of (2) X 100mm conduit sleeves or slots.
Horizontal Cabling Pathways	The cable pathways in accessible ceiling spaces may use an open pathway.
	A tray/trunking system is to be used for 10 or more cables or a catenary wire system may be used for a smaller number of cables.
	The penetration into the building is to be fully enclosed using a conduit or suitable material.
Local Distribution Pathways (from the horizontal cabling pathway to the final outlet destination)	Communications conduits are acceptable for installation in concealed spaces only.
	Wall cavities may also be used.
	Where the pathway is to be surface mounted PVC trunking must be used.

8. Earthing

Every communication room (MCR, BCR) is to be provided with a Communications Earth System (CES), used for both functional earthing and protective earthing purposes. Earthing conductors used for a CES system shall have green/yellow insulation. The size of the earthing conductor shall be in accordance with AS/CA 2009 and be installed in accordance with industry best practices.

Any electrically conductive support system for cables shall be earthed. This includes but not limited to metallic cable trays, trunking systems, distribution frames, mounts, enclosures, racks, cabinets, or catenary supports. A Communication Earth Terminal (CET) is to be installed in each communication room (MCR, BCR). A CET is the terminal that the earthing system connects to within the communications room.

Where shielded cables are installed, the contractor is to ensure that ensure that the earthing of the shields complies both with AS/CA S009 and the manufacturer's advice. Each patch panel for the shielded outlets and shielded cables shall be individually earthed to a single earth point on the cabinet/rack or to an earth bar within a cabinet.

As part of the handover documentation, the contractor shall provide communications drawings showing the earthing system, in particular the CET.

9. Demountables

Where demountable buildings are being installed, it is imperative that DoE ICT representatives be involved from the initial planning phase. As a general rule if one demountable is required then depending on the distance between the demountable and the nearest BD, horizontal cabling (typically external grade) can be used (with surge protection if required).

However, when a cluster of demountables are to be installed or upgraded, a fibre backbone is to be installed to a strategically located distributor near one of the demountables. The other demountables in that cluster shall then cable back to that distributor. The fibre installation is to adhere to the specifications set out in this document.

The use of Aerial catenaries is strictly forbidden.

The sizing of the distributor cabinet must take into consideration the number of existing and future demountables.

10. Capital works/refurbishment/expansions

For existing sites, where there is capital works, refurbishments and/or expansion taking place, these works are to comply with the standards as set out in this document. DoE ITD representatives need to be involved in the lifecycle of the project (from pre-planning, implementation and sign off) to ensure that all works are being correctly specified and these specifications are adhered to.

For any new fibre installation, regardless of the number of fibre cores being installed and regardless of the existing fibre type on site, the standards stated in this document (OS2, minimum 12 core) must be adhered to.

Any cabling infrastructure found and identified by the contractor to be non-conforming to DoE guidelines, the manufacturer’s guidelines, or Australian Standards must be reported to a DoE ITD/Project manager for further investigation.

11. Labelling

All components of the Cabling Subsystem will be labelled with machine generated etched labels (i.e. traffolyte). These labels may be part of the vendor's product range. The labelling system must be adhered to the component, be considered as permanent and last for the entire life of the device. Handwritten labels and tape labels are not acceptable. All labelling is to conform to AS 3085.1 current edition.

The font used shall be Arial, Times New Roman, Helvetica or of a similar type, that is easily readable. All text is to be in capitals as in examples below.

11.1 Cabinet labelling:

Text is to be a minimum of 10mm in height. The name of the distributor must be attached to the front and top of the cabinet (External) and will form part of the label for the outlets.

Cabinets are to be named according to their AMS room code and numbered sequentially from the left of the door entering the room:

- "AR0001-C1" is the first cabinet located in AR0001
- "AR0001-C2" is the second cabinet located in AR0001.

For the Main Communications Room, see specific cabinet numbering sequence in Appendix B. Rack layout.

11.2 Fibre cable labelling:

Text is to be a minimum of 5mm in height.

Campus Backbone cables and termination panels will be labelled with the number of cores, type of cable and the destination distributors AMS room number.

An example labelling of a 12 core OS2 installed from Block A, room AR0012 (MCR) to Block B, room BR0015 (BCR) is:

- On the Block A FOBOT the label will read – "12 CORE OS2 TO BR0015"
- On the Block B FOBOT the label will read – "12 CORE OS2 TO AR0012".

Labels are to be placed on the individual FOBOT inserts (on, above or below) where the cables are terminated and not impede any future insert installations or labelling requirements. Labelling on the FOBOT lid is strictly forbidden.

Every fibre cable, in every pit, is to be labelled using an outdoor grade label that is machine printed with the AMS source and destination location. That same cable is to also be labelled as it enters the room, in a location where it is visible, preferably just before it enters the FOBOT.

An example label is – "AR0012 TO BR0015".

11.3 Horizontal cable labelling in cabinets:

Text is to be a minimum of 5mm in height.

Distributor cables and panels will be labelled with unique and contiguous numbers. The outlet on the panel number must match the outlet numbers and should traverse cabinets in the same room for larger installations. A vendor's labelling solution may be used on the copper patch panels provided that it is tamper proof, machine generated and lasts for the entire life of the device.

Example: Outlets 1-192 in the cabinet C1 and continue with 193+ in cabinet C2.

11.4 Telephony cable labelling in cabinets:

Text is to be a minimum of 5mm in height.

Telephony cables and panels will be labelled with a unique and contiguous number for the UTP connected. The outlet on the panel number must match the outlet numbers in the corresponding cabinet where the cabling is terminated. Sequential numbering such as 1, 2, 3... is sufficient.

Example labelling of a 10 pair installed from Block A, room AR0012 (MCR) to Block B, room BR0015 (BCR) is:

- On the Block A UTP backbone the label will read – "10 pair UTP TO BR0015"
- On the Block B UTP backbone , the label will read – "10 pair UTP TO AR0012"
- With each RJ45 outlet marked as 1, 2, 3.

The label is to be placed on the panel either above or below where the cables are terminated and not impede any future insert installations or labelling requirements.

Every UTP cable, in every pit, is to be labelled using an outdoor grade label that is machine printed with the AMS source and destination location. That same cable is to also be labelled as it enters the room, in a location where it is visible, preferably just before it enters the patch panel.

An example label is – "AR0012 TO BR0015"

11.5 Telecommunications Outlet labelling:

Text is to be a minimum of 5mm in height.

