

**University of Warwick – Enterprise IT Infrastructure - Data Centre's
& Data Cabling Information and Digital Group**

**Voice & Data Systems Specification
Version 7.8**

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1-1 GENERAL REQUIREMENTS

This specification details the requirements for the design, installation, testing and commissioning of telecommunications systems at the University of Warwick.

Throughout this section, references are made to requirements and recommendations detailed within several standards, guidance and statutory regulations. It shall be noted that the information presented herein is in no way intended to replace the detailed information provided within these documents, which must be fully adhered to where applicable.

1-2 DEFINITIONS

Contractor – Where this term is used within this specification, it refers to the contractor undertaking any electrical installation works associated with voice and data systems at the university.

Engineer – Where this term is used within this specification, it refers to the mechanical and electrical services consultant when employed by the university.

UoW – Where this term is used within this specification, it refers to the IDG IT Services department at the University of Warwick who are responsible for the voice and data systems at the university.

Voice / Data Specialist – Where this term is used within this specification, it refers to the Installer of voice and data systems, as detailed in this document, this specialist must be an accredited installer and able to provide the product 25-year warranty

Also refer to Section 3 of BS EN 50174, Section 3 of BS EN 50173 and Part 2 of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations for further details regarding definitions, symbols and abbreviations.

1-3 ENGINEER'S DOCUMENTATION AND SPECIFICATIONS (WHERE PROVIDED)

Where for tender purposes this specification is included as part of an Engineer's documentation it shall not be read in isolation and must be read in conjunction with all other sections of the Engineer's specification and drawings which may define further requirements for the electrical installation associated with the voice and data systems.

1-4 STANDARDS, GUIDANCE AND STATUTORY REGULATIONS

The voice and data systems shall be designed, selected, installed, tested and commissioned in accordance with the latest version of all applicable standards, guidance and statutory regulations (some of the key standards are scheduled below):

STANDARDS AND DOCUMENTS	
BS 7671	IET Wiring Regulations – Requirements for Electrical Installations
IET On-Site Guide – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations	
All IET Guidance Notes – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations	
All IET Standards, Codes of Practice & Guidance	
ANSI/TIA/EIA-568-B	Commercial building telecommunications cabling standard
BS 6701	Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance
BS 7430	Code of practice for protective earthing of electrical installations
BS EN 50173	Information technology – Generic cabling systems
BS EN 50174	Information technology – Cabling installation
BS EN 50310	Telecommunications bonding networks for buildings and other structures
BS EN 50346	Information technology – Cabling installation – Testing of installed cabling
BS EN 60874-1	Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables
BS EN 61935	Specification for the testing of balanced and coaxial information technology cabling
BS IEC 61000-5-2	Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling
BS ISO/IEC 11801	Information technology – Generic cabling for customer premises
BS ISO/IEC 14763	Information technology – Implementation and operation of customer premises cabling – Testing of fibre optic cabling
DIN 41494	Equipment practices for electronic equipment; mechanical structures of the 482.6mm (19 inch) series
IEC 60297	Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482.6mm (19 inch) series
IEC 60603-7	Connectors for electronic equipment
IEC 61156	Multicore and symmetrical pair/quad cables for digital communications

STANDARDS AND DOCUMENTS	
IEC 61280	Fibre optic communication subsystem test procedures
ISO/IEC 11801	Information technology – Generic cabling for customer premises
All current and relevant ISO/IEC, CENELEC and ANSI/TIA/EIA standards	
BICSI – Telecommunications Distribution Methods Manual	
All Statutory Regulations (and Associated Memorandum) detailed within Appendix 2 (Informative) 'Statutory Regulations and Associated Memoranda' of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations. Reference shall be made to all official supporting guidance documents	
All British Standards detailed within Appendix 1 'British Standards to Which Reference Is Made in This Standard' of BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations	
All current and relevant British Standards not detailed within BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations, as referenced throughout this specification	
The Construction Products Regulations	
NJUG National Joint Utilities Group – NJUG Guidelines – Volumes 1 to 6	
University of Warwick Infrastructure Specification / University of Warwick Design Standards	

Where the above standards and documents refer to supporting standards and documents these shall be fully complied with in all respects.

The above standards and documents are continually being updated, with new standards also becoming applicable. All personnel completing the voice / data system and electrical installation works shall be familiar with the latest standards applicable at contract award / receipt of an order and complete all works in accordance with these standards.

Where discrepancy is found between this specification, Engineer's documentation (specification and drawings), specialist quotations and the relevant standards, written clarification shall be obtained from UoW (and where applicable the Engineer) prior to submission of tender / quotation. Where a discrepancy has not been clarified prior to tender submission / submission of a quotation the most onerous requirements shall be included within the tender / quotation price.

1-5 DESIGN REQUIREMENTS

The Contractor shall employ the named Voice / Data Specialist (see Appendix I – Voice / Data Systems – Electrical Equipment and Specialists Schedule) to supply, install, test and commission the systems. The named Voice / Data Specialist have a framework agreement with the University of Warwick. The named voice/data specialist may be consulted with regard to system design where manufacturers requirements call for specific standards, however they shall not be exclusively responsible for the system design unless otherwise stated/requested by the University's IDG team.

1-6 WARRANTY

The telecommunications systems shall be designed, supplied, installed, tested and commissioned in strict accordance with manufacturers' recommendations to achieve a 25-year performance warranty.

A complete solution inclusive of all voice / data systems equipment and cabling shall be provided using a single manufacturer and covered by the manufacturer's 25-year warranty.

1-7 THE CONSTRUCTION PRODUCTS REGULATIONS

The Contractor and Voice / Data Specialist shall ensure all equipment and cabling is suitably certified, tested and CE marked in strict accordance with the latest requirements of The Construction Products Regulations, which came into effect on the 1st of July 2017.

To confirm compliance with the latest requirements of The Construction Products Regulations, the Contractor and Voice / Data Specialist(s) shall provide technical submission for all equipment and cabling (refer to the Technical Submissions section within this specification).

1-8 VOICE AND DATA SYSTEMS – ELECTRICAL EQUIPMENT AND SPECIALISTS SCHEDULE

Appendix I of this section provides a telecommunications system – Electrical Equipment & Specialists Schedule which details specialists, manufacturers, product ranges and materials (where applicable) that shall be included in the tender submission.

Where possible several suppliers have been provided for items of equipment to give a reasonable choice to the Contractor and the telecommunications specialist.

However, where one specialist, manufacturer, product range or material is specified, this may be due to: -

- 1) Alternatives not being available which are equivalent.
- 2) To match existing site installations or site standards.
- 3) Specification by UOW.

Where specialists, manufacturers, product ranges or materials are specified in this document they shall be included in the tender without adjustment or alteration.

1-9 TELECOMMUNICATIONS SYSTEMS – RESPONSIBILITY MATRIX

The design, supply and installation responsibilities for the telecommunications systems are detailed within Appendix II – Voice and Data Systems – Responsibility Matrix. The responsibility matrix outlines the obligations of all parties engaged in the voice and data systems installation.

All due allowances shall be made within the tender submission / quotation for all necessary liaison between the Contractor, Voice / Data Specialist and the UOW, to ensure the telecommunications systems are fully functional on completion of the works.

1-10 ENGINEERS AND ARCHITECTS DRAWINGS (WHERE PROVIDED)

All voice / data equipment, power supplies, electrical equipment and wiring accessories (including data outlets) shall be set out as detailed on the agreed Architects / Specialists elevation drawings. Where these are not available from the Architect or Specialists, the Contractor shall produce elevation drawings for approval by the Engineer in a timely manner to suit the construction program.

However, where there is a discrepancy between the Architects / Specialist elevation drawings and the information provided within this specification (e.g. mounting heights) this shall be brought to the attention of the Architect / Specialist in a timely manner.

The drawing symbols used on the Engineer's drawings are not scaled and therefore an allowance shall be made for any of the installed equipment to be relocated within a 1000mm radius of the indicated position at no further cost. These positions shall then be agreed with the Architect / Specialist in a timely manner during the contract period.

1-11 ROOM DATA SHEETS & DRAWINGS (WHERE PROVIDED)

All voice / data equipment, power supplies, electrical equipment and wiring accessories (including data outlets) shall be provided as detailed on the room data sheets and drawings (where provided).

However, where there is a discrepancy between the rooms data sheets, the Architects / Specialists drawings and the Engineer's drawings written confirmation from UoW and the Engineer shall be obtained prior to submission of tender costs to clarify the requirements, and in the absence of such the more onerous requirements shall be included.

In the absence of room data sheets or drawings an allowance shall be made of 1No. data outlets per workstation as an assumed minimum required.

1-12 SCOPE OF WORKS

The voice / data systems installation shall include the provision of the following (where required): -

- 1) Incoming telecommunications services.
- 2) Internal backbone fibre optic cabling between server, equipment and communications racks, within the main equipment rooms (MER's) and secondary equipment rooms (SER's).
- 3) External backbone fibre optic cabling to the site wide network.
- 4) Internal backbone fibre optic cabling to the site wide network.
- 5) Intelligent Power Distribution Units (IPDU's)
- 6) Server rack(s).
- 7) Equipment rack(s).
- 8) Communications (Comms) rack(s).
- 9) Backbone fibre optic patch panels.
- 10) Backbone fibre optic cabling, including: -
 - a. Fibre transition enclosures.
 - b. Patch leads.
 - c. Pigtails.
- 11) Horizontal structured data cabling patch panels.
- 12) Horizontal structured data cabling, including: -
 - a. Patch leads.
 - b. Data outlets.
- 13) EMC equipotential bonding networks.
- 14) All necessary connectors, pigtails and patch leads.
- 15) All necessary voice frames, patch panels, box connections and connectors.
- 16) All necessary terminations.
- 17) All necessary earthing and bonding.
- 18) All necessary cable support and containment systems (where applicable)
- 19) Inspection, testing and commissioning.
- 20) All necessary identification, notices and labelling.
- 21) All necessary O&M information.

It shall be noted that the above lists are not exhaustive, and reference must be made to all sections of this specification and Engineer's documentation (specification and drawings) where provided.

All due allowances shall be made within the tender submission / quotation to ensure all necessary voice / data equipment and cabling, cable support and containment systems, power supplies, wiring accessories and associated equipment is provided for the voice and data systems

1-13 TECHNICAL REQUIREMENTS

The voice and data systems shall be designed, selected, installed, tested and commissioned in strict accordance with manufacturer's recommendations and the standards detailed earlier within this specification.

The technical requirements for the voice and data systems shall be as follows: -

TECHNICAL REQUIREMENTS	
Incoming telecommunication services	Backbone fibre optic cabling to the site wide network – Dual diversely routed fibre optic cabling Voice Cabling
Campus backbone fibre optic cabling – Single mode: Backbone fibre optic cabling patch leads	Dual diversely routed fibre optic cabling OS2 single mode 9 / 125 µm Central loose tube OS2 fibre cabling, constructed around a silica gel filled tube containing up to 144 colour coded 9 / 125 µm single mode fibres. Tube covered with glass yarn and a flame retardant and low smoke zero halogen (LSZH), outer sheath. Transition point required 2 meters into the building if not of a CCA standard Generally, the required fibre count will be confirmed by UoW Single mode patch leads shall be colored yellow.
Building backbone fibre optic cabling – Single mode: Internal backbone fibre optic cabling between server, equipment and communications racks, within the main equipment rooms (MER's) and secondary equipment rooms (SER's) Backbone fibre optic cabling patch leads	Dual diversely routed fibre optic cabling OS2 single mode 9 / 125 µm Central loose tube OS2 fibre cabling, constructed around a silica gel filled tube containing up to 144 colour coded 9 / 125 µm single mode fibres. Tube covered with glass yarn and a flame retardant and low smoke zero halogen (LSZH), outer sheath. Transition point required 2 meters into the building if not of a CCA standard Generally, the required fibre count will be confirmed by UoW Single mode patch leads shall be colored yellow.
Campus backbone fibre optic cabling – Multimode: Internal and external backbone fibre optic cabling to the site wide network Backbone fibre optic cabling patch leads	Dual diversely routed fibre optic cabling OM4 multimode 50 / 125 µm Central loose tube OM4 fibre cabling, constructed around a silica gel filled tube containing up to 96 colour coded 50 / 125 µm multimode fibres. Tube covered with glass yarn and a flame retardant and low smoke zero halogen (LSZH), outer sheath. Transition point required 2 meters into the building if not of a CCA standard Generally, the required fibre count will be confirmed by UoW Multimode patch leads shall be colored turquoise.
Building backbone fibre optic cabling – Multimode: Internal backbone fibre optic cabling between server, equipment and communications racks, within the main equipment rooms (MER's) and secondary equipment rooms (SER's) Backbone fibre optic cabling patch leads	Dual diversely routed fibre optic cabling: OM4/5 multimode 50 / 125 µm tight buffered Central loose tube OM4 or OM5 fibre cabling, constructed around a silica gel filled tube containing between 4 and 144 colour coded 50 / 125 µm (OM4 / OM5) multimode fibres. Tube covered with glass yarn and a flame retardant and low smoke zero halogen (LSZH), outer sheath. Transition point required 2 meters into the building if not of a CCA standard Generally, the required fibre count will be confirmed by UoW Multimode patch leads shall be colored Purple (OM4) Green (OM5).
Incoming telecommunication services location(s)	As indicated on the layout and schematic drawings (where provided)
Main equipment rooms (MER's)	Server rack(s) / cabinet(s)/ CPI open frames Incoming telecommunication services

TECHNICAL REQUIREMENTS	
Main equipment rooms (MER's) location(s)	As indicated on the layout and schematic drawings (where provided)
Secondary equipment rooms (SER's)	CPI open frames
Secondary equipment rooms (SER's) location(s)	As indicated on the on the layout and schematic drawings (where provided)
Horizontal structured data cabling Horizontal structured data cabling patch leads	Category 6 / 6a U/FTP / Class Cca AS MINIMUM euro class(CPR regulations) All patch leads shall be grey
Data outlet provision – General use	As indicated on the drawings and room data sheets (where provided).
Voice / data systems equipment and cabling warranty	25 years
Important Note: The IDG team at the University of Warwick will specify the backbone fibre optic cabling and horizontal structured data cabling to be utilized prior to works going out to tender or for quotation.	

