NSW GOVERNMENT | Education

Structured Cabling System Specification

February 2019

Version 1.1

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Introduction

The Structured Cabling System (SCS) 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 Australian standards, these include (but are not limited to) the following:

Standard	For
AS/NZS 3080: Current Edition	Telecommunications installations - Generic cabling for commercial premises
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)

The current edition shall be the last edition published, including any amendments, up to one month prior to the closing date of the Tender or Request for Quotation (RFQ). Such installations shall also meet any additional requirements as stipulated by DoE. It is expected that any entity supplying and/or installing cabling infrastructure is expected to have access to and abide by the abovementioned 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 the cabling must be reported to the Network Design team for approval.

All inquiries can be made via:
Network Design Team, Infrastructure Services, ITD
Email: ITInfraServNetworksArchitecture@det.nsw.edu.au

1 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 authorized 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 minimize noise impact during school hours
- Working with Asbestos – perform the actions required when working with asbestos.

It is necessary for all suppliers that are engaged by DoE to carry out work in schools to obtain clearance for entering premises where children are located. All non-DoE staff is 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 Premiers Department 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 will ensure that during the period of works at least one cabler will be onsite and hold an ACMA Open registration with competencies for the cable plant being worked.

The contractor will 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 services and performing traces of cables and conduits.

Should the contractor disrupt service during the course of works they will 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).

The contractor will ensure that their Public Liability insurance (or other) will cover the costs of reinstatement associated with any disruption of services.

2 Horizontal Cabling Specifications

The horizontal data cabling system shall consist of:

- Only Category 6A F/UTP horizontal cabling only (from here on referred to as Cat6A)
- Cable tray and cable support systems
- Patch panels and cable management
- Testing and commissioning

- As built documentation
- Manufacturer certification
- Appropriate labelling

2.1 General

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

Outlet type	Number of 4 pair F/UTP to each RJ45 outlet
Single (STO)	1
Dual (DTO)	2
Triple (TTO)	3

- Cable installation shall be in accordance with the relevant standards and AS/NZS 3080 and AS/CA S0008.
- All internal grade cabling shall have a Low Smoke Zero Halogen sheath.
- All external grade cabling underground will require surge protection to be installed.
- All Wireless Access Points are to be allocated to dual outlets.
- All horizontal cabling shall be installed in dedicated communications cable trays 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 the Building distributor on the same floor, unless explicit permission has been given by the network design 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 DoE 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.**

2.2 Category 6A Channel Performance

The Category 6A F/UTP structured cabling solution will 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).

2.3 Cat6A Cabling Construction for Pathways

There are three (3) classifications of Cat6A cabling to be used, based on the cabling's installation pathways; Underground, Outdoor and Indoor.

Underground:

Optical Cat6A cables that are installed with any portion of its cable;

- in underground conduits and/or;

- are exposed to the elements and;
- **MUST** be classified as “external” and external grade Cat6A is to be installed. Also, surge protection may be required. See section on Surge Protection Device (SPD).

Outdoor:

Cat6A cables that are installed in protected above ground outdoor and adverse internal pathway such as;

- roof and external wall cavities;
- subfloor spaces;
- conduits in environmentally protected spaces and;
- **MUST** be classified as “Outdoor” and indoor graded Cat6A is to be installed. This must be low smoke zero halogens.

Indoor:

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

- Riser cupboards;
- Internal ceiling cavities;
- Internal wall cavities and;
- **MUST** be classified as “indoor” and indoor or plenum grade as required and to below smoke zero halogens.

2.4 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 where approved pathways exist, all horizontal cabling shall be installed in dedicated communications cable trays at all times.

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

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

2.5 Cabinet pathways

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

No cabling is to enter through the floor, front, rear or side panels. Variations will require approval from the DoE ITD Network Design Team.

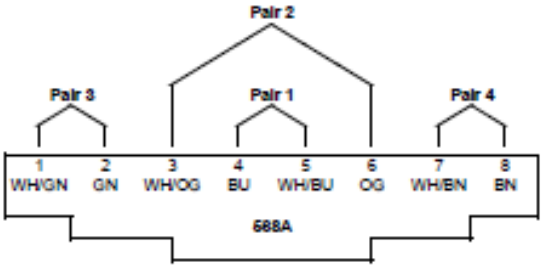
A service loop of minimum 3M is to be maintained for each cable installed. The service loop is to be stored in the cable tray or in the ceiling space in a neat manageable manner. The service loop or excess cabling is not be stored in the cabinet.

2.6 Terminations

The telecommunications outlet pin assignment shall be identical to the existing methodology utilized 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.

T568A Pin Assignment



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 V-panels, recessed panels or protruding panels are used then there must be enough clearance for the door to be closed when cables are installed. The patch panels shall have a provision for labelling. See section 8, Labelling.
- Installed and identified with a unique outlet numbering sequence that is continuous across the entire installation. See section 8, Labelling.
- Service loops or any excess cabling IS NOT to be stored in the cabinet.
- Terminations and termination procedure requirements shall comply with local and international standards plus the manufacturer recommendations in order for certification compliance. Only the length of the cable jacket required for termination shall be removed.
- The untwisted length in any cable element shall be as short as possible. Untwisting of cable pairs shall not exceed 10mm at termination.
- 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.