Telecommunications Outlets will be labelled with the distributor cabinet they are terminated at and a unique and contiguous number that corresponds to the number on the distributor patch panel. See section "Horizontal cable labelling in cabinets". TOs installed below 1600mm FFL are to have the labels on the top of the wall plate, and outlets installed above 1600mm FFL are to be labelled on the bottom of the wall plate for easy identification.

See examples below:

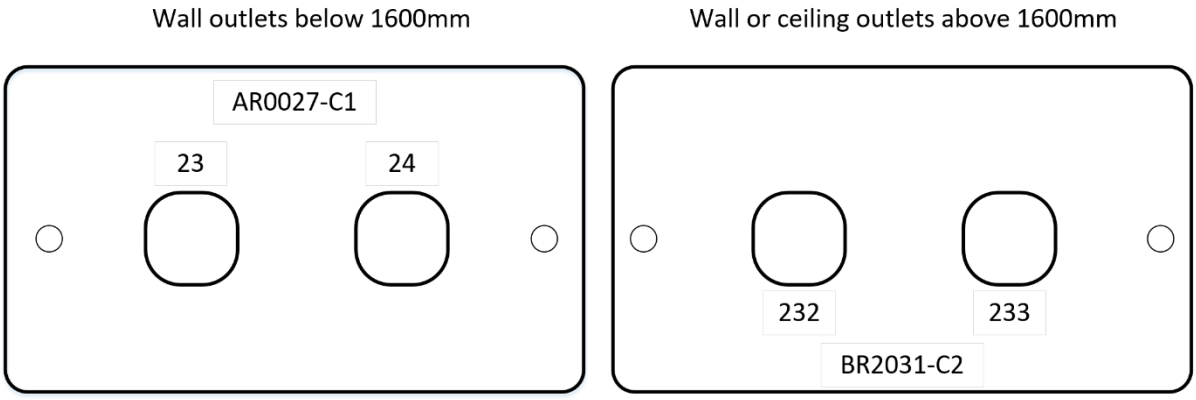


Figure 3 - Wall outlet diagram

This outlet is terminated back to room AR0027, cabinet C1 and the patch panel numbers are 23/24

This outlet is terminated back to room BR2031, cabinet C2 and the patch panel numbers are 232/233.

11.5.1 External Access points:

For external Access points, additional external grade labelling is required on the bottom of the waterproof outlet box. It is to contain the same information as the outlet wall plate label inside the box with a minimum text height of 10mm and legible from ground level.

12. Testing

12.1 General

Prior to testing taking place, all cables and outlets must be fully terminated and installed in their final locations and labelled accordingly (See section 8, Labelling). 100% of all cables are to be tested and all testing is to be carried out in accordance with the relevant standards, namely AS/NZS IEC 61935.1 and ISO/IEC 14763-3.

12.2 Horizontal Cabling

The installer must individually test 100% of all copper cables and all testing shall meet, or exceed, the manufacturer's warranty and testing requirements.

Permanent link performance is the preferred acceptance criteria for all horizontal cabling installations. The Permanent link performance, and channel performance shall meet the minimum requirements of:

- AS/NZS 11801:Current Version for Class EA (using Cat6A components), or
- ISO/IEC 11801 Ed 2 for Class EA (using Cat6A components)

All permanent links must be tested in accordance with AS/NZ IEC 61935.1.

All results must be supplied to DoE representatives prior to the acceptance of the site. The documentation must clearly identify the DoE site and the circuit/link being tested. All testing lengths are to be indicated in meters, not feet. Date stamps and the name of the company and technician must be included. The installer is to also provide to DoE the manufacturer's warranty certificate, along with other documentation such as "as built diagrams" (see section 13. Documentation).

12.3 Optical Fibre

The testing of the optical fibre cable plant shall include:

- Power Insertion Loss (PIL)
- Optical Time Domain Testing
- Length and Propagation Delay

For PIL testing, a Light Source and Power Meter must be used, Optical Time Domain Reflectometer (OTDR's) are not to be used. The optical characteristics of the optical fibre cores are to be tested using an Optical Time Domain Reflectometer. The length and propagation delay testing may form part of the PIL or OTDR testing.

All testing shall meet, or exceed, the manufacturer's warranty and testing requirements. Testing is to be conducted in accordance with AS/NZS ISO/IEC 14763.3.

Testing shall be carried out at in both directions and in the following the optical wavelengths:

- 1310nm
- 1550nm

All test results are to be included with the as-built documentation. The test results are to

be presented in their native electronic format.

13. Documentation

The contractor will provide the following post-installation documentation as part of the contract.

13.1 As-Installed Drawings

The as-installed drawings will include as a minimum:

- Plans showing cable pathways
- The cable pathways are to indicate main components – trays, pits, risers
- Backbone cabling and Horizontal cabling is to be marked separately
- Locations and labelling of outlets
- Locations of distributors

Electronic versions of drawings shall be supplied to DoE as an AutoCAD and/or Adobe PDF drawings. If using scanned hand altered copies of site maps, any as installed alterations need to be clear and legible. DoE entities usually hold hard and soft copies of plans in Adobe PDF of all buildings on their sites. Copies can be made available on request to the site cabler to mark up with the As-Installed works. If requested as part of the design, photos are to be provided by the contractor.

13.2 Test Results

The test results will include those stated in the Structured Cabling System Testing Requirements as mentioned in this document.

The above documentation will be provided in two hardcopy volumes plus one softcopy. As-Installed Drawings are preferred to be marked up Adobe PDF drawings. However other formats are acceptable. The test results can be provided in softcopy only.

13.3 Warranties & Certification

In instances where site cabling is being performed as part of other building work, and these works are managed by a prime contractor or builder, the standard defects and liability warranty will apply. Warranties required under prime/builder contracts will precede those stated below for only the term of the prime contract warranty.

13.3.1 Site cabling Warranties

The contractor will provide a warranty to make good any part of the SCS found to be faulty due to faulty manufacturer materials and/or inadequate installation practices or workmanship. The period of the warranty is to be not less than five (5) years inclusive of any other defects liability period. Pathways are considered a part of the SCS. Hence the conduits and pit systems, catenary and fasteners and duct works are all to be included within the warranty.

13.3.2 Manufacturers Certification

In addition to the above warranties, the contractor will provide a manufacturers application and product certification for the SCS. The certification must include the supply of products and labour to rectify cabling found to be faulty. The minimum period of certification will be twenty (20) years. A certification which also warrants the cable pathway and its components are preferred.

The manufacturer's certificate is to be provided in hard copy and electronic format. A

scanned image is acceptable. Certifications which do not have as part of the manufacturer's program an installers training program are not acceptable. The manufacturer's installer training program must include a design and installation component. The installation training must include the testing of fibre and copper installations required to perform tests required of this specification.