1-14 INCOMING TELECOMMUNICATION SERVICES

Where incoming telecommunication services are to be provided by utility service providers the Contractor shall supply and install all necessary containment, on-site trenching, ducting, backfilling and cable access chambers in strict accordance with the utility service provider's requirements and recommendations (e.g., for incoming telecommunications services UOW standard access chambers shall be used, please refer to UOW infrastructure standard).

The Contractor and telecommunications specialist shall: -

- 1) Liaise with UoW and / or utility service providers regarding programming of the works to suit the construction programme.
- 2) Oversee the coordination of their installations on site and provide technical and site assistance including attendances.
- 3) Liaise with UoW and / or utility service providers to ensure that neat and practical arrangements are achieved where the incoming telecommunications services are to be installed.
- 4) Confirm all builders work requirements with UoW and / or utility service providers and ensure that these are passed on to the grounds work contractor and correctly interpreted.
- 5) Review the proposed installation and incorporate any additional utility service provider's requirements.
- 6) Supply and install all cable support and containment systems and free issued apparatus supplied by UoW and / or utility service providers.
- 7) Liaise with UoW and / or utility service providers regarding any potential telephone cabling that is to be supplied and installed by the Contractor and / or Voice / Data Specialist to ensure all telephony systems are full functional upon completion of the works.

Cable support and containment systems (including cable ducting) shall be provided as detailed within the Cable Support and Containment Systems section of this specification.

1-15 CAMPUS BACKBONE FIBRE OPTIC CABLING

Where external backbone fibre optic or horizontal structured data cabling is required, the Contractor shall supply and install all necessary containment, on-site trenching, ducting, backfilling and cable access chambers in strict accordance with the cabling manufacturers requirements and recommendations for the installation of cabling by the Voice / Data Specialist.

Cable support and containment systems (including cable ducting) shall be provided as detailed within the Cable Support and Containment Systems section of this specification.

1-16 TELECOMMUNICATIONS & EQUIPMENT ROOMS

Telecommunications and equipment rooms that contain server, equipment and communications racks shall be provided in strict accordance with Section 8.3.8 Spaces of BS EN 50174-2 and all supporting standards / documentation. Server, equipment and communications racks shall be located as indicated on the drawings (where provided).

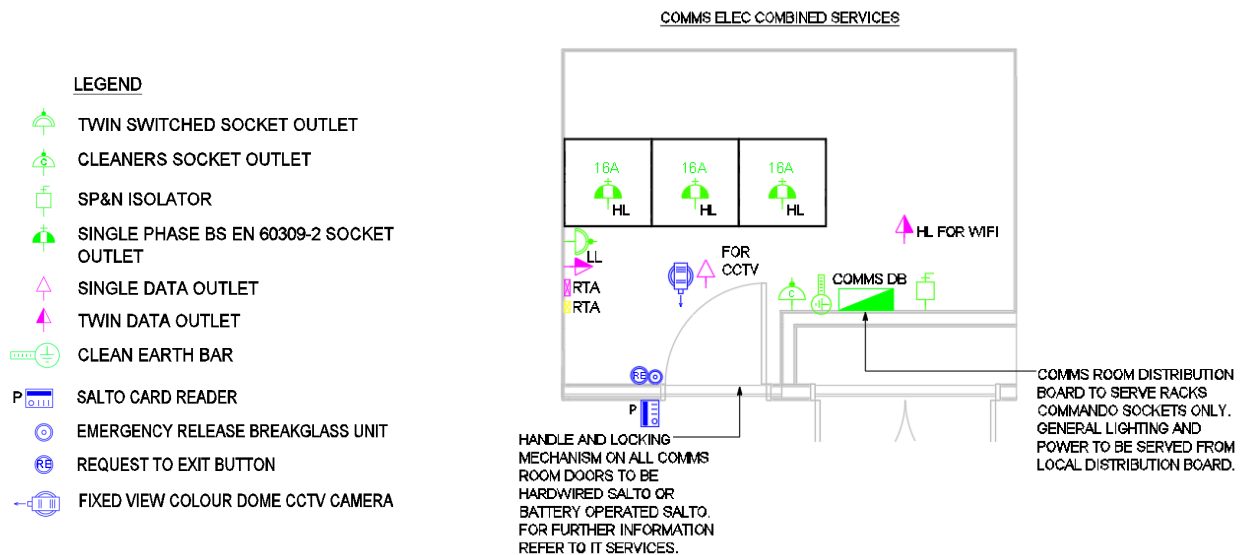
External Telecommunications and Equipment rooms deemed to be distribution locations by the UoW IDG IT department shall incorporate a security door with a minimum rating of no less than SR3 complete with wired access control and CCTV internal / external coverage

Where a project includes the construction or a new distribution or comms rooms, please note the basis criteria to allow acceptance of the space to enable the installation equipment by IDG:

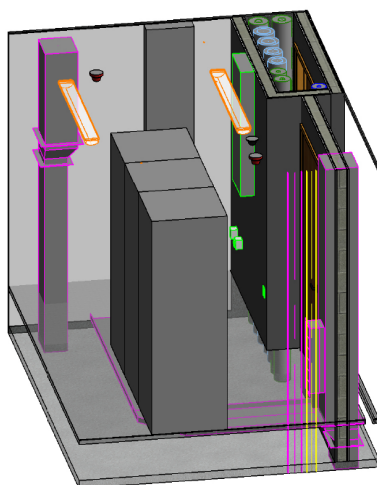
- Built in accordance with the standards set out in this document
- The room to have stable power and lighting
- The room to be classified as a separate fire compartment of a minimum of 60 minutes fire rating to all elements, all cable penetrations to be fire stopped utilizing the specified cable transitions detailed in appendix 1
- Cooling provision installed ready to be powered up on completion of active equipment
- The room to be clean and dust free
- The room to have the final door installed with an agreed level of security (by IDG)

- The room to be completed including all decorations, firestopping and flooring at least three weeks before either the building is due to be handed over or for larger more complicated schemes three weeks before the IT networks need to be in place to enable M&E system commissioning to be commenced.
- All M&E services to be complete, tested and commissioned, requiring no further access after the room has been handed over.

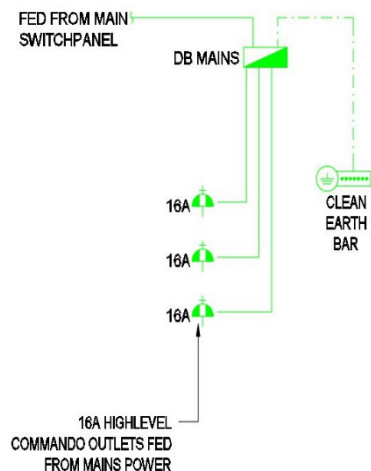
Typical Telecommunication / Equipment Room Layout SER



COMMS 3D VIEW



INDICATIVE I.T. SERVICES
COMMS ROOM SCHEMATIC



1-17 SERVER, EQUIPMENT AND COMMS RACKS

Server, equipment and communications racks shall comply with ANSI/EIA-310, IEC 60297 and DIN 41494. Server, equipment and communications racks shall be provided as indicated on the drawings (where provided).

The table below details the default server, equipment and communication rack requirements that shall be included at tender and used for installation (where applicable): -

FEATURES	SERVER RACKS	EQUIPMENT RACKS	COMMS RACKS
Capacity / height	29U to 47U		CPI Frames – 2163mm
Depth	1000 or 1200mm	800mm or 1000mm	700mm
Width	800 mm		700mm
Colour	RAL 7035		
Material	SPCC cold rolled steel		
Load capacity (static)	1300kg		600kg
High density vertical cable management	✓	✓	✓

FEATURES	SERVER RACKS	EQUIPMENT RACKS	COMMS RACKS
Full height front and rear galvanised steel 19" mounting profiles marked with U height	✓	✓	X
Sliding letterbox style cable entry in top	✓	X	X
Removable top panels for cable entry	✓	✓	X
Removable base panels for cable entry	✓	✓	X
Large cut in base for cable entry	X	X	✓
Multiple brush strip cable entry in top and base	X	✓	X
Removable side panels with barrel locks – Horizontally split on 42U and 47U	✓	✓	X
Mesh style front door and wardrobe style double mesh rear doors (with swing handle locks) – Providing a minimum of 70% free area for ventilation	✓	✓	X
Steel rear door with barrel lock	X	X	X
Suitable for baying with or without side panels – Baying kits to be included	✓	✓	✓
Heavy duty lockable castors and jacking feet – Suitable for simultaneous fitting	✓	✓	X
Spare capacity	20%		

✓	Default requirement shall be included at Tender and used for installation.
X	Shall not be used.

Racks used to distribute horizontal structured cabling shall be located so that the horizontal cabling runs do not exceed 90 meters. Where more than one rack is required within the same location it shall be possible to bay together adjacent cabinets using manufacturers proprietary baying kits.

Power supplies to server, equipment and communication racks shall be provided by dedicated low voltage final circuits and industrial / data rack plugs and socket outlets to BS EN 60309.

Each rack or cabinet shall have an integral proprietary rack bonding bus bar (RBB) (vertical and / or horizontal as required) and shall be equipotential bonded in strict accordance with BS EN 50310 and BS EN 50174.

Cabinet, frame or rack mounted equipment (passive or active) shall be equipotential bonded to the horizontal or vertical rack bonding bus bar (RBB) within in each rack using suitably sized unit bonding conductors (UBC). The unit bonding conductors (UBC) shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 16mm².

All parts of racks including doors, blank panels, gland plates, and any equipment that is provided with earth studs, shall be equipotential bonded individually to the RBB within each rack.

1-18 ACTIVE EQUIPMENT

Generally active equipment (e.g., servers, routers, switches, uninterruptible power supplies (UPS), computer equipment, interactive whiteboards / screens, displays / screens, audio systems, MDP's / DP's, telephones etc.) shall be supplied and installed by UoW.

Wireless access points will be supplied free issue by the UoW for the contractor's data specialist to install. These are generally ceiling mounted except within student residences accommodation where there will be a combination of ceiling mounted access points in common and kitchen spaces and wall mounted units within study bedrooms. In such cases where no suspended ceiling is to be installed, wireless access points are required to be installed in line with the lowest installed metallic fixtures and fittings in order to achieve UOW network WIFI design strategy requirements.

Reference shall be made to Appendix II – Voice and Data Systems – Responsibility Matrix which outlines the obligations of all parties engaged in the voice and data systems installation.

1-19 INTELLIGENT POWER DISTRIBUTION UNITS (IPDU'S)

Intelligent Power distribution units (IPDU's) (or Power distribution units (PDU's) when required, shall be provided within each main equipment / data rack and shall be suitably specified to suit the rack size, socket types, load and monitoring requirements. Please refer to appendix 1 for further details.

1-20 BACKBONE FIBRE OPTIC CABLING – PATCH PANELS

Backbone fibreoptic cabling shall be terminated into patch panels installed within server, equipment and communications racks.

Patch panels shall have the following minimum features: -

- 1) 19" rack mountable, 1U (44mm) in height.
- 2) 1U units shall be suitable for up to 144 fibre optics cables (cores).
- 3) Colour coded adaptors, beige for multimode and blue for single mode. (see manufactures specification).
- 4) Cable management pack that includes cable entry glands, cable ties and splice holders.
- 5) Minimum life of up to 500 insertions.
- 6) Integral labelling fields above each port.
- 7) Be from the same manufacturer as the structured cabling where possible.

A minimum of 1U of manufacturer's proprietary cable management shall be installed for every 2U of fibre patching

1-21 BACKBONE FIBRE OPTIC CABLING – CONNECTORS AND PATCH LEADS

Backbone fibre optic cabling shall be terminated using LC connectors as required, by means of fusion splicing factory terminated pigtails (of the same performance) to the backbone fibre optic cabling.

Patch leads shall be provided for each backbone fibre optic cable and shall have the same performance criteria as the backbone fibre optic cabling utilised. Each patch lead shall be provided with test certification and shall have connector / insertion losses < 0.3 dB (at 850 nm).

Backbone fibre optic cabling patch leads shall be detailed at tender stage including quantity / length

All patch leads shall be LSZH (LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%.

The patch leads must have current independent third-party approval status at component level and include specification references.

1-22 BACKBONE FIBRE OPTIC CABLING – SPLICES

Splices shall be retained within a protective sleeve by either friction or adhesive bonds to the optical fibre and additional strain relief for the completed joint shall be provided.

All splices, joints and their strain relief shall be fixed within the optical fibre management system of the enclosure. The insertion loss through any splice shall not be greater than 0.10dB.

1-23 BACKBONE FIBRE OPTIC CABLING – PIGTAILS

Backbone fibre optic pigtails shall have the same performance criteria as the backbone fibre optic cabling utilised.

1-24 BACKBONE FIBRE OPTIC CABLING

Internal dual diversely routed backbone fibre optic cabling shall be provided between all server, equipment and communications racks, located within the main equipment rooms (MER's) and secondary equipment rooms (SER's). External and internal dual diversely routed backbone fibre optic cabling shall also be provided for connection to the site wide network.

The fibre count of backbone fibre optic cabling shall reflect the overall design requirements, be compatible with any specified or existing mounting hardware and have the correct fibre count modularity to avoid wasting fibre cores due to connection / termination hardware issues.