Telecommunications Outlets:

- Outlets may be installed in any quantity as required by the area being serviced. The outlets are to be installed in face plates and surface mounting to suit the number of required outlets.
- All telecommunication outlets shall have the following attributes;
    - Include shuttered jacks;
    - Have tamper proof faceplates or a protective cover, such that a tool is required for its removal;
    - Installed and identified with a unique outlet numbering sequence that is contiguous across the entire installation. See section 8, Labelling;
    - Are reticulated from the ceiling space, floor space or in internal wall conduits, whichever is applicable;
    - Provided with a minimum of three-meter slack cable to facilitate future relocation.

2.7 Wireless Access Point (WAP) Cabling

All Wireless Access Points (WAPs) are to be allocated to dual outlets.

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 is to be within 30cm for wall mounted outlets (which are visible to users) and within 1m of ceiling mounted outlets (which are hidden in the ceiling).

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 and gymnasiums). All requests for enclosures are to be discussed with the DoE ITD representative.

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 centre of the room with allowance given for a 1m clearance radius that is free from interference (from ceiling fans, lights, sensors, etc.).

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.

See the example shown in Appendix E – Appendix E: External WAP.

2.8 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.

2.9 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 on the patch panel end.

An additional lead will need to be supplied for each surge protection port installed (See section 2.11 Surge Protection Device (SPD)).

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

The length and colour of the patch cords/leads will need to be specified by the ITD representative, as well as the gauge of the patch leads supplied (i.e. 24AWG or 28AWG or a combination of both).

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: 28AWG Patch Cables.

If 28AWG cables are used, then there are to be no more than 12 cables in a bundle.

2.10 Copper cabling between distributors

Copper cabling between distributors is highly discouraged, all services that run over the DoE network are to utilize the fibre network. However, given there could be services that can only function over copper, a minimum of 12 Cat6A cables are to be installed between each building/floor distributor and the campus distributor where required (and surge protection is to be installed if required).

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 utilized.

Cat3 cabling is no longer permitted between distributors. All voice services are to run via the structured cabling system's 4 pair balanced cable.

Any requests for copper cabling between distributors are to be forwarded to DoE ITD Network Design Team.

2.11 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 SPD must protect all conductors in the twisted pair cable. The SDP must have an application performance not less than AS3080 Class EA cabling compliance and support 10000BaseTX (10 Gigabit Ethernet) and IEEE802.3at Power over Ethernet.

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.

2.12 Labelling

See section 8, Labelling.

2.13 Testing

See section 9, Testing.

3 Optical Fibre Cabling Specifications

3.1 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 feed throughs;
- 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 international, national and local 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;
- colour coded, with yellow to be used for OS2 single-mode fibre;
- shall be of a graded index type and;
- conform to the national manufacturing standard.

A minimum of 12 core OS2 fibre cables will be installed at each location with the provision of a minimum of 100% spare capacity. 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.

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

3.2 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 S008:2010 and AS/CA S009:2013.

Where minimum specifications differ between Australian Standards AS/NZS 3080:2003 and AS/NZS 3084:2003 then the greater requirements of Australian Standards shall apply. If a conflict of information arises consult the DoE ITD Network Design team for determination.

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

3.3 Optical 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.

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.

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 below smoke zero halogen.

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.

3.4 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.

3.5 Optical Fibre Cabinet Pathways

All optical fibre cabling installations will enter the cabinets via designated entry points on the cabinet roof corner from the suspended cable trays above. No cabling is to enter through the floor, front, rear or side panels. Variations will require approval from the DoE ITD Network Design 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 not be stored in the cabinet.

3.6 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 3084: 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 and Legacy fibre installations.

3.7 Optical Fibre Patch Panels (FOBOTS)

Optical fibre shall be terminated onto an approved fibre termination unit. 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 utilized before new enclosures are installed, if the enclosure meets current specifications and capacity requirements.
- The fibre entry to the patch panels shall be through a correctly sized 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 72 LC connectors per 1RU. (See sample in Appendix D)
    - Be installed such that the front doors of the equipment rack shall be fully closed and lockable without any interference of equipment or cabling within the enclosure whilst complying with specified bend radii.
    - Have either a slide or swing tray to improve access.
    - Grommets/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 utilize 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 not accessible by contaminates or vermin.

3.8 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 and legacy Fibre patch leads can be found in Appendix D. Fibre examples.

3.9 Optical Fibre Labelling

See section 8, Labelling.

3.10 Optical Fibre Testing

See section 9, Testing.