13.3.3 Multiple Vendor Certifications

It is acceptable for multiple vendors to provide certifications for either the twisted pair and/or optical fibre cable plants. However, the combined cable plants must be included and the vendors must comply with the certification training requirements above. The contractor must not void any manufacturer's certifications or warranties on previously installed structured cabling systems.

13.4 Cabling Checklist

The Cabling checklist attached in Appendix J: Cabling Checklist, is to be used where there has been an installation of copper or fibre cabling in any NSW DoE school premises.

Appendix A. Room distributors

Schedule Area
15.5 m^2

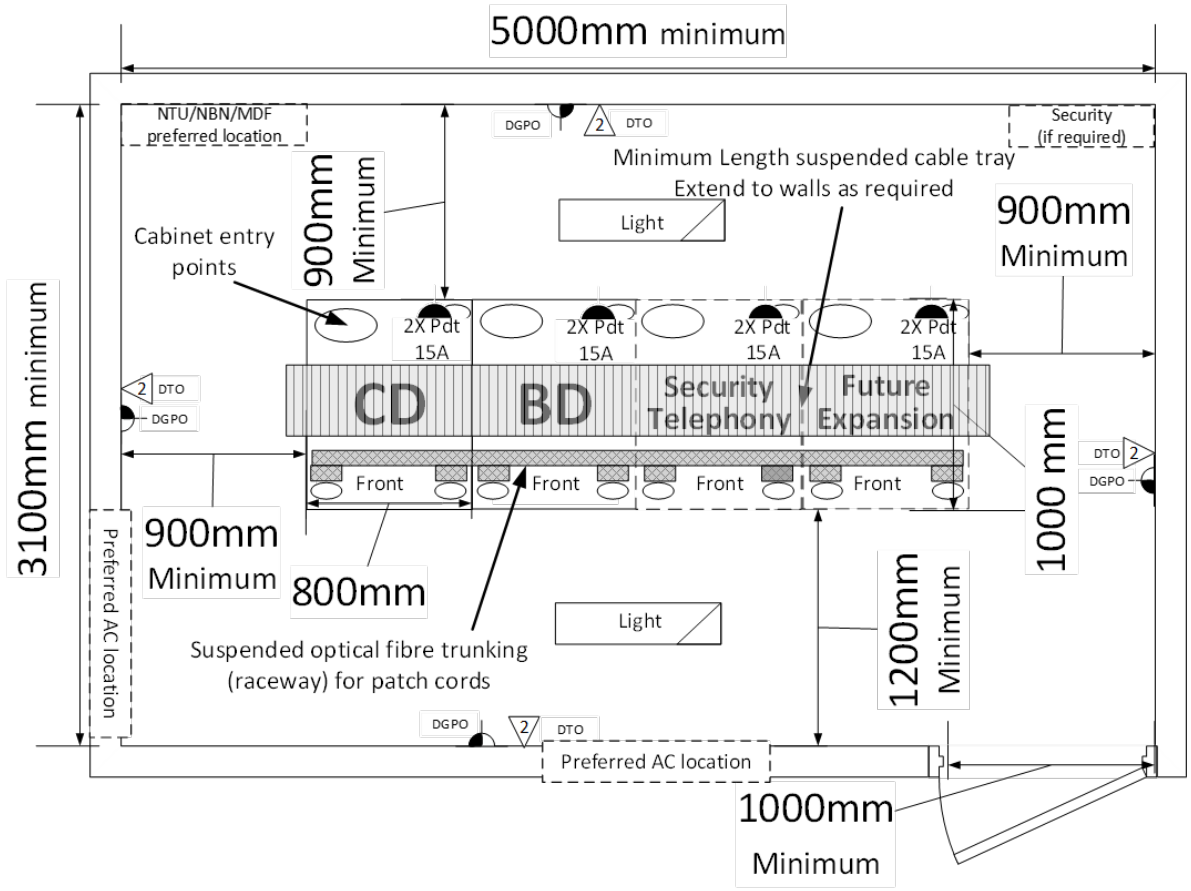
Notes

1 Minimum Room requirements are Critical Dimensions due to equipment being installed.

2 Minimum Ceiling height is 2400mm

3 All cable pathways into cabinets are to be via cable trays installed above 2100mm

Main Communications Room



Building Communications Room (BCR)

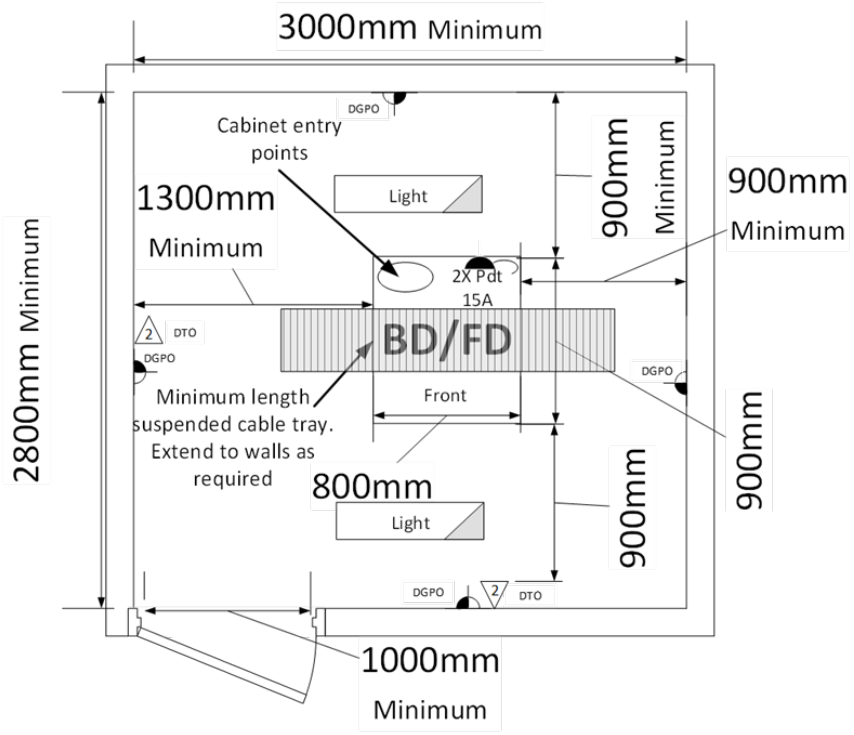
(Single Cabinet)

Schedule Area
8.4 m^2

Notes
1 Minimum Room requirements are Critical Dimensions due to equipment being installed.