The type of backbone fibre optic cabling to be installed shall be as detailed in the technical requirements section of this specification and shall comply with the following performance criteria as appropriate:

CLASS	TYPE OF OPTICAL FIBRES	MAXIMUM CHANNEL ATTENUATION dB			
		MULTIMODE		SINGLEMODE	
		850 nm	1300 NM	1310 nm	1550 nm
OF-300	, OM4, OM5, OS2	2.55	1.95	1.80	1.80
OF-500	, OM4, OM5, OS2	3.25	2.25	2.00	2.00
OF-2000	, OM4, OM5, OS2	8.5	4.5	3.50	3.50
OF-5000	OS2	X	X	4.00	4.00
OF-10000	OS2	X	X	6.00	6.00

Performance criteria for multimode (MM) backbone fibre optic cabling:

CATEGORY	SIZE	BANDWIDTH		
		OVERFILLED LAUNCH		EFFECTIVE LASER LAUNCH
		850 nm	1300 nm	850 nm
OM3	50 / 125 µm	1500 MHz.km	500 MHz.km	2000 MHz.km
OM4	50 / 125 µm	3500 MHz.km	500 MHz.km	4700 MHz.km
OM5	50 / 125 µm	3500 MHz.km	500 MHz.km	4700 MHz.km

Performance criteria for single mode (SM) backbone fibre optic cabling:

WAVELENGTH	MAXIMUM ATTENUATION	
	OS1	OS2
1310 nm	1.0 dB/km	0.4 dB/km
1383 nm	X	0.4 dB/km
1550 nm	1.0 dB/km	0.4 dB/km

The tables below detail the Ethernet applications supported by different classes of backbone fibre optic cabling and their maximum channel lengths:

MULTIMODE			
ETHERNET APPLICATION	OM3	OM4	OM5
1000BASE-SX (Gigabit)	550 m	550 m	550 m
10GBASE-SR/SW (10 Gigabit)	300 m	550 m	550 m
40GBASE-SR4 (40 Gigabit)	100M	150 m	150 m
100GBASE-SR10 (100 Gigabit)	100M	150 m	150 m
100GBASE-SR4 (100 Gigabit)	X	X	100 m

SINGLEMODE		
ETHERNET APPLICATION	OS1	OS2
1000BASE-LX (Gigabit)	2,000 m	5000 m
10GBASE-LX4 & LR/LW (10 Gigabit)	2,000 m	10,000 m
10GBASE-ER/EW (10 Gigabit)	2,000 m	22,250 m
100GBASE-LR4 (100 Gigabit)	10,000 m	10,000 m
100GBASE-ER4 (100 Gigabit)	40,000 m	40,000 m

All internal fibre optic backbone cabling shall comply with CPR

Where fibre optic backbone cabling is to be installed externally it shall be UV stable (commonly black in colour), moisture resistant (polyethylene outer sheath), rodent resistant and designated as external grade (PE).

The installation of backbone fibre optic cabling shall be undertaken with consideration of the minimum cable bending radii e.g. forming of cable basket, cable entries into conduit take-off plates / dado trunking, back box depths, conduit bends etc. Manufacturer's cable installation recommendations, cable pulling tensions and the standards detailed earlier within this specification shall be strictly adhered to. Wherever possible cabling shall be laid rather than pulled into containment systems. All externally installed Fibre Optic cable shall be labeled in each external pit/chamber identifying A & B end, cable type, 'F' reference number and core size.

Fibre optic backbone cabling shall be secured to cable basket or tray at 600mm intervals using Velcro ties / strapping. Care shall be taken to ensure that cables are not damaged due to over tightening.

Cable support and containment systems shall be provided as detailed within the Cable Support and Containment Systems section of this specification.

1-25 HORIZONTAL STRUCTURED DATA CABLING – PATCH PANELS

Horizontal structured data cabling shall be terminated into patch panels installed within server, equipment and communications racks.

Patch panels shall have the following minimum features: -

- 1) Screened 19" rack mountable, in multiples of 1U (44mm) in height.
- 2) 1U units shall provide 24 ports.
- 3) Front connections shall be made via RJ45 jacks with: -
 - a. 50 micro inch gold plated contact pins.
 - b. A minimum life expectancy of 700 insertions.
- 4) Rear connections shall be made by IDC or manufacturer approved connector with: -
 - a. A maximum of 100 re-terminations.
- 5) Cable tie bridges between the IDC blocks to relieve cable stress.
- 6) Integral labelling fields above each port.

A minimum of 1U of manufacturer's blanking panel shall be installed for every 48 ports of copper horizontal structured cable panels and 2U cable management for patch lead transit which shall reflect the Comms room frame layout schematics issued by UoW IDG IT Services.

1-26 HORIZONTAL STRUCTURED DATA CABLING – CONNECTORS, WIRING ACCESSORIES AND PATCH LEADS

Horizontal structured data cabling shall be terminated into data outlets using manufacturer approved connector. Data outlets shall be provided with angled shuttered RJ45 connectors, unless otherwise specified.

Where only a single data outlet is installed in a two-gang faceplate a manufacturer's proprietary blank insert of the same colour as the faceplate shall be provided. No modification shall be made to the wiring of the terminated RJ45 jack and any adaptor must be installed outside of the faceplate, plugged into the RJ45 jack.

Wiring accessories shall be provided as detailed within the Wiring Accessories section of this specification.

Patch leads shall be provided for each data outlet and shall have the same performance criteria as the horizontal structured data cabling utilized. Each patch lead shall be screened and provided with strain relief boots / RJ45 connectors.

Horizontal structured data cabling patch leads shall be specified at tender stage.

All patch leads shall be LSZH (LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%.

The connectors and patch leads must have current independent third-party approval status at component level and include specification references.

1-27 HORIZONTAL STRUCTURED DATA CABLING

Horizontal data cabling shall be provided from server, equipment and communications racks to new data outlets. Cable runs shall be continuous without joins or splices and shall not exceed 90 meters in length.

The type of horizontal data cabling to be installed shall be as detailed in the technical requirements section of this specification and shall comply with the following performance criteria as appropriate: -

HORIZONTAL DATA CABLING TYPE	CLASS	SUPPORTED FREQUENCY (MHz)	APPLICATION			
			10BASE-T	100BASE-TX	1000BASE-T	10GBASE-T
			ETHERNET	FAST ETHERNET	GIGABIT ETHERNET	10 GIGABIT ETHERNET
Category 6	Cca	250	✓	✓	✓	X
Category 6 _A	Cca	500	✓	✓	✓	✓

Notes:

- 1) Horizontal structured data cabling shall comply with the performance criteria detailed within BS EN 50173.
- 2) Generally, all new builds / major refurbishment shall utilize Cat 6A for all outlets, Cat 6 cables shall only be utilized at the direction of the University on minor refurbishment projects

The horizontal structured data cabling must have current independent third-party approval status at component level and include specification references.

All internal horizontal structured data cabling shall be compliant to BS 6701 and conform to the construction product regulations (CPR)

Where horizontal structured data cabling is to be installed externally it shall be UV stable (commonly black in colour), moisture resistant (polyethylene outer sheath), rodent resistant and designated as external grade (PE).

The table below details the minimum installed bending radii for cabling and the maximum number of cables to be installed in conduit: -

HORIZONTAL DATA CABLING TYPE	CABLE DIAMETER (MM)	MINIMUM INSTALLED BENDING RADIUS (MM)	MAXIMUM NO. OF CABLES TO BE INSTALLED (FROM BICSI TDMM)		
			CONDUIT DIAMETER (MM)		
			20	25	32
Category 6 (U/FTP) Class Cca	7.2	TBC	2	4	6
Category 6A (U/FTP) S-Foil Class Cca	6.7	27	2	4	6

Notes:

- 1) The above technical information has been obtained from horizontal structured data cabling manufacturers.
- 2) The Contractor and Voice / Data Specialist shall verify the above technical information with the cable manufacturer prior to installation.
- 3) TBC – To be confirmed with the horizontal structured data cabling manufacturer.
- 4) The installation of horizontal data cabling shall be undertaken with consideration of the minimum cable bending radii e.g. forming of cable basket, cable entries into conduit take-off plates / dado trunking, back box depths, conduit bends etc.
- 5) Cable basket and conduit shall be provided in strict accordance with this specification.

The installation of horizontal data cabling shall be undertaken with consideration of the minimum cable bending radii e.g. forming of cable basket, cable entries into conduit take-off plates / dado trunking, back box depths, conduit bends etc. Manufacturer's cable installation recommendations, cable pulling tensions and the standards detailed earlier within this specification shall be strictly adhered to. Wherever possible cabling shall be laid rather than pulled into containment systems.

Back box depths shall be selected in strict accordance with manufacturer's recommendations to accommodate the minimum installed bending radii of the cabling with consideration of the following: -

- 1) Data outlet type specified.
- 2) Shutter type specified (generally all data outlets shall be provided with angled shutters unless otherwise specified)

Back boxes shall have a minimum depth of 40mm.

Where horizontal structured data cabling is installed upon cable basket or tray, cables shall be loose laid as the manufacture's recommendation on straight runs, but Velcro tied at any change of direction and vertically cables shall be Velcro tied and secured to the cable basket at 300mm intervals.

Care shall be taken to ensure that cables are not damaged due to over tightening.

Cable support and containment systems shall be provided as detailed within the Cable Support and Containment Systems section of this specification.

1-28 TELEPHONE CABLING

The Contractor and Voice / Data Specialist(s) shall provide all necessary internal cabling as detailed in the tender documents

1-29 EARTHING AND BONDING

This section of the specification details the general requirements for earthing and bonding. Earthing and bonding shall be provided in strict accordance with BS EN 50310, BS EN 50174, BS 7430, BS 7671 and all supporting IET documentation.

Each building / installation shall be provided with a dedicated telecommunications bonding network in strict accordance with BS EN 50310. Protective earthing and equipotential bonding to the electrical installation associated with the voice / data systems shall be provided in strict accordance with the requirements for automatic disconnection of supply, as detailed within BS 7671.

The installation of earthing and bonding cabling shall be undertaken with consideration of the minimum cable bending radii in strict accordance with the IET On-Site Guide, IET Guidance Note 1 – Selection & Erection and the cabling manufacturer's recommendations.

1-29-1 PROTECTIVE CONDUCTORS

Where a protective conductor is a single core cable or the core of a cable it must be identified by the colors green-and-yellow and the colour combination of green-and-yellow shall not be less than 30% or more than 70% for each colour. However copper strip earthing tapes may be a different colour.

All protective conductor cabling shall be low smoke zero halogen (LSZH, LSOH, OHLS) with emissions of hydrogen chloride gas < 0.5%.

1-29-2 PROTECTIVE EQUIPOTENTIAL BONDING CONDUCTORS

Generally protective equipotential bonding conductors shall be installed on cable support and containment systems, however where they are fixed to the building structure / fabric they shall be supported at spacing's as detailed within IET Guidance Note 8 – Earthing and Bonding.

TELECOMMUNICATIONS PRIMARY BONDING BUSBARS (PBB)

Each building / installation shall be provided with a telecommunications primary bonding bus bar (PBB) which shall be connected to the electrical installation main earthing terminal (MET) as part of the dedicated telecommunications bonding network.

Telecommunications primary bonding bus bars (PBB) shall be connected to main earthing terminals (MET) using suitably sized telecommunications bonding conductors (TBC). The telecommunications bonding conductors (TBC) shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 16mm².

The telecommunications primary bonding bus bars (PBB) shall provide a central connection points for the building / installation telecommunications bonding backbone (TBB).

SECONDARY BONDING BUSBARS (SBB)

Each telecommunication, server, equipment, communications room (e.g. main equipment rooms (MER's) and secondary equipment rooms (SER's) shall be provided with a secondary bonding bus bar (SBB) as part of the dedicated telecommunications bonding network.

Each secondary bonding bus bar (SBB) shall be connected to the building / installation telecommunications primary bonding bus bar (PBB) using a suitably sized telecommunications bonding backbone / backbone bonding conductors (TBB / BBC). The telecommunications bonding backbone / backbone bonding conductors (TBB / BBC) shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 16mm².

Each server, equipment, communications rack or cabinet shall have an integral proprietary rack bonding busbar (RBB) (vertical and / or horizontal as required) and shall be equipotential bonded in strict accordance with BS EN 50310 and BS EN 50174.

Cabinet, frame or rack mounted equipment (passive or active) shall be equipotential bonded to the horizontal or vertical rack bonding bus bar (RBB) within in each rack using suitably sized unit bonding conductors (UBC). The unit bonding conductors (UBC) shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 4mm².

All parts of racks including doors, blank panels, gland plates, and any equipment that is provided with earth studs, shall be equipotential bonded individually to the RBB within each rack.

Each rack bonding bus bar (RBB) shall be connected to the secondary bonding bus bar (SBB) within the same room using suitably sized rack bonding conductors (RBC). The rack bonding conductors (RBB) shall be sized in strict accordance with BS EN 50310 and shall have a minimum cross-sectional area of 10mm² for a cabinet, frame or rack of ≤ 21U and 16mm² for a cabinet, frame of rack of > 21U, daisy chaining between cabinets shall not be carried out/

METALLIC CABLE BASKET

All cable basket / wire mesh systems shall be equipotential bonded using the manufacturer's proprietary copper earth conductor clamps in strict accordance with the manufacturer's recommendations and with due allowance made for thermal expansion / contraction.

The cable basket shall have adequate electrical continuity characteristics as defined in BS EN 61537. A suitably sized protective bonding conductor shall be run for the entire length of cable basket systems and shall be clamped at a minimum of 15m intervals before final connection to the main earth terminal (MET) or the equipotential bonding network. The cable basket shall also have copper earth continuity connectors / links at all joining locations.

The electrical continuity of the cable ladder rack, cable tray and/or basket shall be tested in accordance with BS EN 61537.

METALLIC CABLE TRUNKING

All cable trunking shall be equipotential bonded using the manufacturer's proprietary components and fixings in strict accordance with the manufacturer's recommendations and with due allowance made for thermal expansion / contraction.

The cable trunking shall have adequate electrical continuity characteristics as defined in BS EN 50085. A protective bonding conductor shall connect the cable trunking systems to the main earth terminal (MET) or the equipotential bonding network (for equipotential bonding networks).

The electrical continuity of the cable trunking shall be tested in accordance with BS EN 50085.

METALLIC CONDUIT AND FITTINGS

Metallic cable conduit and fittings shall be provided with adequate electrical continuity as defined in BS EN 61386 when connected to cable tray, cable basket and cable trunking. The metallic cable conduit shall be connected to the main earth terminal (MET) or the equipotential bonding network via the primary containment systems (e.g. cable trunking, tray or basket).

The electrical continuity of the cable conduit shall be tested in accordance with BS EN 61386.

EXTERNAL TELECOMMUNICATIONS CABLING

All underground telecommunication services (including incoming telecommunication services) shall be protected with suitable surge protection devices (SPD's) as required by BE EN 62305 and all supporting standards / documentation.

The surge protection system(s) shall be designed, selected, installed, tested and commissioned in strict accordance with BS EN 62305, BS EN 62561, BS EN 61643, BS EN 61663, BS 7430, BS 7671 and BIP 2118.

Where agreed with incoming telecommunication service providers, the metallic sheath of incoming telecommunications cables shall be equipotential bonded to the electrical installation main earth terminal (MET).