4 Distributor Design

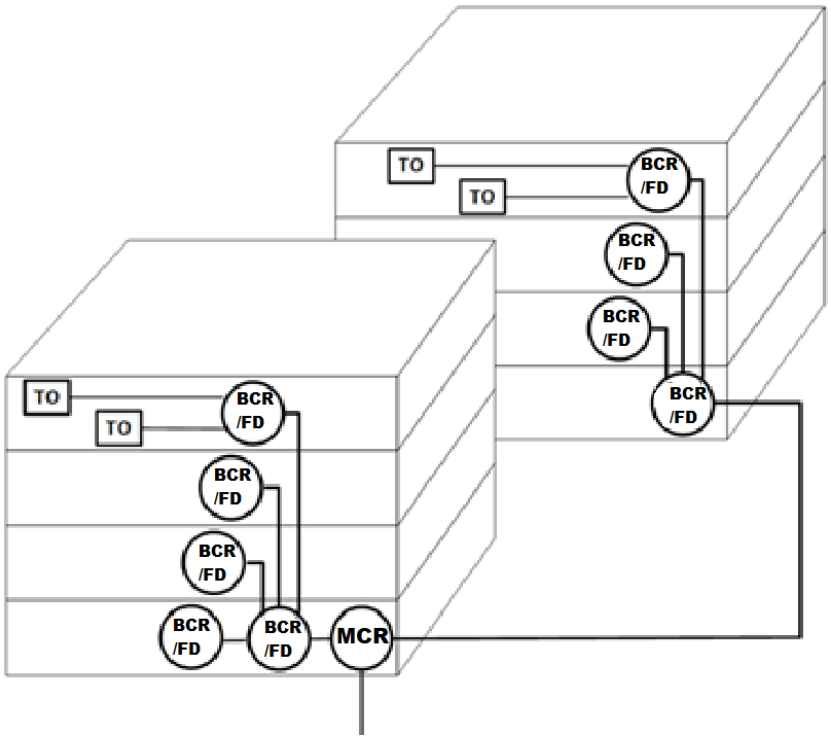
The size, location, and provisioning of services and facilities shall be in accordance with AS/NZS 3084 in conjunction with this document. Site distributor design includes three of the four tiers, these being:

- Campus Distributor (CD)
- Building Distributor (BD)
- Floor Distributor (FD)
- Consolidation Points (CD)

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 ITD Network Design 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 1 BD/FD per floor



4.1 Communication Rooms – Definitions

Main Communications Room (MCR contains CD and BD)
(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.

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.

4.2 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 2100mm, to provide full access to all sides of the cabinet row.
- No cabling or services will connect to the cabinets below the 2100mm 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.

4.3 Communication Rooms – Locations

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 ITD Network Design 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.

Building Communications Rooms (BCR contains BD/FD)
For a building that contains multiple BCR's, one will be defined by the ITD Design 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.

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.

Multi-level buildings:
Multi-level buildings will require, at minimum, 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 ITD Network Design 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 ITD Network Design Team's discretion.

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

4.4 Cabinet Specifications

The table below shows the required cabinet specifications:

Item	Specification		Additional Information
	Main Communications Room	Building Communications Room	
Height	42RU		
Depth	1000mm	900mm	
Width	800mm		
Maximum External Height	Less than 2100mm		
Construction Type	All Metal construction. Fully welded frame		
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
Mounting	Floor mounted with adjustable feet.	Floor mounts must be squarely located using adjustable feet to the floor. Castor wheels are **NOT** to be used.
Vertical cable management	2 per cabinet located outside of each front rail. Running full height of the cabinet. Slotted duct system with covers or doors. Capacity for minimum of 100 Cat6A Cables	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	Slotted duct system with covers or doors. Capacity for minimum of 100 Cat6 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	Slotted duct system with covers or doors Capacity for minimum 50 Cat6 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. Dual fans fitted internal to cabinet ceiling.	
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.

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

4.5 Cabinet Layouts

Cable pathways:

- Cable pathway to cabinets will be via suspended cable trays, to be installed at a minimum of 2100mm from the FFL, above the cabinet.
- Cabling of any type must not be run across floors or at a height less than 2100mm 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.

Cable trays:

- Are for data communications including fixed fibre and security cabling only, not for power installation.
- Security cabling shall be secured in cable trays separate to data communications cabling.
- 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 patch leads.
- Entry and exit points to have approved bend radius support for the installed cabling.

Optical Fibre Trunking (raceway):

- For optical fibre patch leads between cabinets, not fixed fibre.
- 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.

5 Pathways

5.1 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 provides the 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.

5.1.1 Campus Backbone Pathways

All campus backbone pathways and cabling are to be Optical Fibre cabling, as specified in the Optical Fibre cabling specifications section 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 ITD Design team and will then service other BCR's that may be located in the same building using building backbone cabling.

Due to the varying school designs and works at brownfield sites, the ITD Network Design Team 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 ITD Network Design Team's discretion and will be identified at the design stage.

5.1.1.1 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.

5.1.1.2 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.