2 Minimum Ceiling height is 2400mm

3 All cable pathways into cabinets are to be via cable trays installed above 2100mm



Building Communications Room (BCR)

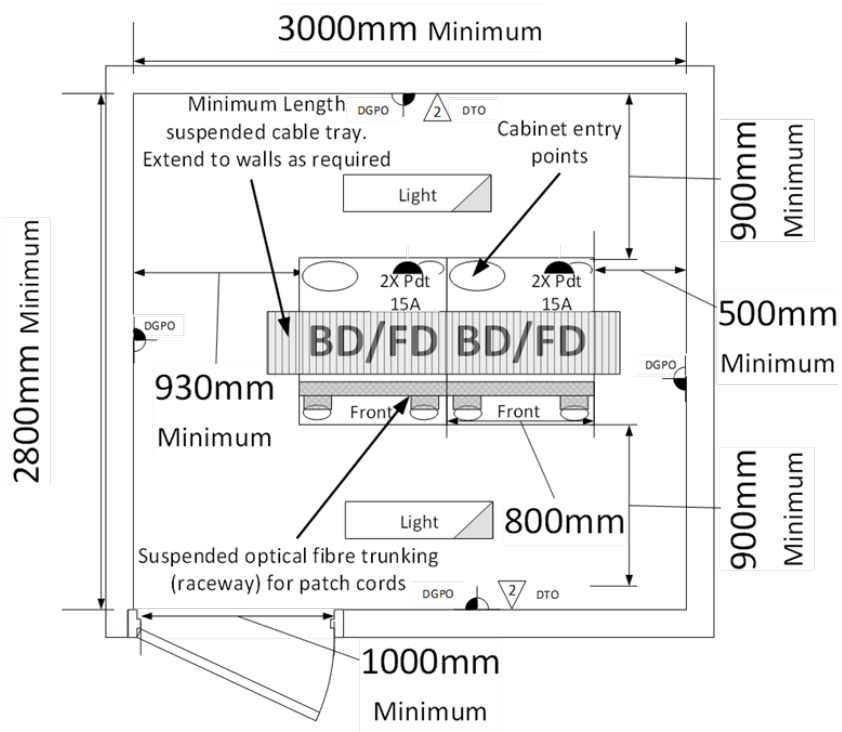
(Dual Cabinet)

Schedule Area
8.4 m^2

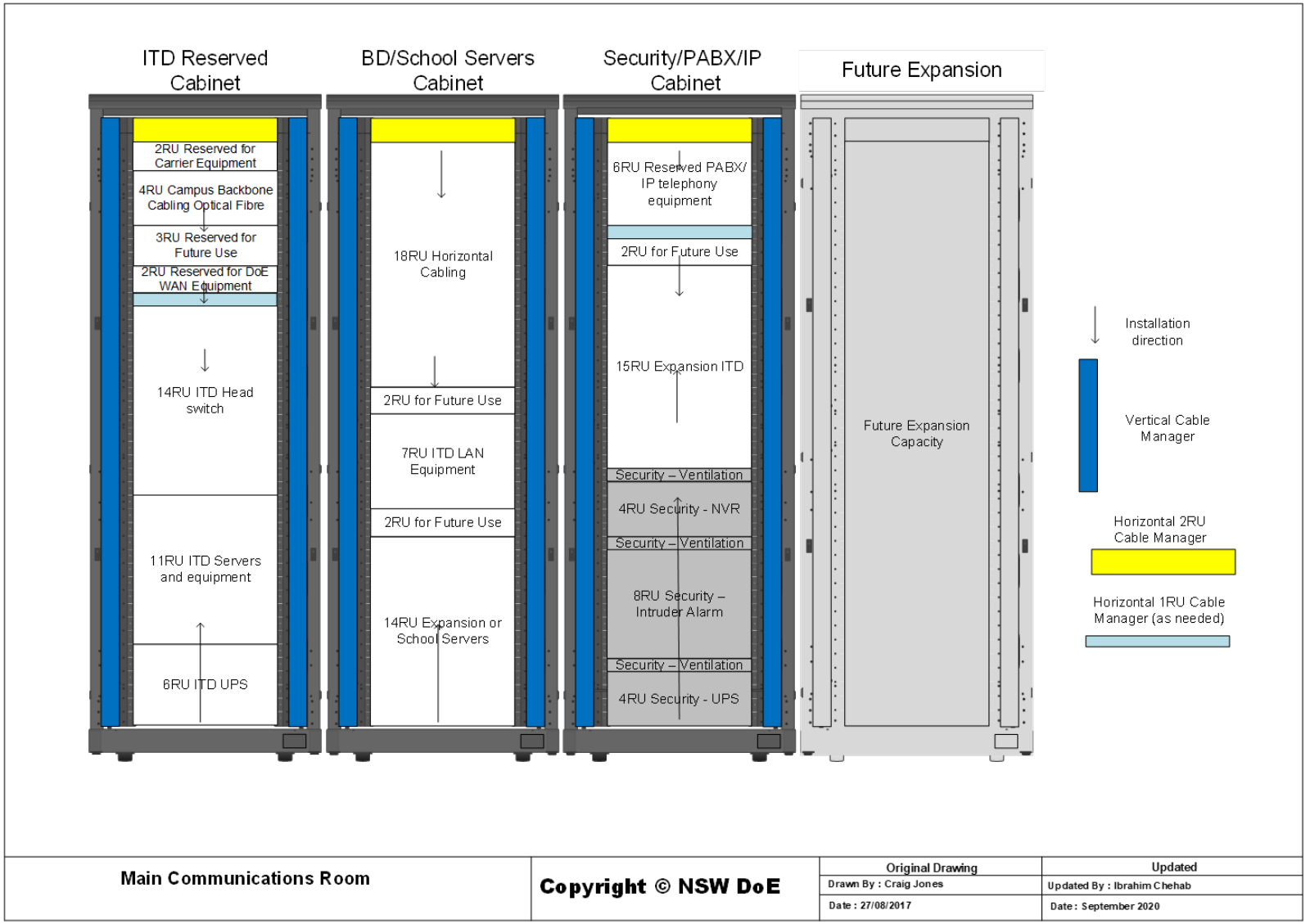
Notes
1 Minimum Room requirements are Critical Dimensions due to equipment being installed.