1-30 PROXIMITY OF WIRING SYSTEMS AND MEASURES AGAINST ELECTROMAGNETIC DISTURBANCES

This section of the specification details the general requirements for the proximity of wiring systems and measures against electromagnetic disturbances.

1-30-1 PROXIMITY AND SEGREGATION OF WIRING SYSTEMS

GENERAL

Electrical services cabling shall be segregated in strict accordance with BS 5266, BS 5839, BS 6701, BS EN 50174, BS EN 62305, NJUG Guidelines, BS 7671, UOW infrastructure specification and all supporting IET documentation.

Voltage Band I and Voltage Band II circuits must not be contained in the same wiring system as a circuit of nominal voltage exceeding that of low voltage.

INFORMATION TECHNOLOGY AND TELECOMMUNICATIONS WIRING

Information technology (e.g. data cabling) and telecommunications wiring systems shall be segregated from all other electrical circuits and wiring systems. This shall include any building services systems that may utilize the information technology / telecommunications wiring e.g. access control, CCTV, BMS etc., if non-structured cabling specification.

Where underground telecommunications cables and underground power cables cross or are in proximity a minimum clearance of 100mm shall be maintained unless one of the methods is adopted from BS 7671.

These methods are as follows: -

- 1) The provision of a fire retardant partition shall be provided between the underground telecommunication and power cables. e.g. bricks, clay / concrete cable protection caps, concrete shaped blocks, protective cable conduit or troughs made of fire retardant materials.

Or,

- 2) Where underground telecommunication cables and power cables cross, mechanical protection between the cables shall be provided.
e.g. cable conduit, concrete cable protection caps or concrete shaped blocks.

GENERAL INSTALLATION REQUIREMENTS

The cable support and containment systems detailed within this specification shall be included at tender and used for installation.

To provide adequate segregation each of the wiring systems may be installed in their own dedicated cable management systems or in common cable management systems (e.g. cable basket / wire mesh tray, cable trunking, cable ducting, dado / skirting trunking etc.) with other electrical wiring systems.

Where installed in common cable management systems they shall be provided with their own individual dedicated compartments.

The compartments may be manufactured before delivery to site, however where dividers / partitions are installed on-site they must be from the same manufacturer as the cable management system and the manufacturers proprietary fixings shall be used.

The compartment walls or dividers / partitions within the common cable management system shall be: -

- 1) Securely fixed and manufactured from the same material as the cable management system.
- 2) Mechanically strong and continuous throughout the cable management system.
- 3) The same height as the sides of the common cable management system and without perforations.
- 4) Equipotential bonded to the cable management system.

Voice and data cabling shall not be installed within a common cable management system that contains low voltage wiring unless the dividers / partitions are manufactured from steel with a minimum thickness of 1.5mm.

All wiring systems shall be fully segregated from each other and shall not be installed in the same compartment of a combined cable management system or in the same dedicated cable management system. Each wiring system shall have its own cable conduits and shall not be installed in the same conduits as the cables of other wiring systems.

Under no circumstances shall any wiring systems be strapped or fixed to the outside of cable management systems.

Underground electrical wiring systems shall be buried and separated as detailed by the NJUG National Joint Utilities Group. All buried wiring systems shall be installed within their own dedicated cable ducting systems.

1-30-2 PROXIMITY OF WIRING SYSTEMS TO NON-ELECTRICAL SERVICES

Wiring systems shall not be in close proximity to non-electrical services that produce heat (e.g. hot pipework), smoke or fumes, or below services that may cause condensation (e.g. water, steam, gas services), unless adequate precautions are taken to prevent harmful effects to the wiring.

Mechanical / thermal shielding or suitable spacing shall be provided between electrical and non-electrical services to prevent the operation of one service affecting another.

Where wiring systems are located in proximity to non-electrical services, they shall be installed in accordance with BS 7671 and shall meet the following requirements: -

- 1) Where the presence of non-electrical services may be hazardous to wiring systems, suitable protection of the wiring systems shall be provided.
- 2) The protective measure automatic disconnection of supply shall be provided in accordance with BS 7671.

1-30-3 MEASURES AGAINST ELECTROMAGNETIC DISTURBANCES

To avoid and reduce electromagnetic disturbances good engineering practices shall be followed and the electrical installation works shall be undertaken in strict accordance with BS 7671, all supporting IET documentation, and the following standards detailed within BS 7671: -

REFERENCE STANDARDS / DOCUMENTS	
BS 6701	Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance
BS EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment
BS EN 50174	Information technology – Cabling installation
BS IEC 61000-5-2	Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling

Where referenced within this section of the specification data and signaling cabling shall include the following systems: -

- 1) Information technology and telecommunications systems.
- 2) All life safety / fire-fighting systems.
- 3) Security systems.
- 4) BMS systems.
- 5) ELV mechanical services controls
- 6) Any other systems that utilise ELV signalling wiring.

BS 7671 details potential sources of electromagnetic disturbances found within an installation, the location of these sources shall be considered in relation to the positioning of other equipment e.g. the positioning of cabling support and containment systems containing data and signaling cabling.

Information technology and telecommunication cabling shall be installed in strict accordance with BS 6701 and BS EN 50174. Reference shall be made to BS EN 50174-2 for the minimum separation distances from data / signaling cabling to sources of electromagnetic interference (e.g. fluorescent / neon / mercury vapour / high-intensity discharge lamps, arc welders, frequency induction heating, hospital equipment, radio / television transmitters and radars).

In summary:

- 1) In free air there must be at least a separation distance of 200mm.
- 2) Follow the recommendations in BS 7671, which are summarised below: -

INSTALLATION METHOD (ALL CABLE SUPPORT AND CONTAINMENT SYSTEMS ARE STEEL)		SEPARATION DISTANCE
DATA CABLING	LOW VOLTAGE CABLING	
Dedicated cable basket or tray	Cable tray or basket	200mm
Dedicated cable basket or tray	Cable trunking (wall thickness less than 1.5mm)	150mm
Dedicated cable trunking (wall thickness less than 1.5mm)	Cable tray or basket	150mm
Dedicated cable trunking	Dedicated cable trunking	0mm
Notes: <ol style="list-style-type: none"> 1) The above minimum separation distances are based upon the assumptions detailed within BS 7671. 2) The minimum separation distances shall apply in three dimensions. 3) Data cabling shall not be installed within a common cable management system that contains low voltage wiring unless the dividers / partitions are manufactured from steel with a minimum thickness of 1.5mm. 4) Where data cabling and power cabling are required to cross each other and the minimum separation distances cannot be maintained, they must cross each other perpendicularly at 90 degrees for at least the minimum separation distance either side of the crossing. 		

Safety requirements shall take precedence over measures to avoid and reduce electromagnetic disturbances in all instances.

1-31 CABLE SUPPORT AND CONTAINMENT SYSTEMS

This section of the specification details the general requirements for cable support and containment systems.

Internal backbone fibre optic cabling (e.g. single mode and multimode), horizontal structured data cabling (e.g. category 6 and category 6A) and multi-pair telecommunications cabling (e.g. CW1308) shall be installed in metallic cable basket / wire mesh systems along primary distribution routes (e.g. ceiling voids, raised access floors) and then within metallic cable conduit and dado, skirting and bench trunking systems etc.

However, there may be a requirement in some instances to install the cabling within metallic cable trunking systems as opposed to cable basket / wire mesh systems in exposed environments (e.g. switch rooms, plant rooms, 'industrial' and 'back of house' areas).

All cable support and containment systems must be fully continuous throughout.

1-31-1 DEFAULT SPARE CAPACITY WITHIN CABLE SUPPORT AND CONTAINMENT SYSTEMS

Cable support and containment systems shall be provided with 40% spare capacity and an additional 40% allowance shall be added to the calculated safe working load (SWL) for supports, for the provision of future cabling.

1-31-2 GENERAL REQUIREMENTS FOR CABLE SUPPORT AND CONTAINMENT SYSTEMS

All cable support and containment systems must be fully continuous throughout and utilize (where applicable) couplers, joint strips, connectors, brackets, bends, gussets, clips, clamps, risers, angles, tees, cross pieces, reducers, bell mouths, end caps, conduit boxes, adaptable boxes, conduit take-off plates and fixing components etc. from the same manufacturer.

Where visible, uPVC cable support and containment systems shall be from the same manufacturer so that variations in colour are avoided. uPVC cable support and containment systems shall not be used within environments that have extreme low or high temperatures.

Angles, bends, risers, tees, cross pieces etc. shall be adequately sized to accommodate the minimum bending radius of the largest cabling to be installed. Cabling bends shall be sized in accordance with the IET On-Site Guide, IET Guidance Note 1 and in strict accordance with the cabling manufacturer's recommendations.

Where possible cabling shall retain its position through all bends, tees, cross pieces etc. so that crossovers are minimized / eliminated.

All proprietary fasteners, screws, bolts, washers, nuts, lock nuts and cover clips shall be from the same material and manufacturer as the cable support and containment system. These fixings and fittings shall not intrude into the cable support and containment system in such a manner that they may cause damage to the cabling.

Where covers / lids (closed or ventilated) and dividers / partitions are specified they must be from the same material and manufacturer as the cable support and containment system. Covers / lids and dividers / partitions shall be fully continuous throughout the entire cable support and containment system. All covers / lids and dividers / partitions shall be fixed using the manufacturer's proprietary screw fixings and self-tapping screws shall not be used.

Where covers / lids are installed, long lengths of covers / lids shall be removable. However, where cable support and containments systems pass through the building fabric the covers / lids shall be cut and fixed to project 75mm either side of the obstruction. When the structure is made good, this section of cover shall not be removable.

Where dividers / partitions are specified, printed labels shall be fixed to each compartment divider at 3m intervals and shall denote the use of the compartment / section.

Where galvanized steel cable support and containment systems are cut all burrs must be removed and edges suitably painted with cold galvanize zinc-rich paint before erection. All cuts shall be straight and squared off where required. Where the galvanized coating to systems, fittings and accessories has been damaged the damaged areas must also be painted with cold galvanize zinc-rich paint.

Where uPVC cable support and containment systems are cut all burrs must be removed and all cuts shall be straight and squared off where required.

Proprietary cutters / croppers shall be used where required (e.g., cable basket, non-metallic conduit etc.) in strict accordance with the manufacturer's recommendations.

Adequate allowance shall be made for changes in length of the cable support and containment systems due to thermal expansion and contraction; this may be in the form of expansion couplers / slip connectors. Expansion as opposed to rigid couplers shall also be used across expansion joints of the building structure. Connections that provide electrical continuity shall also allow for thermal expansion / contraction.

Where flexible couplers are used calculations shall be undertaken in strict accordance with the manufacturer's recommendations.

All cabling shall be separated and segregated as detailed within the Proximity of Wiring Systems and Measures against Electromagnetic Disturbances section within this section of the specification.

Where cable support and containment systems pass through the building(s), suitable measures shall be undertaken to prevent thermal bridging.

Non-metallic cable support and containment systems shall not be installed external to the building(s).

Under no circumstances shall slab fixed cable tie support systems be used.

1-31-3 METAL CHANNEL CABLE SUPPORT SYSTEMS AND OTHER ASSOCIATED SUPPORTS

Metal channel and/or manufacturer's proprietary cable support systems shall be used to support the cable management systems. Metal channel cable support systems shall comply with BS 6946. The manufacturer's proprietary cable support systems shall be provided in strict accordance with the manufacturer's recommendations.

All supports, brackets, fixings and suspension components shall be formed from steel compliant with BS 1449-1 and shall be hot dip galvanized after manufacture to the requirements of BS EN ISO 1461.

Supports, brackets, fixings, drop rods (minimum 8mm diameter) and suspension components shall be provided at intervals to support an additional 30% allowance added to the calculated safe working load (SWL) for the provision of future cabling.

Metal channel and/or manufacturer's proprietary cable support systems shall be provided at intervals to prevent excessive deflection of the cable management systems in strict accordance with the manufacturer's recommendations. In addition to this, no supports shall be installed at center's greater than 2000mm.

Supports shall be provided within 300mm of couplers, brackets, bends, risers, tees, crosspieces, reducers and all proprietary manufacturer's fittings. Where cable support and containment systems rise walls, they shall be fixed to metal channel at 1500mm centers.

All cut ends of metal channel (e.g. Unistrut) shall be painted with cold galvanize zinc-rich paint and shall have plastic protective caps fitted.

Where threaded drop rods (minimum 8mm diameter) are used they shall be secured to brackets or supports by vibration proof lock-nuts. Fixings at an angle shall be achieved by using manufacturers' proprietary angle brackets and all drop rods shall be vertically suspended. Under no circumstances is it permissible to bend drop rods to suit the rake of a roof.

Threaded rod / studding and screws shall be reduced in length so that no more than two threads are exposed. All cut ends shall be painted with cold galvanize zinc-rich paint.

Supports for mechanical services shall not be used to support electrical services and vice versa, without the bracketry being designed specifically with this in mind.

Under no circumstances shall Grapple wire be used to support primary cable support and containment systems.

1-31-4 FIRE RESISTANCE OF CABLE SUPPORT AND CONTAINMENT SYSTEMS

Cable cleats and supports for cable management systems shall be provided within 750mm of all fire barrier / stopping seals and shall be able to withstand the mechanical load induced by the collapse of wiring systems on the fire side of the seal, to prevent strain and damage to the seal, as required by BS 7671. This is not required if the seal itself is able to provide adequate support under such conditions.

Internal fire barriers shall be provided where metallic cable trunking systems pass through walls, floors or fire compartments, these fire barriers shall be rated in accordance with the fire compartmentation. Internal fire barriers shall also be installed within vertical cable trunking systems greater than 5m in height.

Under no circumstances shall non-metallic cable trunking systems pass through walls, floors or fire compartments.

All wiring systems in escape routes shall be adequately supported to prevent premature collapse under fire conditions in strict accordance with BS 7671 and BS 5839.

Fully continuous metallic cable support and containments systems that meet the necessary flame propagation requirements (as specified within their respective standards) shall be utilized in escape routes as opposed to fire-rated clipping, unless agreed with the UoW (and where applicable the Engineer).

1-31-5 CABLE STRAPPING

Where horizontal structured data cabling is installed upon cable basket or tray, cables shall be installed in accordance with the manufacturer's recommendations. Care shall be taken to ensure that cables are not damaged due to overtightening, no plastic cable ties shall be utilized in any part of the installation process.