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 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 installation, 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. Pit used in roadways and traffic areas must use the appropriate weight carrying capacity lid. Pit lids are to be labelled as "Communications" or "Comms".

The pit is 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 P3.

The use of existing carrier conduits 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 section 10 Documentation for detailed information)

5.1.2 Building backbone Pathways

If a building contains more than one BCR then a primary BCR (containing the building distributor) will be nominated by the ITD Design team to connect to the Campus Backbone cabling and this will then service other BCR's 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 the Optical Fibre cabling specifications section.

5.1.2.1 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.

5.1.2.2 Fibre capacity

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

5.1.3 Horizontal Cabling Pathways

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

All horizontal pathways and cabling are to be Category 6A F/UTP, as specified in the Horizontal cabling specifications section.

5.1.3.1 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. 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 building distribution 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 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.

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 3080. The area shall also be free from sharp edges, ensuring no strain is placed on the cable.

Appendix B – Pathways 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 are not to be used for DoE cabling.
Building Distribution Pathways	• Conduits are acceptable for installation in concealed spaces only. • Wall cavities may also be used. • 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. • All other Building Distribution pathways are to be a fully enclosed system consisting of metal trays or trunking with lids/covers or a combination of both.
Building Distribution within Ceiling Spaces	• 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	• 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.

6 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 is to be installed or upgraded a fibre backbone is to be installed to a strategically located distributor in or near one of the demountables. The other demountables in that cluster will 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 not permitted.

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

7 Capital works/refurbishment/expansions

For existing sites, where there is capital works, refurbishments and/or expansion taking place, these works are to meet 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 adhered to.

For existing sites, where minor cabling is required e.g. Installation of a DTO into the existing building) then the installation is to be consistent with the existing structured cabling on-site.

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.

8 Labelling

All components of the Cabling Subsystem will be labelled with machine printed labels. 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 are not acceptable.

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

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.

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.

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".

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.

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

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 FOBOT, the label will read – "10 pair UTP TO BR0015"
- On the Block B FOBOT, 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"

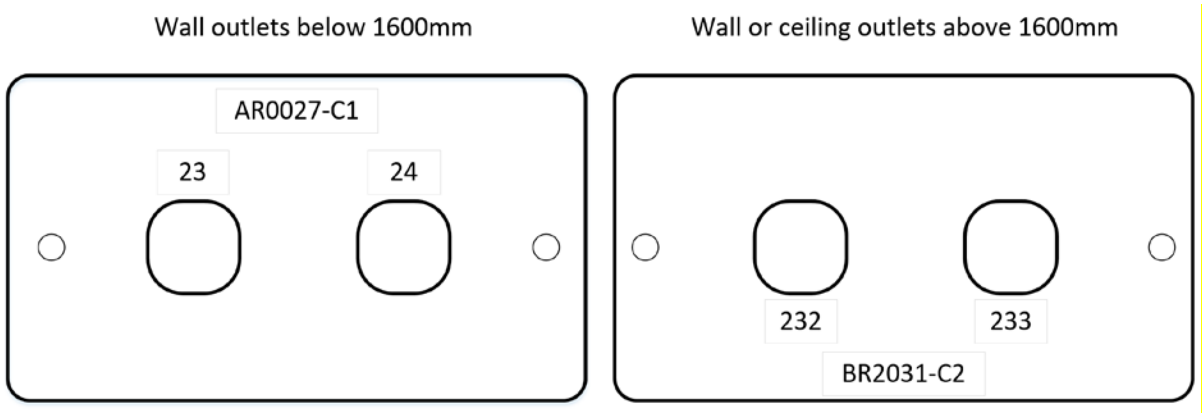
Telecommunications Outlet labelling:

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

Outlets are to show the Distributor cabinet that they are connected to and the outlet number either above or below the outlet.

Outlets installed below 1600mm FFL are to have the labels on the top of the front panel, and outlets installed above 1600mm FFL are to be labelled on the bottom of the front panel for easy identification.

See examples below:



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 faceplate label inside the box with a minimum text height of 10mm and legible from ground level.

9 Testing

9.1 General

Prior to testing taking place, all cables and outlets must be 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.

9.2 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 3080 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 10 Documentation).

9.3 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.

10 Documentation

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

10.1 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.

10.2 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.

10.3 Warranties & Certification

In the instances where the 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.

10.3.1 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.