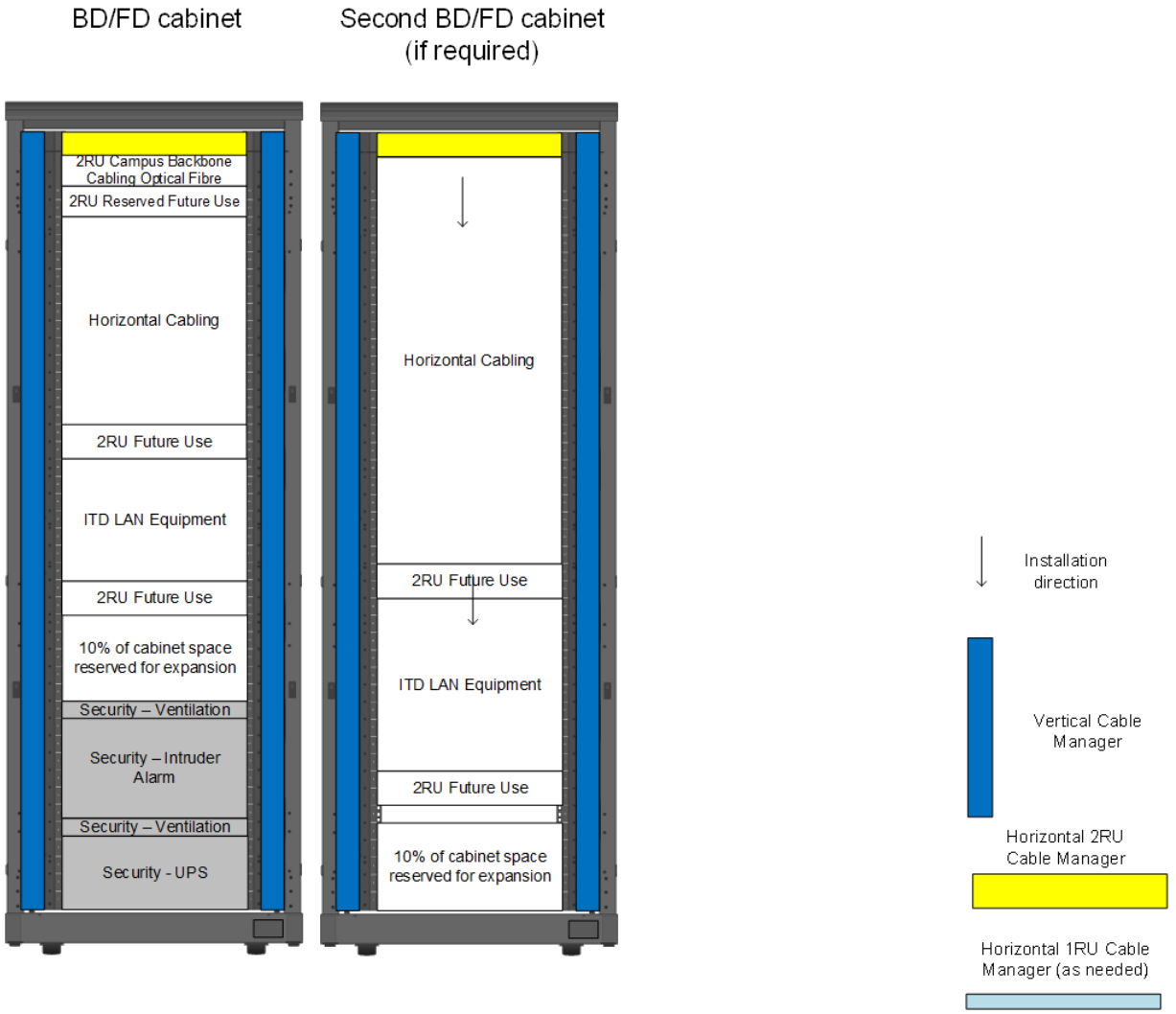
2 Minimum Ceiling height is 2400mm

3 All cable pathways into cabinets are to be via cable trays installed above 2100mm



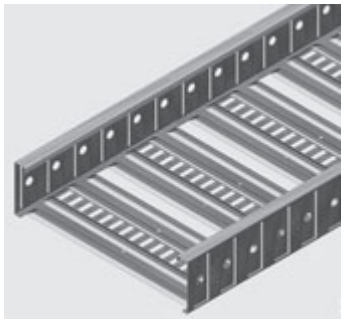
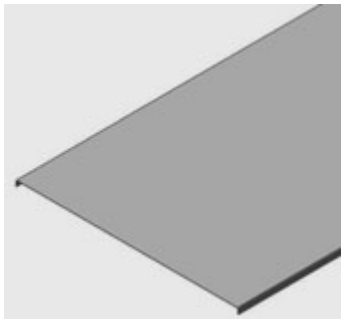
Appendix B. Rack layout

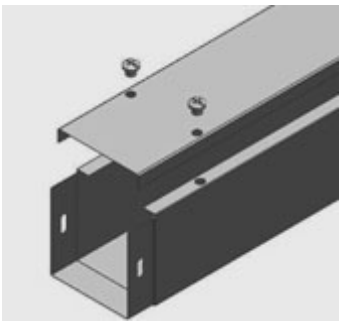
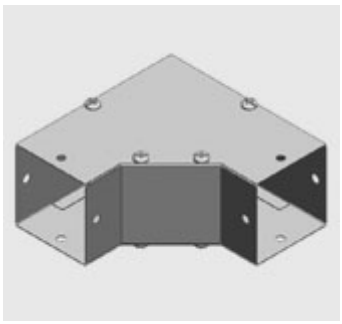




Building Communications Room Single/Dual Cabinet Layout	Copyright © NSW DoE	Original Drawing	Updated
		Drawn By : Craig Jones	Updated By : Ibrahim Chehab
		Date : 27/08/2017	Date : September 2020

Appendix C. Pathway materials and fixings

Item	Description	Picture
Trunking PVC 25 X 25mm 4mtr WHITE	Permanent Outlet Pathway	
Trunking PVC 100 x 50mm	Local Distribution Pathway	
Mesh Cable tray Enclosed Trunking (in exposed areas)	Horizontal Cabling Pathway	Mesh cable tray Enclosed trunking (in exposed areas)
Cable bend radius compliant waterfall	Horizontal Cabling Pathway	
Metal Cable Tray + Lid	Building Backbone Pathways	 Metal cable tray  Lid

Item	Description	Picture
Metal Duct	Building Backbone Pathways	 
Raceway	For fibre and copper connections between cabinets in the same room	
Hook & Loop Straps	Reusable Cable support	

Appendix D: Fibre examples

Fibre Enclosures:

Figure 4 - Example of a high-density fibre enclosure

Fibre connections and patch leads

Single-Mode: OS1/OS2.