Wiring systems shall be supported such that they will not be liable to premature collapse in the event of a fire. Suitably spaced steel clips or ties shall be used on wiring systems hanging across access or egress routes. Under no circumstances shall any cabling be strapped or fixed to the outside of cable management systems.

All cable strapping and ties shall be low smoke zero halogen (LSZH).

1-31-6 PROTECTIVE EARTHING (PE) FUNCTION AND ELECTROMAGNETIC DISTURBANCES

All metallic cable support and containment systems shall be equipotential bonded as detailed in the Earthing and Bonding section within this section of the specification.

1-31-7 CIRCUIT PROTECTIVE CONDUCTORS

Under no circumstances shall cable support and containment systems be used as circuit protective conductors.

1-31-8 CABLE BASKET / WIRE MESH TRAY SYSTEMS

Cable basket / wire mesh tray systems shall comply with BS EN 61537 and shall be supported by metal channel and/or manufacturer's proprietary components e.g. cantilever arms, central hangers, suspension hangers, stand-off / mounting brackets, floor brackets etc.

Where the term cable basket system is used within this specification it also refers to wire mesh cable tray systems.

Cable basket shall be formed from steel wire welded into a mesh pattern and shall be electro-galvanized after manufacture (electroplated with zinc) to the requirements of BS EN 12329 / BS EN ISO 2081. Deep galvanized, hot dip galvanized, stainless steel, powder coated, and non-metallic cable basket systems shall not be used unless specified elsewhere within this specification.

Bends, gussets, risers, tees, cross pieces etc. shall be cut / formed on site using proprietary cutters / croppers in strict accordance with the manufacturer's recommendations.

Cable basket shall not be installed inverted under any circumstances

All cable basket fittings such as couplers, joint strips, connectors, brackets, clips, clamps, conduit take-off plates, fixing components and covers / dividers shall be formed from steel sheet and shall be electro-galvanized after manufacture (electroplated with zinc) to the requirements of BS EN 12329 / BS EN ISO 2081, or pre-galvanized before manufacture to the requirements of BS EN 10346

Cable dropout and conduit take-off plates shall be used where cabling exits the cable basket system and the cabling shall be adequately supported to its final termination location.

Conduit take-off plates along with couplings, brass male bushes and serrated washers shall be utilized to connect conduit to the cable basket system. The clipping direct of cabling to the building fabric (e.g. concrete slab) on exit from the cable basket to conduit drops at wall locations is not permitted. The cable basket and conduit shall form a fully continuous containment system throughout from source to destination terminations

Cable basket shall not be installed external to the building(s).

1-31-9 CABLE TRUNKING SYSTEMS

GENERAL REQUIREMENTS

Where cable trunking is fixed direct to the building fabric it shall be supported at spacing's as detailed within the IET On-Site Guide, IET Guidance Note 1 – Selection & Erection and in strict accordance with manufacturers' literature.

Cable trunking systems shall be sized as detailed within the IET On-Site Guide and IET Guidance Note 1 – Selection & Erection.

All bends, tees and cross overs used within multi-compartment trunking systems shall be multi-compartment fittings to ensure the full segregation of cabling throughout the cable trunking.

Cable retainers shall be installed at intervals of 600mm where cable trunking lid / covers are installed to the bottom or side of the cable trunking system. Pin racks shall be installed within cable trunking on vertical runs greater than 3m and shall be installed at 2m intervals to support the cabling installed.

Where non-sheathed cables are installed in cable trunking the entire trunking system (including all fittings) shall provide at least the degree of protection (IP code) of IP4X or IPXXD to BS EN 60529, as required by BS 7671. It shall only be possible to secure or remove the cable trunking lid by means of a tool or deliberate action.

Cable trunking shall not be installed external to the building(s).

METALLIC CABLE TRUNKING SYSTEMS

Metallic cable trunking systems shall comply with BS EN 50085 and shall be supported by metal channel and/or manufacturers proprietary components e.g. trapeze / stirrup / overhead hangers etc.

Cable trunking shall be formed from steel sheet and shall be pre-galvanized before manufacture to the requirements of BS EN 10346. Deep galvanized, hot dip galvanized, stainless steel, powder coated, and non-metallic cable trunking systems shall not be used unless specified elsewhere within this specification.

This section of the specification does not apply to metallic dado trunking systems.

All cable trunking fittings such as couplers, lid / covers, cover straps, bends (gusset and square), tees, cross overs, reducers, bell mouths, end caps, flanges etc. shall be formed from steel sheet and shall be pre-galvanized before manufacture to the requirements of BS EN 10346.

Where cable trunking is recessed covers shall be installed to form a flush finish with the adjacent building fabric.

Circular conduit boxes or couplings, brass male bushes and serrated washers shall be utilized to connect conduit to the cable trunking system. The clipping direct of cabling to the building fabric (e.g. concrete slab) on exit from the cable trunking to conduit drops at wall locations is not permitted. The cable trunking and conduit shall form a fully continuous containment system to IP4X or IPXXD, from source to destination terminations.

Conduits shall not pass through compartments to reach the appropriate destination compartment; they shall connect to the compartment using circular conduit boxes mounted below / adjacent on the outside of the cable trunking. Where multi-compartment trunking is recessed into the building fabric circular conduit boxes shall be mounted behind the appropriate destination compartment.

Metallic cable trunking shall not be used as a circuit protective conductor (CPC) for final circuit wiring.

uPVC CABLE TRUNKING SYSTEMS

Non-metallic cable trunking systems shall comply with BS EN 50085 and BS 4678 (BS 4678-2 and BS4678-4 are still current) and shall be fixed / supported in strict accordance with the manufacturer's recommendations.

Non-metallic cable trunking shall be heavy gauge white uPVC and shall have the following properties: -

- 1) Corrosion resistance.
- 2) High impact resistance.
- 3) Non-flame propagating.
- 4) Self-extinguishing.

Non-metallic cable trunking systems shall not be used unless agreed with UoW (and where applicable the Engineer). This section of the specification does not apply to non-metallic dado trunking systems.

The cutting and manipulation of trunking lengths to form proprietary components is deemed not acceptable, proprietary manufacturer's components must be used in all instances e.g. internal / external couplers, end caps, angles, tees, internal / external bends, cross overs etc.

All cable trunking fittings such as internal / external couplers, end caps, angles, tees, internal / external bends, cross overs etc. shall be heavy gauge white uPVC and meet the requirements detailed above (Items 1 to 4).

Where required conduit boxes or couplings / male bushes shall be utilized to connect conduit to the cable trunking system. The cable trunking and conduit shall form a fully continuous containment system to IP4X or IPXXD, from source to destination terminations. Only heavy gauge white uPVC conduit shall be connected to the uPVC cable trunking.

1-31-10 DADO, SKIRTING AND BENCH TRUNKING SYSTEMS

GENERAL REQUIREMENTS

Where applicable the general requirements for cable trunking systems shall also apply.

The dado, skirting and bench trunking systems shall be suitable for the category of data cabling to be installed (e.g. Cat 6 and Cat 6A) and shall not impair the performance of the cabling. It shall also be suitable for the other types of cabling to be installed (e.g. LV final circuits cabling, audio visual cabling etc.).

Dado and skirting trunking systems shall have a minimum of three compartments and it shall be possible to install manufacturer's proprietary 45mm deep back boxes. Bench trunking systems shall have a minimum of two compartments and it shall be possible to install manufacturer's proprietary 35mm deep back boxes.

Voice and data cabling shall not be installed within a compartment that contains LV wiring. Screening dividers shall be provided to adequately segregate LV power cabling from data / signaling cabling. The screening dividers shall be steel and have a minimum thickness of 1.5mm.

Dado and skirting trunking shall be provided with cable retainers installed at intervals of 600mm.

Generally, the dado trunking systems shall be fed from vertical dado trunking lengths which will rise to high level (e.g. ceiling void) and shall terminate in a position adjacent to primary / secondary containment systems for concealed entry into compartments via end caps. Screening dividers shall also be provided throughout the vertical dado trunking drops.

Where conduits are used to drop to dado, skirting and bench trunking they shall be concealed within the building fabric and shall be connected to the trunking systems using recessed circular conduit boxes mounted behind the appropriate destination compartment.

The vertical trunking lengths and screening dividers shall be from the same manufacturer's product range as the horizontal trunking systems.

Dado, skirting and bench trunking systems shall not be provided with an antibacterial finish unless detailed elsewhere within this specification.

Where antibacterial (e.g. silver additive based) dado, skirting and bench trunking systems are required (e.g. healthcare, laboratories etc.) they shall be detailed elsewhere within this specification.

METALLIC DADO, SKIRTING AND BENCH TRUNKING SYSTEMS

Metallic dado, skirting and bench trunking systems shall comply with BS EN 50085 and BS 4678 (BS 4678-2 and BS4678-4 are still current) and shall be fixed / supported in strict accordance with the manufacturer's recommendations.

Cable trunking shall be formed from steel sheet and shall be pre-galvanized before manufacture to the requirements of BS EN 10346. They shall also have a white powder coat finish to RAL 9010 or RAL 9003. Aluminum cable trunking systems shall not be used unless specified elsewhere within this specification.

All cable trunking fittings such as end caps, angles, tees, internal / external corners etc. shall be formed from steel sheet and shall be pre-galvanized before manufacture to the requirements of BS EN 10346. They shall also have a white powder coat finish to RAL 9010 or RAL 9003. The proprietary components shall be selected to suit either dado trunking, skirting or bench trunking systems.

uPVC DADO, SKIRTING AND BENCH TRUNKING SYSTEMS

Non-metallic dado, skirting and bench trunking systems shall comply with BS EN 50085 and BS 4678 (BS 4678-2 and BS4678-4 are still current) and shall be fixed / supported in strict accordance with the manufacturer's recommendations.

Non-metallic cable trunking shall be heavy gauge white uPVC and shall have the following properties: -

- 1) Corrosion resistance.
- 2) High impact resistance.
- 3) Non-flame propagating.
- 4) Self-extinguishing.

The cutting and manipulation of trunking lengths to form proprietary components is deemed not acceptable, proprietary manufacturer's components must be used in all instances e.g. end caps, angles, tees, internal / external corners etc.

All cable trunking fittings such as end caps, angles, tees, internal / external corners etc. shall be heavy gauge white uPVC and meet the requirements detailed above (Items 1 to 4). The proprietary components shall be selected to suit either dado trunking, skirting or bench trunking systems.

1-31-11 CONDUIT AND FITTINGS

GENERAL REQUIREMENTS

Where cable conduit is fixed direct to the building fabric it shall be supported at spacing's as detailed within the IET On-Site Guide and IET Guidance Note 1 – Selection & Erection.

Conduit systems shall be provided with spare capacity so that 40% more cable/s of a similar size and type can be installed.

30% physical spare capacity and conduits less than 20mm diameter shall not be used.

As a guide, maximum data cable capacity within conduits shall be as follows:

20mm diameter – maximum of 2 cables

25mm diameter – maximum of 4 cables

32mm diameter – maximum of 8 cables

Surface conduits shall also be supported within 300mm of floors, ceilings, boxes and at each side of every bend.

Fixing of conduits shall be as follows: -

- 1) Wall chases or floor screed – Crampets or ordinary saddles.
- 2) Ceiling, roof or floor voids – Spacer bar saddles.
- 3) Surface mounted on ceiling – Spacer bar saddles.
- 4) Surface mounted on walls – Distance saddles.

Cable conduits shall be sized as detailed within the IET On-Site Guide and IET Guidance Note 1 – Selection & Erection.

Inaccessible conduits shall be arranged on a 'loop in' system so that all draw in points for cables are accessible at finished surfaces.

Proprietary conduit draw points shall be provided to facilitate initial installation, rewiring and future maintenance; the maximum distance between draw points shall be 10m. A maximum of one 90° bend (or the equivalent total of all bends) shall be permitted between draw points.

Bends, elbows, tees or u-bands shall not be used. Bends for metallic conduit shall be formed on a proprietary bending machine. uPVC bends shall be formed using a suitably sized spring and by the application of heat.

Where conduits are installed for use by third parties, draw wires shall be provided to facilitate the installation of cabling.

All conduit boxes and adaptable boxes shall be filled with moisture repelling compound or have drains where there is a risk of condensation and within plant rooms / external locations all box lids shall be fitted with gaskets. In damp environments conduits shall enter wiring accessories from the bottom to prevent the build-up of moisture.

Chasing of walls must be carried out in accordance with the Structural Engineer's recommendations where appropriate. Under no circumstances shall horizontal chases exceed 500mm in length. Back to back chasing is also not permitted.

Cable conduit shall not be installed within floor screeds or cast-in unless detailed elsewhere within this specification.

Under no circumstances shall metal or plastic capping be used for cabling drops installed within walls.

Non-metallic cable conduit systems shall not be installed external to the building(s).

METALLIC CONDUIT AND FITTINGS

Metallic cable conduit shall comply with BS EN 61386 and shall have a resistance to corrosion classification of 'Class 4' as detailed within Table 10 of BS EN 61386.

Cable conduit shall be formed from heavy gauge steel and shall be hot dip galvanised after manufacture to the requirements of BS EN ISO 1461, to provide a high level of corrosion protection both inside and outside to meet the classification 4 requirements.

Metal conduit with resistance to corrosion classifications of 1, 2 or 3 shall not be used unless detailed elsewhere within this specification.

Connections to accessory boxes on a concealed installation shall be with couplings, brass male bushes and serrated washers. For surfaces installation, flanged couplers with lead washers shall be used.

Conduits shall be threaded to butt closely together in couplings and sockets.

Except at running couplings, threads shall not be exposed, and these shall be cleaned, primed and painted with cold galvanise zinc-rich paint after installation.

All conduit drops in chases in plastered walls shall be painted with red oxide paint before plaster is applied and shall have a coupler inserted in the run 300mm from ceiling level.

Pressed steel accessories shall not be used under any circumstances and all conduit boxes, adaptor boxes and accessories shall be formed from malleable cast iron.

Metallic cable conduit shall not be used as a circuit protective conductor (CPC) for final circuit wiring.