10.3.2 Manufacturers Certification

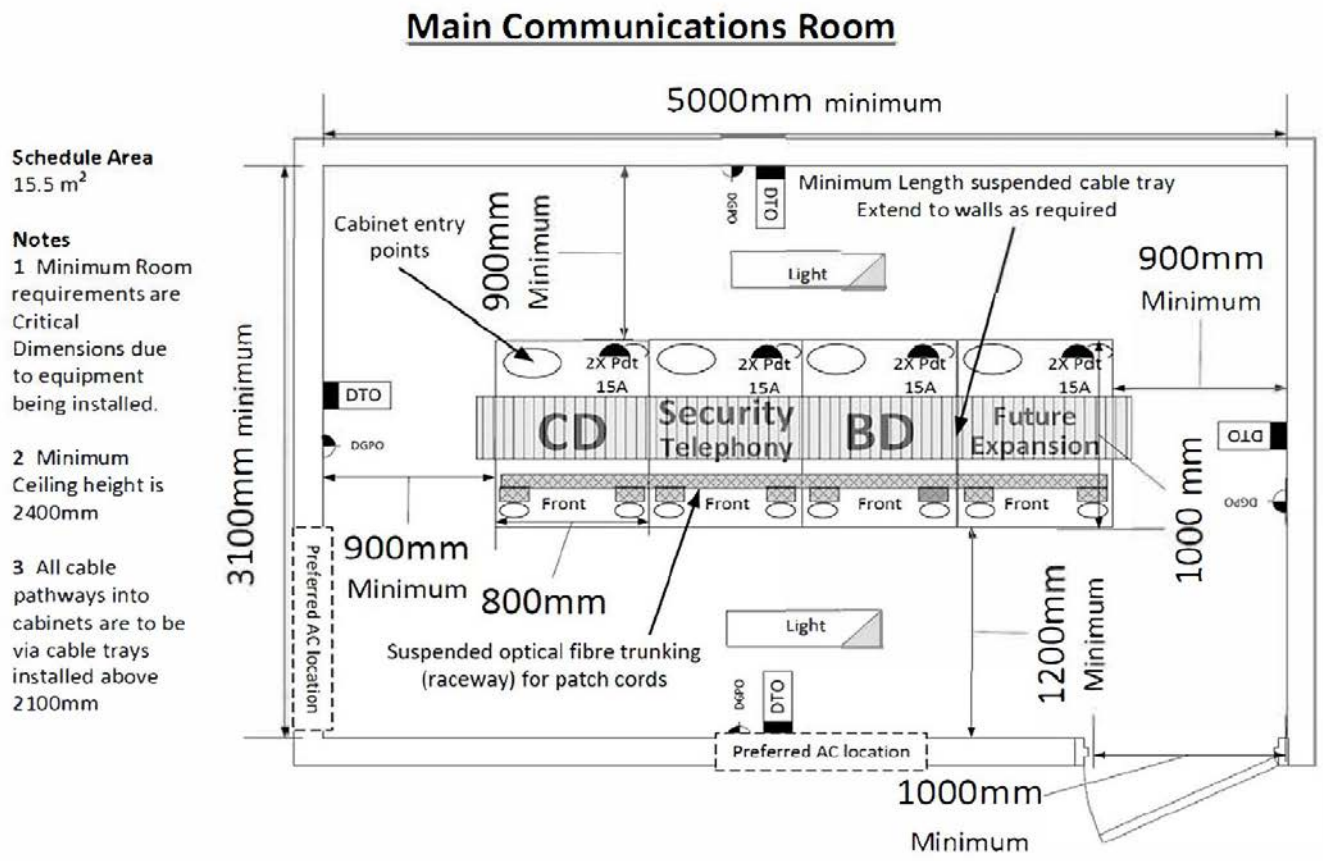
In addition to the above warranties, the contractor will provide a manufacturers application and product certification for the SCS that meets Annex F of AS/NZS 3080: 2003. The certification must include the supply of products and labour to rectify cabling found to be faulty. The minimum period of certification 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 design must include the normative components of the AS/NZS 3080:2003 standard. The installation training must include the testing of fibre and copper installations required to perform tests required of this specification.

10.3.3 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.