Patch leads will be “YELLOW” with connectors or strain relief/mating adapter will be “BLUE”

Figure 5 - Yellow patch lead with blue strain relief/mating adaptor

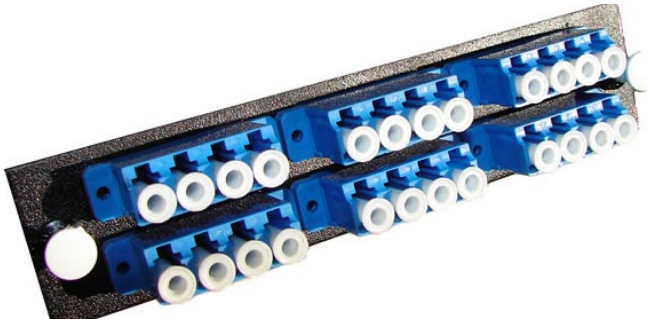


Figure 6 – Fibre adaptor panel

Appendix E: External WAP

Figure 7 - External WAP installation ref. 1 (Note use of the waterproof cover)

Figure 8 - External WAP installation ref. 2 (Note use of BSP fitting for cable ingress to WAP)

Figure 9 - Wireless bridge installation ref. 3 - BSP fitting and water proofing need to be followed as per instructions

Appendix F: Patch cables

Figure 10 - Patch cable examples

Table 2 - Summary of total 28 AWG patch cord length vs. maximum channel length.

Total 28 AWG Patch Cord Length		Maximum 23 AWG Horizontal Cable Length		Maximum Total Channel Length	
Meters	Feet	Meters	Feet	Meters	Feet
2	7	98*	321	**100**	328
3	10	96*	314	99	324
4	13	94*	308	98	321
5	16	92*	301	97	317
6	20	**90**	295	96	315
7	23	88.5	290	95.5	313
8	26	86.5	283	94.5	309
9	30	84.5	277	93.5	307
10	33	83	272	93	305
11	36	81	265	92	301
12	39	79	259	91	298
13	43	77	252	90	295
14	46	75	246	89	292
15	49	73.5	241	88.5	290
16	52	71.5	234	87.5	286
17	56	69.5	228	86.5	284
18	59	67.5	221	85.5	280
19	62	65.5	214	84.5	276
20	66	64	209	84	275

Figure 11 - Summary of total 28 AWG patch cord length vs. maximum channel length

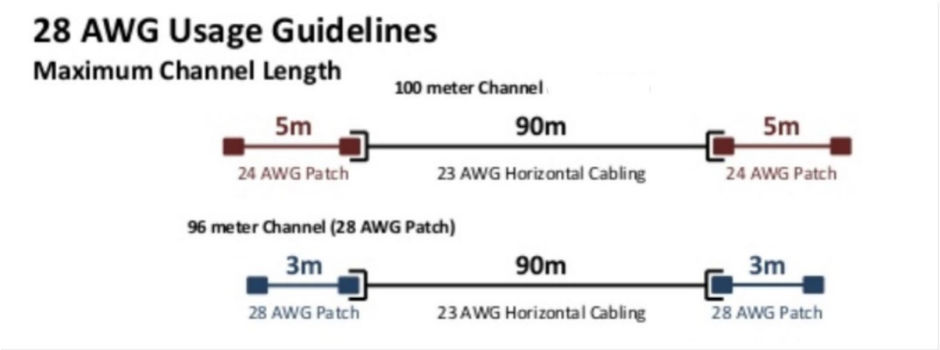
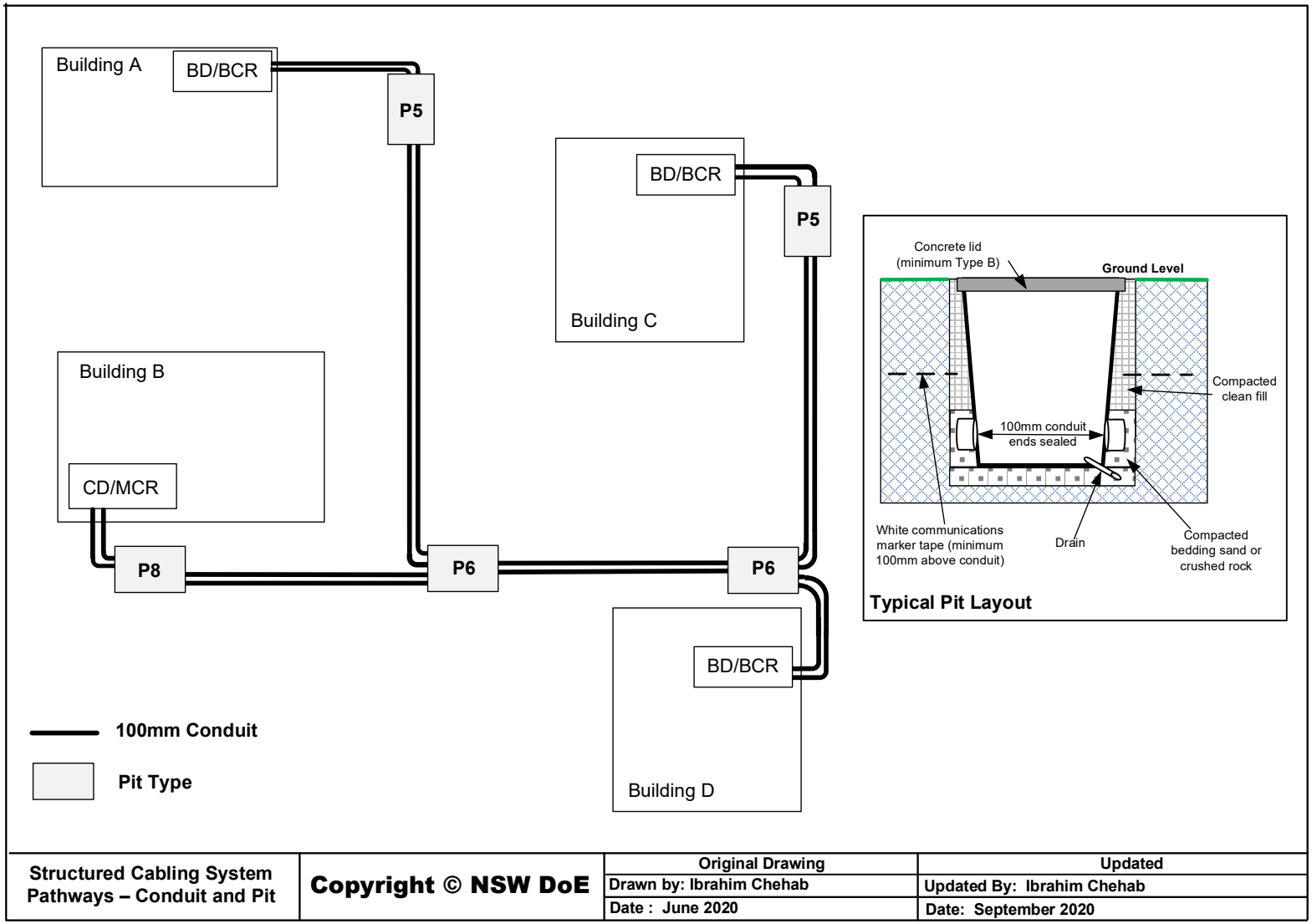