Under no circumstances shall push-fit / quick-fit conduits be used. All conduits shall be threaded to ensure adequate earth continuity.

uPVC CONDUIT AND FITTINGS

Non-metallic cable conduit shall comply with BS EN 61386 and shall be heavy gauge white uPVC and have the following properties: -

- 1) Corrosion resistance.
- 2) High impact resistance.
- 3) Non-flame propagating.
- 4) Self-extinguishing.

Non-metallic cable conduit systems shall not be used unless agreed with UoW (and where applicable the Engineer).

Connections to accessory boxes shall be with couplings / male bushes and care must be taken to ensure that all joints are glued correctly.

In extremely cold weather the cable conduit shall be slightly warmed before use in accordance with the manufacturer's recommendations.

Proprietary steel or brass insert clips shall be fitted where luminaries are suspended from circular boxes to ensure that the weight of the luminaries is carried by the structure rather than the conduit box.

FLEXIBLE AND PLIABLE CONDUIT

Metallic flexible conduit shall comply with BS EN 61386 and shall be formed from helical coiled steel with an overall waterproof sheath.

Non-metallic flexible conduit shall comply with BS EN 61386 and shall be heavy duty, corrosion resistant and non-flame propagating.

Non-metallic flexible conduit shall not be used unless specified elsewhere within this specification.

Generally flexible conduit shall be used for the final connection to the following: -

- 1) Equipment that is required for ducting, pipework etc. such as control sensors, motorised valves etc.
- 2) As part of a raised floor building, where the data cabling is distributed within the floor void and data points are terminated within floor boxes / grommets, in this instance a 3 metre loop of data cabling feeding the floor box / grommet shall be coiled under the floor to enable floor boxes to be repositioned, the data cables shall be contained within flexible conduit fixed to the cable basket and the floor box utilised propriety brackets and adaptors
- 3) Equipment subject to vibration e.g. motors, pumps etc.
- 4) Equipment where movement may be required for maintenance / access.

Flexible conduit shall be connected to conduit boxes and equipment termination boxes using compression glands.

The length of flexible conduit shall not exceed 1000mm.

Non-metallic flexible conduit shall not be used in environments where heat may be detrimental to its material properties or where additional mechanical protection may be required.

1-31-12 BELOW GROUND CABLING

DEPTH REQUIREMENTS

Cabling and ducting shall be buried at the following depths unless detailed elsewhere within this specification: -

CABLING TYPE / SIZE	MINIMUM DEPTH OF LAYING
Communications	600mm

All buried cabling and ducting shall be provided in strict accordance with NJUG National Joint Utilities Group guidelines and the UoW infrastructure specification.

EXCAVATION

All trenches for cables must be straight between points where there are no changes in direction. Trenches must not have step changes in level but be gradual where needed. The bottom of trenches must be smooth and free from stones.

Where excavations reveal unsuitable ground containing rocks or ashes with a predominant or unusual chemical content, or any conditions liable to affect the life or performance of the cable, it must be brought to the attention of UoW (and where applicable the Engineer).

Means are to be proposed to UoW (and where applicable the Engineer), to minimize the effects on works traffic caused by any excavations during the execution of the work.

Where trench depths exceed 1.2m, trench boarding must be provided. Where other services are encountered, during excavation, adequate support and protection must be provided particularly when digging, backfilling and cable pulling.

In conditions which may result in trenches flooding, the provision of pumping equipment must be allowed for. The method of disposing of pumped liquid must be approved.

CABLE DUCTS

Cable ducts must be of reputable manufacture and must be made from **purple** uPVC unless otherwise specified and shall be a minimum 150mm diameter. Advice shall be sought from the UoW on cable ducts material to be used where there are contaminated ground conditions.

The ducts must be laid and bedded in such a way as to prevent damage from rocks etc. within the trench or in the back-filling materials.

Where cable routes are designed to pass under areas of hard standing or through foundations etc., the cables must be enclosed in pipe ducts or sleeve. The protection of ducts running under roads etc. shall be by concrete haunchings or other approved suitable means.

The provision of cable draw pits at points of route deviation, and the transition from open ground to ducts must be agreed with UoW (and where applicable the Engineer). Draw pits shall be suitably sized considering the number, type and size of cables to be installed. Deep draw pits must be of a sufficient size to allow access to the lowest ducts. All draw pits shall be dedicated for voice and data only, no other electrical services will be permitted with a voice / data draw pit.

All draw pits / manholes shall comply with the UoW standard construction details and preferred manufacturers, please refer to the UoW infrastructure specification for specific details

Where new ducts clusters are being installed, 40% of the total ways available must be spare, with a minimum of two, unless single way ducts are specified. All spare ducts must be sealed against ingress of water and or vermin, with proprietary products approved by both the duct and cable manufacturer. Cable ducts shall be laid at a gradient away from building entries.

A nylon draw cord must be left in each spare duct for its entire length and in any used ducts with spare capacity.

All ducts / manholes provided for data cabling shall be used exclusively for this purpose, no other cabling shall be installed within dedicated data ducts and manholes.

Before cables are drawn into any ducts, new or existing, the ducts must be swabbed to ensure that it is free of debris and clean. Before cables are drawn into ducts the entry points must be protected by temporary bell mouths to ensure that there is no damage to the outer serving of the cable during the pulling operation.

Following the drawing in of the cable, the duct must be sealed using materials or devices authorized to provide protection against vermin, passage of gases, fire etc.

All building entry points shall be sealed with gas tight / vermin resistant propriety seals, please refer to the appendix 4 and the UoW infrastructure specification for specific details

Where external grade cat 6 / 6A cables are utilised these shall be terminated at a transition points within 2 metres of building entry utilizing a transition jointing box, please refer to appendix 5 and discuss / agree proposals with IT services utilizing the technical submission route.

1-31-13 SURFACE / EXPOSED CABLE SUPPORT AND CONTAINMENT SYSTEMS

Where surface / exposed primary cable management (e.g. cable ladder, cable tray and cable trunking) and secondary containment systems (e.g. final conduit runs) are acceptable, the location and routing of these systems must be agreed with UoW (and where applicable the Engineer and Architect) prior to installation.

1-31-14 DESIGN REQUIREMENTS

The Contractor shall assume design responsibility for the following: -

- 1) The provision of adequate cable supports, fixings and suspension components to support all cabling management systems.

- 2) The provision of adequate cable supports, fixings and suspension components to support cabling management systems which are intended to support fire-resistant cabling in a fire condition, to prevent premature collapse of the cable management system and therefore failure of the cabling installed.
- 3) The provision of adequate bends, risers, tees, cross pieces etc. to accommodate the minimum bending radius of the largest cabling to be installed.
- 4) The provision of adequate fixing components for changes due to thermal expansion / contraction and across expansion joints of the building structure.
- 5) Where required the provision of adequate electrical continuity as defined in BS EN 61537 and BS EN 50085, to provide a protective earth (PE) function and to avoid / reduce electromagnetic disturbances.
- 6) The sizing and routing of all secondary cable support and containment systems e.g. final conduit runs.
- 7) The provision of adequate measures to prevent thermal bridging.

1-31-15 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

- 1) Technical specifications for all cable support and containment systems to be installed.

The time allowed for comment by UoW and the Engineer (where applicable) shall be at least 10 days, this period should be allowed for within the Contractors program of works.

1-32 SELECTION AND ERECTION OF WIRING SYSTEMS TO MINIMIZE THE SPREAD OF FIRE

This section of the specification details the general requirements for the selection and erection of wiring systems to minimize the spread of fire. To minimize the risk of spread of fire appropriate materials and erection methods shall be selected in strict accordance with The Building Regulations – Approved Document B, BS 9999, BS 7671 and all supporting IET documentation.

1-32-1 PRECAUTIONS WITHIN A FIRE SEGREGATED COMPARTMENT

The general building structural performance and fire safety shall not be reduced by the installation of wiring systems.

Cables that comply with the flame propagation requirements of BS EN 60332-1-2 may be installed without special precautions, some of the cables that comply with BS EN 60332-1-2 are listed below: -

REFERENCE STANDARDS / DOCUMENTS	
BS 6004	Electric cables – PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting
BS EN 50525	Electric cables – Low voltage energy cables of rated voltages up to and including 450/750 V (Uo/U)

Where cables do not comply with the flame propagation requirements of BS EN 60332-1-2, they shall not pass from one fire segregated compartment to another, and they shall be limited to short lengths for connection of appliances to the permanent wiring system.

Where products have the necessary resistance to flame propagation as specified in the standards below, they may be installed without special precautions: -

REFERENCE STANDARDS / DOCUMENTS	
BS EN 50085	Cable trunking systems and cable ducting systems for electrical installations
BS EN 61386	Conduit systems for cable management
BS EN 61537	Cable management – Cable tray systems and cable ladder systems

Other products that also have the necessary resistance to flame propagation (as specified within their respective standards) may also be installed without special precautions.

Additional measures shall be taken where a particular risk of fire is identified in strict accordance with BS 7671 and all supporting IET documentation.

1-32-2 SEALING OF WIRING SYSTEM PENETRATIONS

Where wiring systems pass through floors, walls, roofs, ceilings, partitions, cavity barriers and other elements of the building construction, the penetrations through the building fabric shall be suitably sealed (e.g. fire barriers / stopping) to provide the level of fire resistance and acoustic properties required by the building element that has been penetrated.

Manufacturers' proprietary cable transit systems and sleeves shall be utilized. Under no circumstances shall expandable foam be used.

Cable ducting, cable trunking, conduit and bus bar systems etc. shall also be internally sealed to provide the level of fire resistance required by the building element that has been penetrated.

Where the wiring system / products are classified as non-flame propagating according to the relevant product standard, internal sealing is not required provided that: -

- 1) The wiring system has a maximum internal cross-sectional area of 710mm² e.g. 32mm diameter conduit or smaller, or 25 x 25mm trunking. (However, they may require sealing for other reasons, such as to prevent condensation, in classified hazardous areas etc.).
- 2) The system has the degree of protection of IP33 to BS EN 60529.
- 3) Any termination of the system in one of the compartments, separated by the building construction being penetrated, has the degree of protection of IP33 to BS EN 60529.

Temporary fire stopping arrangements shall be provided if required during the installation works. Existing fire stopping that is disturbed during alteration works shall be reinstated as soon as practical. Temporary sealing arrangements shall provide the level of fire resistance required by the building element that has been penetrated.

The fire sealing must also resist external influences to the same degree as the wiring system and shall meet the five requirements e.g. resistance to combustion, ingress protection from water, be from compatible material, permit thermal movement and have adequate mechanical stability.

Cable cleats and supports for cable management systems shall be provided within 750mm of all fire barrier / stopping seals and shall be able to withstand the mechanical load induced by the collapse of wiring systems on the fire side of the seal, to prevent strain and damage to the fire seal. This is not required if the seal itself is able to provide adequate support under such conditions.

Intumescent gaskets and covers shall be provided where electrical equipment or accessories are installed within ceilings or walls whose fire integrity has been compromised by their installation e.g. recessed luminaires in ceilings to maintain the ceilings fire integrity, accessory boxes in thin skinned walls that form part of a fire compartment etc.

Manufacturers' proprietary cable transit systems and associated fire stopping products shall be sized to accommodate the same spare capacity as that provided for the cable support and containment systems.

Labelling shall be provided at each penetration location and shall have a designated unique reference, include the installation date and details of the specialist installer.

On completion of the fire barriers / stopping works fully detailed completion / compliance certification shall be provided along with record drawings that detail all fire barrier / stopping locations.

1-32-3 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

- 1) Technical specifications for all manufacturers' proprietary fire stopping systems and materials e.g. cable transit systems and sleeves.

The time allowed for comment by UoW and the Engineer (where applicable) shall be at least 10 days, this period should be allowed for within the Contractors program of works.

1-33 WIRING ACCESSORIES

1-33-1 GENERAL REQUIREMENTS

This section of the specification details the general requirements for wiring accessories associated with the telecommunications systems. Wiring accessories shall be provided in strict accordance with BS 8300, The Building Regulations – Approved Document M, BS 7671 and all supporting IET documentation.

telecommunications wiring accessories shall exactly match the appearance of those associated with utility power, light switches and the like. Thus, a common manufacturer and range shall be used for all such, and the Contractor shall inform UoW (and where applicable the Engineer) of any anomalies in this respect prior to installation.

The table below details the default wiring accessories that shall be included at tender and used for installation (where applicable).

WIRING ACCESSORY	MANUFACTURER / PRODUCT RANGE	FINISH
General areas:-		
Voice and data outlets to ISO/IEC 11801, EN 50173, TIA 568 and EN 41003	Leviton R&M Cabling Solutions Excel MK Logic Plus	Plastic white with white inserts
Switch rooms, plant rooms, ceiling voids and 'back of house' areas:		
Voice and data outlets to ISO/IEC 11801, EN 50173, TIA 568 and EN 41003	Leviton R&M Cabling Solutions Excel	Metallic powder coated with white inserts
Surface back boxes to BS 5733	MK Logic Plus	Metallic powder coated
Miscellaneous:		
Recessed back boxes to BS 5733	MK Ltd	Galvanized steel with a minimum depth determined by the cable manufacturers recommendations
Floor boxes	Mk Ackermann	General note – data cabling within underfloor voids feeding data outlets within floor boxes, 3m coil of cabling to be included adjacent floor box to

WIRING ACCESSORY	MANUFACTURER / PRODUCT RANGE	FINISH
		allow relocation of floor box, this cabling to be enclosed within heavy duty 25mm diameter flexible conduit connected to floor box and cable basket utilizing manufacturers adaptors
Notes: 1) Where more than one product range is specified above for a wiring accessory the most expensive option shall be included within the tender price. 2) Wiring accessories shall be fixed in strict accordance with manufacturers' literature. 3) Under no circumstances shall screw less clip-on wiring accessories be used.		

To comply with The Building Regulations – Approved Document M and BS 8300 a difference of 30 points in Light Reflectance Value (LRV) shall be provided between wiring accessories and their surroundings.

Colored surrounds shall be provided to all wall recessed plastic white wiring accessories. Colored surrounds or side wings shall be provided to plastic white accessories installed within dado, skirting and bench trunking.

The appearance and colour of colored surrounds / side wings shall be agreed with UoW (and where applicable the Engineer and Architect).

1-33-2 TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

- 1) A schedule (including images) and technical specifications for all wiring accessories, along with a physical sample of each wiring accessory type.
- 2) A physical sample of coloured surrounds / side wings.