11 Appendix A. Room Distributors



Building Communications Room

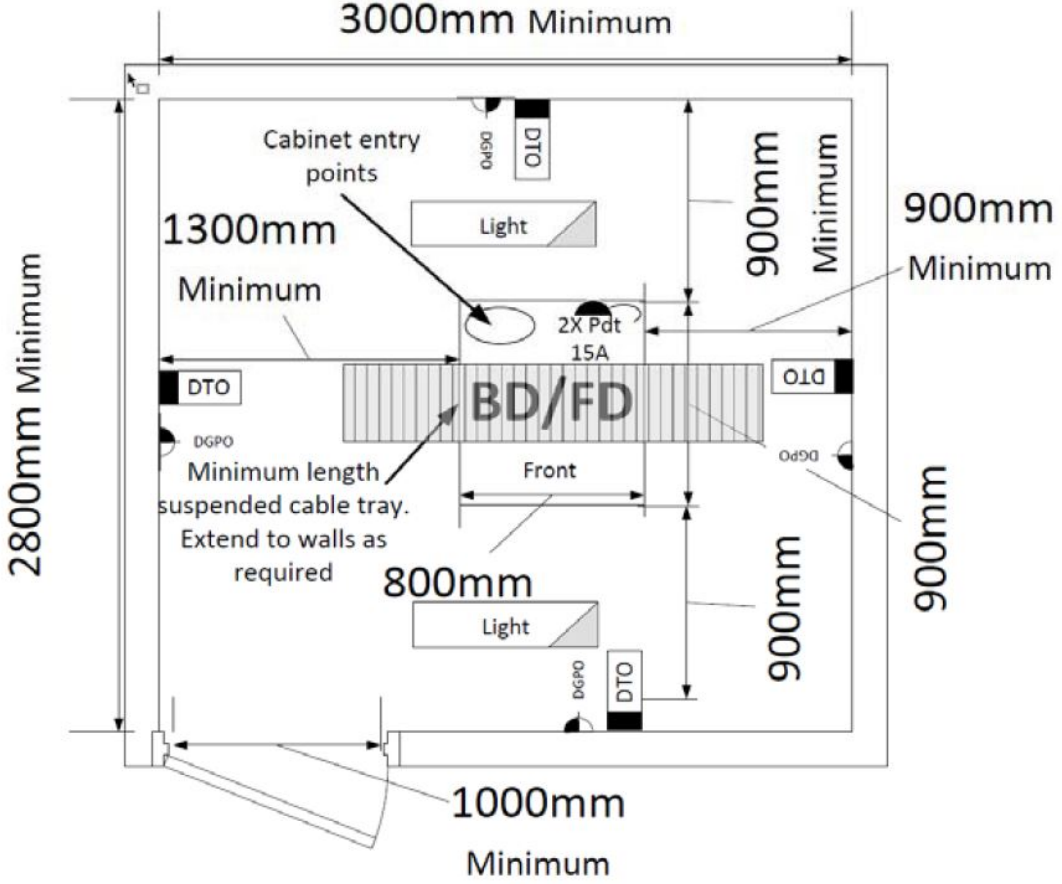
Schedule Area
8.4 m^2

Notes

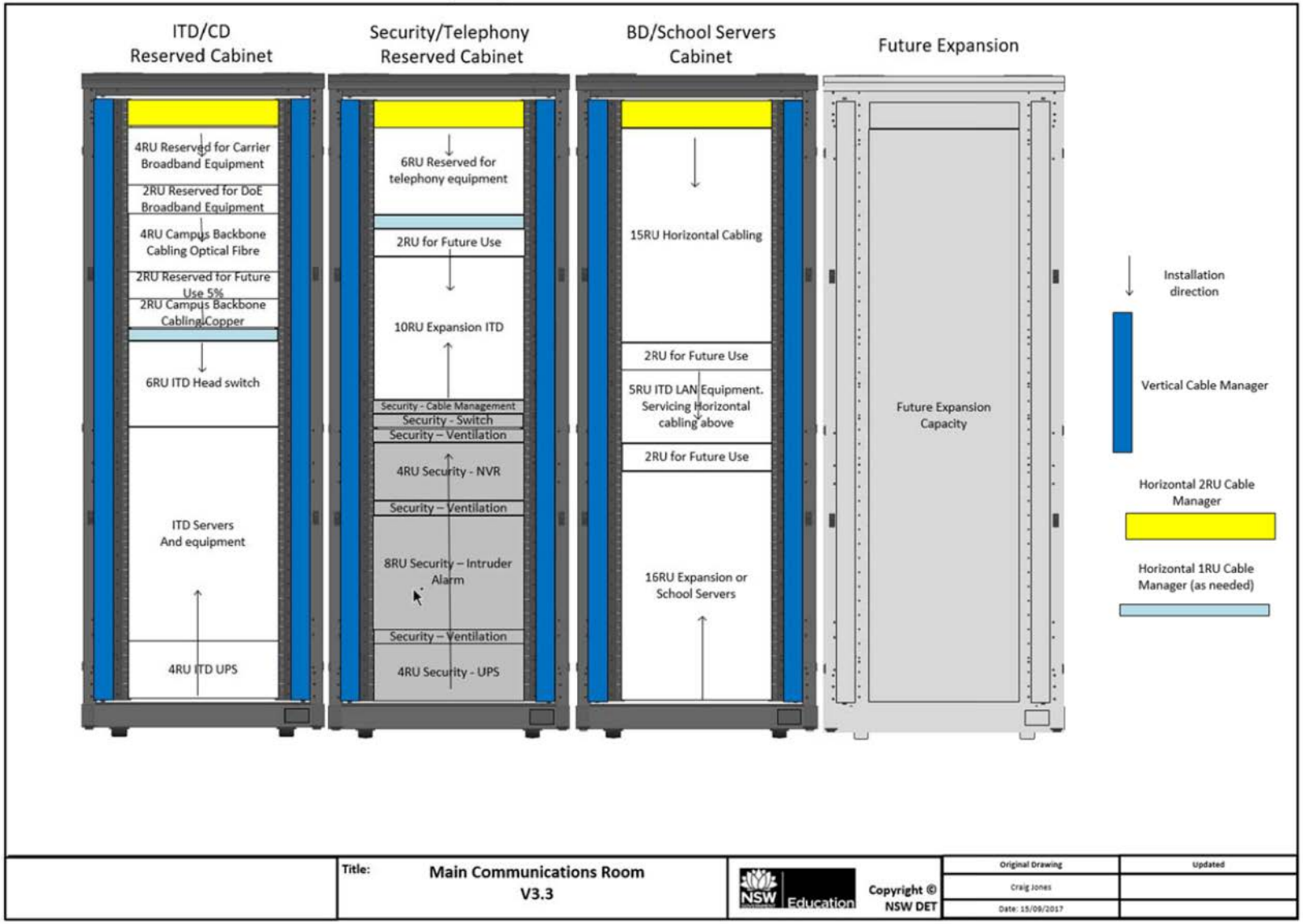
1 Minimum Room requirements are Critical Dimensions due to equipment being installed.