Figure 12 - 28 AWG usage guidelines

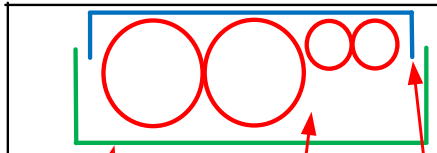
Patch cable colour chart

Device	Colour
Workstations, printers	Blue
VOIP Controller, dedicated VOIP handsets	Black
Digital/Analog handsets	Beige
Wireless Access Point	White
Security devices (CCTV, Access control etc.)	Red
BMS devices (Solar, Environmental etc.)	Grey
Audio-visual	Purple
Switch uplinks (DAC cables exempted)	Pink
Carrier NTU to DoE WAN device	Yellow
DoE WAN device to Core Switch	Green

Appendix G: Conduit and pit diagrams



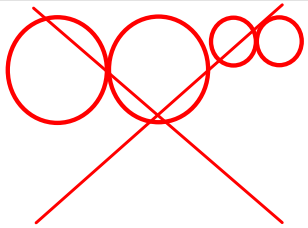
Structured Cabling System Pathways – Conduit and Pit	Copyright © NSW DoE	Original Drawing	Updated
		Drawn by: Ibrahim Chehab	Updated By: Ibrahim Chehab
		Date : June 2020	Date: September 2020



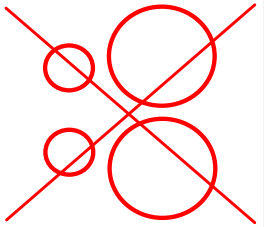
Powder coated top hat mechanical protection to 2m high

Vertical Cable Tray

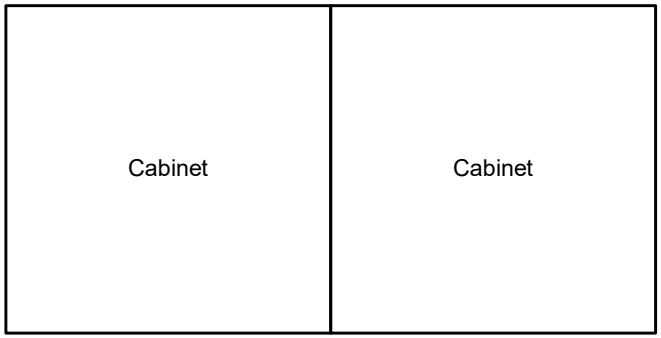
Correct Conduit Entry Location (Conduits placed along the wall located close to the corner)



Poor placement of Conduits. Conduits located behind cabinet reducing the clearance of the cabinet to the wall



Poor placement of Conduits. Conduits protrude into room too far



Comms Room U/G Conduit Entry Design	**Copyright © NSW DoE**	**Original Drawing**	**Updated**
		Drawn by: Danny Yeadon	**Updated By:**
		Date : July 2020	**Date:**

Appendix H: Examples of complying TO components

Brand	Panduit
Range	Mini-Com TX6A Spring Shuttered Shielded Jack
Model	CJSH6X88TG

Brand	Molex
Range	Powercat 6A shielded jack
Model	KSJ-00062-XX

Brand	Siemon
Range	Z-MAX 6A shielded jack
Model	Z6A-SH XXD

Brand	Panduit
Range	Min-Com Classic Series Faceplates
Model	CFPH2IW

Brand	Clipsal
Range	Pro Series
Model	P3042G

Brand	Legrand
Range	Excel Life Secure Plate model
Model	ES770/2GPLWE

Brand	R&M
Range	Freenet
Model	R795602

Brand	Siemon
Range	10G MAX
Model	10GMX-HFP-0X-XX
Note: Shall have solid label fitted over the label window to be approved	

Appendix I: Equipment Sample Approval (ESA) Form

Sample Number		ABC001	
SUBCONTRACTOR TO COMPLETE			
Subcontractor company name		Cabling4U Pty Ltd	
Subcontractor contact name		John Smith	
Subcontractor contact phone number		1234 5678	
Site installation Name		Test School	
Site Code (4 digit)		9999	
Location to be Installed (buildings, rooms)		Blocks A, B and C	
Item Description		Cat6A shielded jack	
Product Model No. (specific part number)		CJSH6X88TGY-TX6A	
Specification Reference		Department of Education, NSW Structured Cabling System Specifications 2020	
Supplied as specified [Y]/[N] Alternate Solution		Y	
Sample Information Provided	Physical Sample		
	Tech Data Sheet/Product Manual	Y	Spec sheet attached
	Certificates		
	Shop Drawings		
	Other		

Consultant endorsement		Name	Signature	Date
Electrical/Data (If Applicable)				
	Approved	Comments:		
	Approved with Comments			
	Resubmit as per comments			
	Rejected			

Client endorsement		Name	Signature	Date
School Network Solution Design Authority (Required)		John Smith		24/07/2020
X	Approved	Comments:		
	Approved with Comments			
	Resubmit as per comments			
	Rejected			
Foundations.T4L (Required)		John Doe		24/07/2020
X	Approved	Comments:		

	Approved with Comments
	Resubmit as per comments
	Rejected

Appendix J: Cabling Checklist

School Name:		**Address:**	
Project Name:		**Date:**	
Cabling Contractor:		**Contractor Contact Details:**	
DoE Project Manager:		**SCSS Version:**	
Checked By:		**Project Sign Off:**	