The time allowed for comment by UoW and the Engineer (where applicable) shall be at least 10 days, this period should be allowed for within the Contractors program of works.

1-34 POSITIONING AND MOUNTING HEIGHT OF ELECTRICAL SERVICES

This section of the specification details the general requirements for the mounting heights of electrical services associated with the voice and data systems.

Electrical services shall be positioned and mounted in strict accordance with BS 8300, The Building Regulations – Approved Document M, BS 7671 and all supporting IET documentation.

The tables below detail the positioning and mounting height requirements for electrical services: -

EQUIPMENT / ACCESSORY	MOUNTING HEIGHT AFFL (mm) TO THE CENTRE OF OUTLETS	NOTES
Outlets:		
TV / AV screen outlets	450 – 1000mm	Dependent on location of screen. At high level where required and only accessed by skilled persons (electrically). Generally, within 100mm of any associated socket outlets.
Data outlets	450 – 1000mm	Dependent on equipment. Generally, within 100mm of any associated socket outlets.
Industrial / data outlets	450 – 1000mm	Dependent on use / equipment.
Data outlets at high level	1000 – 2800mm	Dependent on use / equipment eg high level CCTV camera, wireless access points etc. At high level where required and only accessed by skilled persons (electrically).
Equipment with visual displays, however no controls, switches or pushbuttons:		
Equipment with visual displays	1200 – 1800mm	Wall mounted screens
It shall be noted the above list is not exhaustive and reference must be made to the requirements detailed within all applicable standards / documents and also to specialist / manufacturers requirements.		
Notes:		
1) All electrical equipment and accessories shall be located as detailed on the Architects elevation drawings (where provided). However, where there is a discrepancy between the Architects elevation drawings and the above information this shall be brought to the attention of the Engineer and Architect in a timely manner.		

EQUIPMENT / ACCESSORY	MOUNTING HEIGHT AFFL (mm) TO THE CENTRE OF OUTLETS	NOTES
2)	The above heights are from finished floor level to the centre of the electrical equipment / accessory, unless otherwise stated.	
3)	Outlets, switches and controls shall be a minimum of 350mm from the corners of a room or area, unless otherwise stated.	
4)	Electrical equipment / accessories of the same type shall be mounted at the same height throughout the building.	
5)	Where adjacent and in close proximity to each other, electrical equipment / accessories of the same type shall be mounted at the same height e.g. single gang accessories such as light switches, door access control etc. However, this must be within the prescribed mounting height range for the particular items.	
6)	Where building features affect mounting height (e.g. wall tiling) the equipment / accessory shall still be located within the prescribed range.	
Refer to Part 2 Definitions of BS 7671 for the definition of a skilled person (electrically).		

Where positioning and mounting heights are not provided above, reference shall be made to BS 8300, The Building Regulations – Approved Document M and all applicable standards / documentation.

1-35 FIXINGS TO THE BUILDING STRUCTURE / FABRIC

This section of the specification details the general requirements for the fixing of electrical services to the building structure / fabric. Fixings to the building structure / fabric shall comply with BS 5080, BS 8000, BS 8539, BS 7671 and all supporting IET documentation.

Fixings shall not be made to the building structure / fabric that could compromise the structural performance and fire compartmentation of the building. Fixing components shall be provided in strict accordance with manufacturers' literature.

The following fixing methods are deemed acceptable as required: -

FIXING APPLICATIONS / BASE MATERIALS	FIXING TYPE
Building structural steelwork	Clamp-on bracketry e.g. flange clamps
Heavy loads to concrete, blockwork and brickwork	Proprietary fixings such as metallic expansion anchors / bolts
Light loads to concrete, blockwork and brickwork	Proprietary fixings such as metallic and plastic expansion anchors / bolts, plugs / screws, screws
Plasterboard	Wooden pattresses, noggins and battens shall be utilized with wood screws for fixing Proprietary fixings may be used such as metallic and plastic expansion plugs / screws, self-drive fixings, plastic toggles, spring toggles, etc.
Wood	Screws

The following fixing methods are deemed not acceptable: -

FIXING APPLICATIONS / BASE MATERIALS	FIXING TYPE
Building structural steelwork	Cutting and drilling of the buildings structural steelwork is not acceptable
Building structural steelwork	Welding to the buildings structural steelwork is not acceptable
Blockwork and brickwork	Fixings to blockwork and brickwork shall not be made in the mortar joint.

Fixing components shall be sized with consideration that the tensile strength of steel will be significantly reduced in a fire situation and shall be provided at intervals in accordance with manufacturers' literature. It shall be noted that failure to consider this requirement will result in premature collapse of the cable management system and therefore failure of the cabling installed.

1-36 VOICE AND DATA SYSTEMS – TECHNICAL SUBMISSIONS

Prior to installation on-site the Contractor shall provide technical submissions for the following: -

- 1) Technical specifications and certification for all voice and data cabling to confirm compliance with the latest requirements of The Construction Products Regulations.
- 2) Technical specifications for all voice and data equipment and cabling to be installed.
- 3) Network and wiring schematic drawings for all voice / data systems to be installed, generic manufacturer's schematics will not be accepted.

- 4) Wiring schematic drawing for the voice / data system dedicated telecommunications bonding network, generic manufacturer's schematics will not be accepted.
- 5) Layout drawings for all MER's and SER's.
- 6) Layout drawings / elevations for all server, equipment and communications racks.
- 7) Schedule of all identification, notices, labels (including safety signage) and cable identification labels / markers along with a physical sample of each label type.
- 8) Full cross connected patching schedules.

The time allowed for comment by UoW and the Engineer (where applicable) shall be at least 10 days, this period should be allowed for within the Contractors program of works.

1-37 IDENTIFICATION, NOTICES AND LABELLING

This section of the specification details the general requirements for the provision of identification, notices and labelling. Identification, notices and labelling shall be provided in strict accordance with site standards, BS EN 50174, BS 7671 and all supporting IET documentation. The identification, notices and labelling systems shall also be in accordance with any existing site standards and shall be agreed with the UoW and the Engineer (where applicable) prior to installation.

Cable sleeves, labels and markers as a minimum shall be made from materials equivalent to that of the cabling being labelled e.g. LSF / LSOH / LSZH etc. They shall also be selected to suit the environment in which they are installed.

1-37-1 BACKBONE FIBRE OPTIC CABLING

Backbone fibre optic cabling shall be provided with identification labels / markers so that it can be identified for inspection, testing, maintenance, repair or alteration of the installation.

Identification labels shall be fixed as follows at:-

- 1) Each end of the cable.
- 2) Convenient inspection locations.
- 3) Locations where buried cabling enters / exits the ground.
- 4) All draw pit locations.
- 5) Building entry points.

Each identification label shall include the following: -

- 1) Cable type e.g. OS2 single mode 9 / 125 µm 16 core.
- 2) Approximate length in metres.
- 3) Cable reference code, provided by UoW upon request.
- 4) Source and destination location(s).
- 5) Date of installation in DD/MM/YYYY.

Cable route markers shall be provided to all underground cabling and shall include: -

- 1) Depth at which the cable is buried.

All backbone fibre optic cabling shall be provided with 'WARNING FIBRE OPTIC CABLE' labels which can be obtained from UoW.

1-37-2 FIBRE TRANSITION ENCLOSURES

Backbone fibre optic cabling transition enclosures shall be provided with heat shrink printed identification labels either side of the splice. Each identification label shall include the following: -

- 1) Cable type e.g. OS2 single mode 9 / 125 µm 16 core.
- 2) Manufacturer.
- 3) Cable reference code, provided by UoW upon request.
- 4) Date of installation in DD/MM/YYYY.

1-37-3 VOICE CABLE BOX CONNECTIONS

Box connections shall be provided with self-adhesive printed labels denoting the DP / ID and cable source / destination. The label shall be located on the lid. The format shall be black text upon white background in a non-serif type font.

Within the box connections each 237a strip shall be labelled with designation Strips 51a using printed labels of card strips. The labels shall denote the circuit ID.

1-37-4 HORIZONTAL STRUCTURED DATA CABLING SYSTEMS

Horizontal structured data cabling systems shall be provided with unique building and communications identifiers which shall be provided by UoW upon request.

Each telecommunications / equipment room may have more than 26 RJ45 patch panels, so it is possible that multiple first digits of the panel indicator may be assigned to that particular room e.g. Panel 1 will be A-01 to A-24, Panel 2 will be B-01 to B-24 and so on until Panel 26 which will be Z-01 to Z-24. Panel 27 will be AA-01 to AA-24, Panel 28 will be AB-01 to AB-24 etc. etc.

COLOUR CODING

Orange: Demarcation point e.g. central office (telephone exchange) connections.

Green: Network connections e.g. network and auxiliary equipment.

Purple: Common equipment e.g. connections to PBX, mainframe computer, LAN, multiplexer.

White: First level backbone e.g. termination of building backbone cable Connecting MC (CD) to ICs (BDs).

Grey: Second level backbone e.g. termination of building backbone cable Connecting ICs (BDs) to HCs (FDs).

- Blue: Horizontal cable e.g. horizontal connection to telecommunications outlet / connectors, formerly referred to as 'station cable'.
- Brown: Inter building backbone (campus cable terminations). Note: Brown takes precedence over white or grey for inter building runs.
- Yellow: Miscellaneous e.g. auxiliary, alarms, security etc.
- Red: Reserved for future use, also key telephone systems.

COPPER CABLING

Horizontal copper cables shall be labelled with wrap around self-adhesive printed identification labels, 200mm from the patch panel termination point and within 100mm of a work area termination. The labelling scheme shall match the patch panel and faceplate port ID.

FIBRE CABLING

Horizontal fibre cables shall be labelled with an engraved label using the correct colour and fixed with cable ties / tie wraps, 200mm from the patch panel. The labelling scheme shall match the patch panel

CATEGORY 6 / CATEGORY 6A PATCH PANELS

Each patch panel shall be labelled with a unique engraved traffolyte adhesive label. The labelling scheme will be confirmed by UoW and will normally follow a simple port indicator e.g. Panel 1 will be A-01 to A-24, Panel 2 will be B-01 to B-24 etc. The format shall be white text upon a blue background in a non-serif type font.

FIBRE PANELS

Each duplex fibre termination port shall be labelled with a unique engraved traffolyte adhesive label. The labelling scheme will be confirmed by UoW and normally each duplex port shall be labelled within a two-digit port indicator and a two-digit alphanumeric panel indicator with the panel indicator coming first in the sequence (as detailed above).

Each fibre patch panel or breakout box shall be provided with a 'WARNING FIBRE OPTIC CABLE' label affixed in a visible location.

WALL AND FLOOR MOUNTED CABINETS / RACKS

Each wall or floor mounted cabinet / rack shall be labelled with an A6 engraved traffolyte adhesive label fixed to the front door, top right, detailing the comms room code ID. The format shall be black text upon a white background in a non-serif type font.

OPEN FRAMES

Each open frame shall be provided with a suitably engraved traffolyte adhesive label fixed to the top of the frame, detailing which floor the frame serves. The format shall be black text upon a white background in a non-serif type font.

1-38 DIAGRAMS AND DOCUMENTATION

Diagrams and documentation shall be provided in strict accordance with BS EN 50174 and BS 6701.

The drawings shall include: -

- 1) Network and wiring schematic drawings for all voice / data systems to be installed, generic manufacturer's schematics will not be accepted.
- 2) UoW will provide the Contractor / Voice & Data Specialist with the existing site drawings for updating.
- 3) Layout drawings detailing the locations of all voice and data equipment, telephone outlets and data outlets etc. (every telephone / data outlet shall be shown with its unique references).
- 4) Layouts drawings indicating all backbone fibre optic cabling routes including transition points and cable types.
- 5) Layout drawings for all cable support and containment systems.
- 6) Layout drawings detailing the locations of all fire barrier / stopping locations.
- 7) Layout drawings for all MER's and SER's.
- 8) Layout drawings / elevations for all server, equipment and communication racks.
- 9) Layout Schedules to accompany and offer reference detail to the layout drawings.
- 10) Full cross connected patching schedules.

Note: Where the works includes the provision of new (or modification of existing) campus backbone fibre optic cabling, the Contractor / Voice & Data Specialist will be provided with suitable drawings by UoW for annotation / updating. These drawings shall include network schematics and cable route drawings indicating cable types and transition points.

All drawing shall be provided in both paper and electronic format (.DWG).

The documentation shall include a technical manual including the following: -

- 1) Title page including:
 - a. The text 'Technical Manual for Telecommunications Cabling at the University of Warwick – INSERT PROJECT NAME HERE'.
 - b. Names, addresses, email addresses and telephone numbers for the Contractor / Voice & Data Specialist.
 - c. Date of handover in DD/MM/YYYY.
 - d. Photographic image of the building's front elevation.
- 2) Table of contents.
- 3) System description providing a brief overview of the project and its scope of works.
- 4) Certification for all voice and data cabling to confirm compliance with the latest requirements of The Construction Products Regulations.
- 5) Current independent 3rd party component compliance certification for all items supplied and installed, indicating manufacturer and component references.
- 6) Technical specifications for all voice and data equipment and cabling to be installed.

- 7) Diagrams and drawings as detailed above.
- 8) Test certification for all horizontal structured data cabling and backbone fibre optic cabling (including patch leads).
- 9) Completion / compliance certification for all fire barrier / stopping locations.
- 10) Methods statements for all works undertaken by the Contractor / Voice & Data Specialist.
- 11) Health & Safety policy including risk assessments for all the works undertaken by the Contractor / Voice & Data Specialist and any sub-contractors.
- 12) Quality assurance plan of the Contractor / Voice & Data Specialist.
- 13) Any maintenance procedures required to be undertaken on the works to maintain the warranty conditions.
- 14) Fault call out procedure providing a detailed statement defining fault reporting and warranty claim procedures.
- 15) Certification for a single manufacturer's 25-year warranty.

The technical manual shall be provided in paper and .pdf format. The drawings and documentation shall also be provided in CD format and included within the O&M manual.

1-39 INSPECTION, TESTING AND COMMISSIONING – VOICE & DATA SYSTEMS

The voice and data system(s) shall be inspected, tested and commissioned in strict accordance with BS EN 50173, BS EN 50174, BS EN 61935, BS EN 50346, IEC 61280, BS ISO/IEC 11801, ANSI/TIA/EIA-568-B, manufacturer's recommendations and the standards detailed earlier within this specification as appropriate.