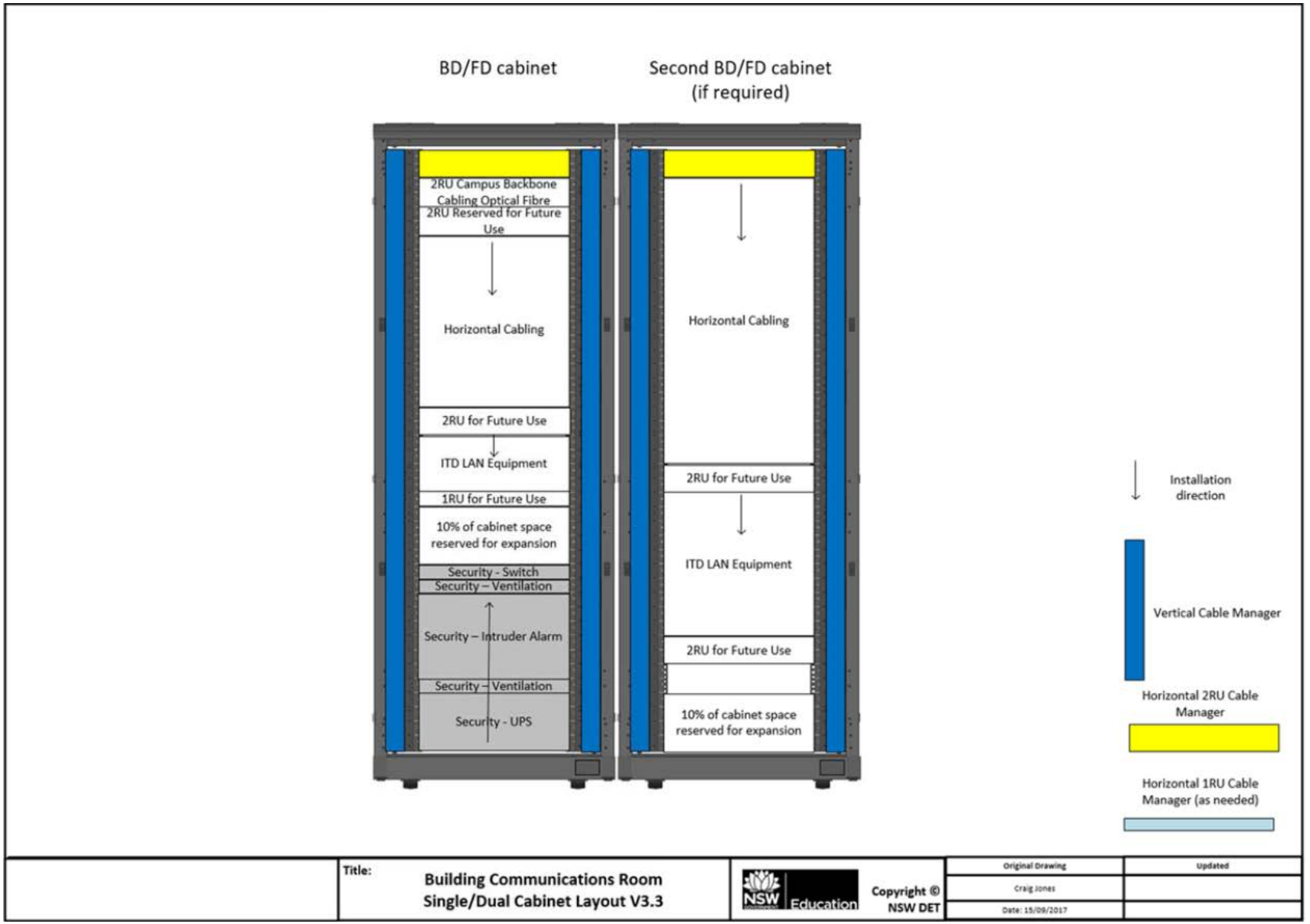
2 Minimum Ceiling height is 2400mm

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



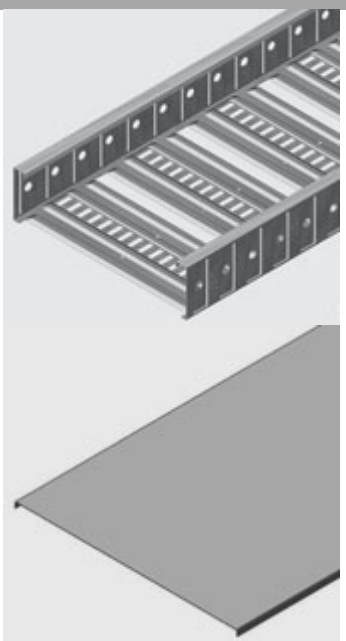
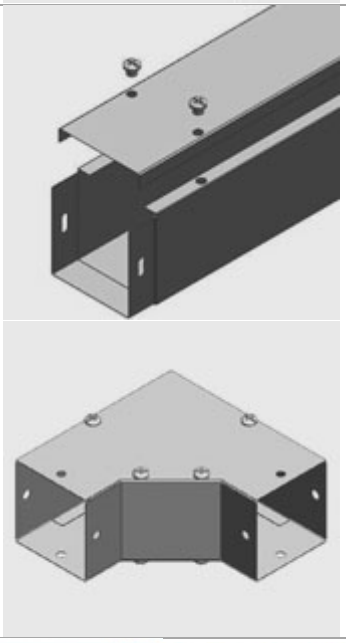
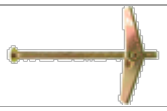
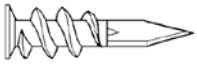
12 Appendix B. Rack Layout




BD/FD cabinet
Second BD/FD cabinet
(if required)
2RU Campus Backbone Cabling Optical Fibre
2RU Reserved for Future Use
Horizontal Cabling
2RU for Future Use
ITD LAN Equipment
1RU for Future Use
10% of cabinet space reserved for expansion
Security - Switch
Security – Ventilation
Security – Intruder Alarm
Security – Ventilation
Security - UPS
Horizontal Cabling
2RU for Future Use
ITD LAN Equipment
2RU for Future Use
10% of cabinet space reserved for expansion
Installation direction
Vertical Cable Manager
Horizontal 2RU Cable Manager
Horizontal 1RU Cable Manager (as needed)
Title:
Building Communications Room
Single/Dual Cabinet Layout V3.3
NSW Education
Copyright © NSW DET
Original Drawing
Craig Jones
Date: 15/09/2017
Updated

13 Appendix C. Pathway Materials and Fixings

ITEM	DESCRIPTION OF USE	PICTURE
Trunking PVC 25 X 25mm 4mtr WHITE	Permanent Outlet Pathway	
Trunking PVC 100 x 50mm	Local Distribution Pathway	 
Mesh Cable tray and enclosed trunking	Building Distribution Pathway	 