Item No	Description	Y / N or N/A	Comments
1	**General**		
1.1	Cabling Contractor is SCM0020 certified		
1.2	Cabling Contractor is accredited with the cable manufacturer as an approved Installer		
1.3	Cabling Contractor and the person(s) working on the cable plant have the required ACMA endorsements		
1.4	Cabling and data installation locations have been carried out in accordance with detailed design signed off schematics		
1.5	Cabling Contractor has read and agrees to abide by the SCSS		
1.6	A single certified cabling system is used throughout the site		
1.7	WAPS are installed at an acceptable height and location		
1.8	Proposed components of the Structured Cabling System have been verified by the SNDSA as meeting DoE requirements		
2	**Communications Rooms**		
2.1	MCR meets room dimensions as per SCSS and EFSG		
2.3	MCR/BCR is located in a suitable area		
2.4	BCR meets room dimensions as per SCSS and EFSG		
2.5	MCR has air conditioning		
2.6	BCR has adequate cooling		
2.7	Comms rooms contain only IT related equipment/not used as a storeroom		
2.8	Comms rooms have adequately sized doors		
2.9	Comms rooms have adequate access leading to it		
2.10	Comms room has a minimum DTO installed		
2.11	Comms rooms are adequately secured (i.e. lock, swipe card)		
2.12	Comms rooms are clean and dust free		
2.13	All penetrations in comms room are adequately sealed and fire stopped		
2.14	MCR has capacity for an additional cabinet (with power sockets pre-provisioned) marked as “Future Expansion”		
2.15	Lighting in comms rooms is operational		
2.16	No other services e.g. electrical risers/boards/cupboards, water, mechanical are travelling through or installed in these rooms.		

2.17	All cabling in the comms room has been terminated, tested and labelled		
2.18	The communications riser, and other services risers or equipment is outside the required minimum cabinet clearances.		
3	**Racks/Data Cabinets**		
3.1	Racks in MCR meet spec (45RUx800x1000)		
3.2	Racks in BCR meet spec (45RUx800x800)		
3.3	Racks are an all metal construction with a welded frame		
3.4	Racks are installed properly (i.e. bolted to the floor)		
3.5	Each racks has 2 x vertical cable managers that can cater for a minimum of 150 CAT6A 28AWG cables per manager		
3.6	Racks have adequate horizontal cable managers that can cater for up to 50 CAT6A 28AWG cables		
3.7	Each rack has 2 x dedicated 15Amp captive pendants above		
3.8	10 way vertical PDU installed in each MCR rack		
3.9	Each rack contains a shelf		
3.10	Racks are bonded to protective earth		
3.11	Cabinet locks keyed with the standard DoE type 180 key lock		
3.12	Rack doors are meshed		
3.13	All racks have RU markings front and back		
3.14	All racks are labelled as per the SCSS		
3.15	Cabinets, with side panels intact, are located centrally in the room.		
3.16	Front and rear rails are 'L shaped profile and are adjustable		
3.17	Racks in MCR have a raceway installed between them		
3.18	Cable pathways into cabinets are cabinet top entry points via ceiling mounted cable trays from side walls or ceiling to provide full access to all sides of the cabinet row.		
3.19	No cabling or services connect to the cabinets below the 2200mm level so as to allow 360-degree access to the cabinet installation row.		
4	**Pathways**		
4.1	Different pathways are used for structured cabling and electrical wiring		
4.2	Pathway is accessible throughout its length		
4.3	Cable trays are used where there is 10 or more cables		
4.4	Cable trays are adequately suspended		
4.5	Cable trays have no sharp edges		
4.6	Cable trays have adequate waterfall and bend components		
4.7	All cable trays have a minimum 50% spare capacity at the time of installation		
4.8	Cables are adequately secured onto cable trays		
4.9	Velcro is used and not plastic tie cables		
4.10	Catenary wire has less than 10 cables		
4.11	Catenary wire is adequately secured		
4.12	Pit(s) installed are of adequate size as per SCSS		
4.13	Lids are of appropriate load rating		
4.14	All pits and cables are labelled as per the SCS		

4.15	Inter-cabinet pathways are to be through cabinet top entry points.		
5	**Fibre**		
5.1	Minimum of 12 core single-mode fibre is installed per BCR		
5.2	All fibres are terminated		
5.3	FOBOT is placed at the top of the cabinet		
5.4	Unused ports on FOBOT have cap covers		
5.5	Ports on FOBOT are labelled accordingly		
5.6	Fibre cable and components all belong to the same mode		
5.7	No visible kinks, crushed and tight bends in the cable		
5.8	The fibre cable leading into the FOBOT is labelled as per the SCSS		
5.9	The FOBOT is labelled as per the SCSS		
5.10	Fibre patch leads are of adequate number and length		
5.11	Spare fibre patch leads are available		
6	**4-Pair Copper Cabling**		
6.1	Cable is Low Smoke Zero Halogen (LSZH)		
6.1	Patch panels, patch cords and jacks used all match the category and construction of the cable installed		
6.2	Patch panels, keystone jacks and telecommunication outlets used are all from the same manufacturer		
6.3	Cables are within the 90 meter permanent link requirements		
6.4	No visible kinks, crushed and tight bends in the cable		
6.5	Cables terminated into the rack are done in a neat fashion		
6.6	All cabling is more than 300mm away from power cabling		
6.7	All cabling enters through the roof space and into the designated roof corner of the cabinet		
6.8	24 port 1RU patch panels are used		
6.9	All cables are installed with unique outlet numbering sequence that is continuous across the entire installation		
6.10	No more than 24 cables in a bundle when in a cable tray or in the cabinet		
6.11	If shielded cable is used, then all components (cable, patch panel, rack etc) are earthed as per the manufacturers recommendation		
6.12	Labelling of the patch panel is done as per the SCSS		
6.13	Telecommunications Outlets are installed in an appropriate location and at an acceptable height		
6.14	Telecommunication outlets have spring-loaded shutters		
6.15	Telecommunication outlets require a tool in order to get to the jack or labelling		
6.16	Telecommunication Outlet has adequate slack		
6.17	All ports in the patch panel are patched in a neat manner and are using the supplied cable managers		
6.18	Patch cables used are of adequate gauge size and match the colour patch guide		
6.19	External copper runs use external rated cables		
6.20	Surge protection installed at the distributor end for each external rated copper cable		

7	Documentation		
7.1	Fibre Optic Test results provided to DoE as per SCSS		
7.2	4-Pair UTP Test results provided to DoE as per SCSS		
7.3	Cable pathway diagrams provided by the contractor to DoE showing pits, risers, cable trays etc		
7.4	Floor plans showing outlet locations and their associated identifier provided to DoE by the cabling contractor		
7.5	Patch records for each comms rack is provided		
7.6	Manufacturer's warranty certificate provided to DoE by the cabling contractor		