Cable bend radius compliant waterfall	Building Distribution Pathway	

ITEM	DESCRIPTION OF USE	PICTURE
Metal Cable Tray + Lid	Campus & Building Pathways	
Metal Duct	Campus & Building Pathways	
Hook & Loop Straps	Reusable Cable support	
M8 X10mm x 60mm Dynabolts	Masonry fixing	
50 mm toggles	Hollow wall fixing	
Zip its / Wall mates metal	Plaster wall fixing	
8g x 32mm button head screws	Timber fixing	

ITEM	DESCRIPTION OF USE	PICTURE
7g x 50mm bugle head screws	Timber fixing	
8g x 16mm SD Large wafer screws	Metal fixing	
3/16" x 10 – 16mmHollow wall bankers	Hollow wall fixing	
M8 10mm x 60mm Closed Eye Dynabolts	Masonry fixing for use with catenary wires and other internal hung supports	
Catenary wire roll 180 meters	For use in enclosed spaces	

14 Appendix D. Fibre examples

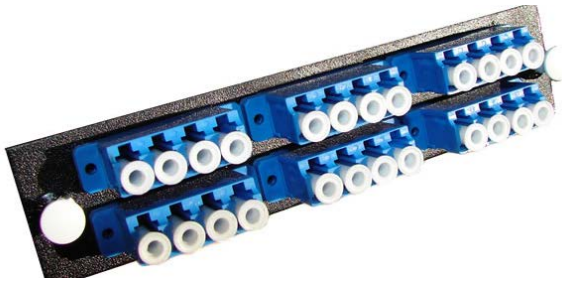
Fibre Enclosures:

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”



15 Appendix E: External WAP

External WAP installation ref 1

External WAP installation ref 2 (note use of BSP fitting for cable ingress to WAP)

16 Appendix F: 28AWG Patch Cables

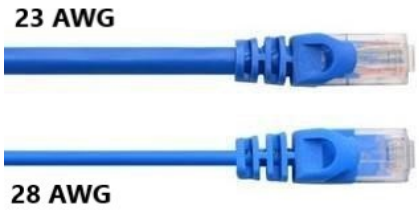


Table 2 - Summary of total 28 AWG patch cord length vs. maximum channel length.

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