Where the above standards and those detailed earlier within this specification refer to supporting standards and documents these shall be fully complied with in all respects.

It is a requirement and preference of Information & Digital Group, UOW that all testing and commissioning parameters are carried out to ISO/IEC standards where defined as compliant by the manufacturer in accordance with accompanying product datasheets & white papers.

DEFINITIONS

Channel – The channel is defined as the 90 meters of horizontal cable, the telecommunications connector and patch cord in the work area as well as two connectors and a maximum of two patch / equipment cords in the telecommunications room. The maximum allowable length of patch cords and equipment cords is 10 meters. Also included in the channel is an optional transition or consolidation point.

Permanent Link – The permanent link is defined as a maximum of 90 meters of horizontal cable, an optional transition or consolidation point and one connection on each end. The Permanent Link does not include the instrument cords or connectors on the field test equipment.

Link Segment – An optical fibre link includes the connectors, splices (if required) and the passive cabling between two optical fibre connection hardware termination points. There are three backbone segments:

- 1) MC (Main Cross-connect) or CD (Campus Distributor) to IC (Intermediate Cross-connect) or BD (Building Distributor).
- 2) MC (Main Cross-connect) or CD (Campus Distributor) to HC (Horizontal Cross-connect) or FD (Floor Distributor).
- 3) IC (Intermediate Cross-connect) or BD (Building Distributor) to HC (Horizontal Cross-connect) or FD (Floor Distributor).

Every installed channel, permanent link and link segment shall be tested against the performance criteria detailed in the above standards.

1-39-1 TEST EQUIPMENT

Test instruments shall be selected in strict accordance with the standards detailed earlier within this specification. Test instruments shall also be selected to meet the required instrument accuracy and performance criteria for the channels, permanent links and link segments to be tested.

As a minimum the accuracy of test instruments shall be confirmed by formal calibration / re-calibration at intervals recommended by the manufacturer and shall be supported by calibration certificates provided by laboratories accredited by the United Kingdom Accreditation Service (UKAS).

More frequent re-calibrations may be required if test instruments are exposed to changes in temperature / humidity and if they are roughly handled and regularly transported / stored in vehicles. It shall be the Contractors / Voice & Data Specialists responsibility to ensure that the test instruments meet the required accuracy and performance criteria prior to testing.

The model and serial number for each test instrument shall be recorded on the certification, reports and schedules. A copy of the calibration certificate for each test instrument shall be provided as part of the Operation and Maintenance Manual.

BALANCED CABLING – HORIZONTAL STRUCTURED DATA CABLING

As a minimum the test instruments shall comply with or exceed the instrument accuracy requirements as required and shall be selected in strict accordance with the standards e.g. Fluke DSX Cable Analyzer series or similar, as appropriate for the testing being undertaken.

Test instruments shall be classified as detailed below dependent upon the class of cabling and the required performance level: -

PERFORMANCE LEVEL	HORIZONTAL DATA CABLING TYPE	CLASS
Level III test equipment or better	Category 6	E
Level III E test equipment or better	Category 6A	E _A

OPTICAL FIBRE CABLING – BACKBONE FIBRE OPTIC CABLING

The test instruments shall comprise of an optical source / optical power meter and shall be selected in strict accordance with the standards and as required for the multimode and single mode fibre optic cabling to be tested e.g. Fluke Opti Fiber / CertiFiber / MultiFiber or similar

1-39-2 BALANCED CABLING – HORIZONTAL STRUCTURED DATA CABLING

VISUAL INSPECTION

Visual inspection of installed cabling shall be performed by observing that: -

- 1) the condition, workmanship and finish are satisfactory,
- 2) the marking is legible,
- 3) mechanical damage is absent and there is not undesired movement or displacement of parts,
- 4) flaking of materials or finishes is absent.

Examination shall generally be undertaken without any magnification.

TESTING TRANSMISSION PROCEDURES

Every installed channel and permanent link shall be tested against the performance criteria detailed in the above standards and shall be provided with a 'PASS' or 'FAIL' condition for each test transmission parameter as determined by the test instrument.

As a minimum the following parameters shall be tested for every installed channel and permanent link (unless stated otherwise):

- 1) Wire-map.
- 2) Continuity.
- 3) Propagation delay.
- 4) Delay skew.
- 5) Length.
- 6) Insertion loss.
- 7) Near-end crosstalk (NEXT) loss.
- 8) NEXT, power sum (PS NEXT).
- 9) Attenuation-to-crosstalk ratio, near end (ACR-N).
- 10) ACR-N, power sum (PS ACR-N)
- 11) Equal level far ends crosstalk (ELFEXT) or attenuation-to-crosstalk ratio, far end (ACR-F).
- 12) ELFEXT, power sum (PS ELFEXT) or attenuation-to-crosstalk ratio, far end, power sum (PS ACR-F).
- 13) Return loss.

The following shall be calculated: -

- 1) Direct current d.c. loop resistance.

Sample testing shall be provided for the following where the performance criteria is not met by the design. The sample size to be tested shall be in strict accordance with BS EN 50174 / IEC 61935: -

- 1) Power sum alien NEXT (PS ANEXT).
- 2) Power sum attenuation-to-alien crosstalk ratio, far end (PS AACR-F).

Test results of individual parameters shall be marked with an asterisk if the difference between the measured result and the test limit is less than the specified measurement accuracy.

Tests that provide a PASS condition are acceptable and tests that provide a FAIL condition are not acceptable. Tests that provide a PASS* or FAIL* condition are not acceptable and shall be treated in the same way as a FAIL condition.

Any channel / permanent link that provides a PASS*, FAIL* or FAIL condition shall be diagnosed, rectified and re-tested to confirm compliance with the required performance criteria and provide a PASS condition, with the Contractor / Voice & Data Specialist bearing all costs associated with this work.

An overview of the testing transmission parameters is provided below, it shall be noted the information presented is in no way intended to replace the detailed information provided within the standards, which must be fully adhered to: -

WIRE-MAP & CONTINUITY

A conductor map test shall be undertaken to verify correct pin termination at each end and to check for installation connectivity errors. For each of the conductors in the cable (and the screen(s) if any), the conductor map shall indicate: -

- 1) continuity to the remote end,
- 2) shorts between any two or more conductors/screen(s),
- 3) transposed pairs.
- 4) reversed pairs,
- 5) split pairs,
- 6) any other connection errors.

Wire map tests shall report PASS if the cabling is determined to be correct.

PROPAGATION DELAY AND DELAY SKEW

Propagation delay and delay skew shall be determined from phase angle measurements which are frequency dependent. For testing purposes, the propagation delay at 10 MHz shall be reported. The test instrument shall be able to measure the propagation delay on each pair.

The test limits for the channel and link configuration shall be as specified in the standards. It shall be noted with 2 m long test cords at each end, this additional propagation delay is 22 ns at 10 MHz

Propagation Delay

Propagation delay is the time required for the signal to travel from one end of the link to the other. This measurement is to be performed for each of the four wire pairs.

Minimum test results documentation (summary results):

Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

Delay Skew

Delay skew indicates the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero.

Minimum test results documentation (summary results):

Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

LENGTH

The test instrument shall be able to measure the length of all pairs of a permanent link or channel based on the propagation delay measurement and the average value for nominal velocity of propagation (NVP).

This length figure shall be reported and shall be used for making the PASS / FAIL decision. The PASS / FAIL criteria shall be based upon the standards with the maximum length allowed for the permanent link configuration (90 meters) or the channel (100 meters) respectively.

INSERTION LOSS

Insertion Loss is a measure of signal loss in the permanent link or channel and shall be derived from swept / stepped frequency voltage measurements. Insertion Loss shall be tested on each wire pair. A balanced input signal shall be applied to a pair at the near end of the link while a differential signal on the same pair is measured at the far end.

Insertion Loss maximum step size / test limits for the channel and link configuration shall be as specified in the standards. Insertion loss increases with temperature and therefore the measurements shall be conducted at the same temperature throughout the test so that the effect of the change in temperature is negligible.

Minimum test results documentation (summary results):

Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst-case value occurs, and the test limit value at this frequency.

NEXT AND POWER SUM NEXT

Pair-to-pair NEXT

Pair-to-pair near-end crosstalk loss (NEXT Loss) measures crosstalk disturbance and shall be derived from swept/stepped frequency voltage measurements. NEXT loss shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). A balanced input signal shall be applied to a disturbing pair at the near end of the link while the induced differential signal on the disturbed pair is measured at the near-end.

NEXT Loss maximum step size / test limits for the channel and link configuration shall be as specified in the standards.

Minimum test results documentation (summary results):

Identify the wire pair combination that exhibits the worst case NEXT margin and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

Power Sum NEXT

Power Sum NEXT loss (PSNEXT Loss) shall be evaluated and reported for each wire pair from both ends of the link-under-test (a total of 8 results). PSNEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals.

Power Sum NEXT Loss maximum step size / test limits for the channel and link configuration shall be as specified in the standards.

Minimum test results documentation (summary results):

Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

ACR-N AND POWER SUM ACR-N

ACR-N

The ACR-N of each pair combination of a channel shall meet the difference of the near-end crosstalk loss (NEXT) requirement and the Insertion Loss requirement. ACR is a computed parameter that is analogous to ELFEXT and expresses the signal to noise ratio for a two-wire-pair system. The ACR-N requirements shall be met at both ends of the cabling. This calculation yields 12 combinations – six from each end of the link.

Minimum test results documentation (summary results):

Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

Power Sum ACR-N

The Power Sum version of ACR (PSACR-N) is based on PSNEXT and considers the combined near-end crosstalk loss (NEXT) disturbance of all adjacent wire pairs on each individual pair. The PSACR-N requirements shall be met at both ends of the cabling. This calculation yields 8 combinations – one for each wire pair from both ends of the link.

Minimum test results documentation (summary results):

Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PSACR-N. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

ELFEXT, POWER SUM ELFEXT, ACR-F, POWER SUM ACR-F

ACR-F and Power Sum ACR-F test limits shall be as specified in the standards. ELFEXT and Power Sum ELFEXT limits are assumed to be identical to those for ACR-F and Power Sum ACR-F respectively.

ELFEXT and ACR-F shall be computed from far-end cross-talk (FEXT) and Insertion Loss measurements.

FEXT

FEXT Loss measures the unwanted signal coupling (crosstalk disturbance) on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair and shall be derived from swept/stepped frequency voltage measurements. FEXT Loss shall be measured for each wire-pair combination from both ends of the link-under-test.

A balanced input signal shall be applied to a disturbing pair at the near end of the link while the induced differential signal on the disturbed pair is measured at the far-end. FEXT Loss maximum step size / test limits for the channel and link configuration shall be as specified in the standards.

ELFEXT

ELFEXT measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire-pair combinations. ELFEXT maximum step size / test limits for the channel and link configuration shall be as specified in the standards.

Minimum test results documentation (summary results):

Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

PSELFEXT Loss

Power Sum ELFEXT is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields 8 wire-pair combinations. Power Sum ELFEXT maximum step size / test limits for the channel and link configuration shall be as specified in the standards.

Minimum test results documentation (summary results):

Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

RETURN LOSS

Return Loss (RL) is the measure of the reflected energy caused by impedance mismatches in the cabling systems. RL is especially important for application that use simultaneous bi-directional transmission.

RL maximum step size / test limits for the channel and link configuration shall be as specified in the standards.

Minimum test results documentation (summary results):

Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

1-39-3 OPTICAL FIBRE CABLING – BACKBONE FIBRE OPTIC CABLING

TESTING TRANSMISSION PROCEDURES

Every installed link segment shall be tested against the performance criteria detailed in the above standards and shall be provided with a 'PASS' or 'FAIL' condition for each test transmission parameter (where required) as determined by the test instrument.

As a minimum the following parameters shall be tested for every installed link segment (unless stated otherwise): -

- 1) Link attenuation.
- 2) Length
- 3) Continuity.
- 4) Propagation delay.

Sample testing shall be provided for the following provided that polarity has been confirmed: -

- 1) Delay skew.

Tests that provide a PASS condition are acceptable and tests that provide a FAIL condition are not acceptable.

Any link segment that provides a FAIL condition shall be diagnosed, rectified and re-tested to confirm compliance with the required performance criteria and provide a PASS condition, with the Contractor / Voice & Data Specialist bearing all costs associated with this work.

An overview of the testing transmission parameters is provided below, it shall be noted the information presented is in no way intended to replace the detailed information provided within the standards, which must be fully adhered to: -

LINK ATTENUATION

EN 50173 prescribes the single performance parameter for field-testing of fibre optic links as link attenuation (alternative and equivalent term: insertion loss), when installing components compliant with this standard.

The link attenuation shall be calculated in accordance to the specifications within EN 50173. These specifications are representative of the following formulas: -

- 1) Link Attenuation = Cable_Attn + Connector_Attn + Splice_Attn
- 2) Cable_Attn (dB) = Attenuation Coefficient (dB/km) * Length (km)

The values for the Attenuation Coefficient are detailed in the following table:-

TYPE OF OPTICAL FIBRE	WAVELENGTH (nm)	ATTENUATION COEFFICIENT (dB/km)
Multimode 62.5 / 125 µm	850	3.5
	1300	1.5
Multimode 50 / 125 µm	850	3.0
	1300	1.0
Single mode	1310	0.4
	1550	0.4

- 3) Connector_Attn (dB) = number of connector pairs * connector loss (dB)
- 4) Maximum allowable connector loss = 0.5 dB
- 5) Splice_Attn (dB) = number of splices (S) * splice loss (dB)
- 6) Maximum allowable splice loss = 0.2 dB

Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is preferred.

The above link test limits attenuation is based on the use of the One Reference Jumper Method specified by Method 1 of IEC 61280-4-1 for multimode and Method 1 of IEC 61280-4-2 for single mode. The user shall follow the procedures established by these standards or test equipment manufacturer recommended modifications.

The horizontal link (multimode): acceptable link attenuation for a multimode horizontal optical fibre cabling system is based on the maximum 90 m distance. The horizontal link should be tested at both wave lengths and in both directions i.e. A-B & B-A in accordance with Method 1 of IEC 61280-4-1, One Reference Jumper.

The backbone link (multimode) shall be tested in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.

Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with Method 1 of IEC 61280-4-1 or test equipment manufacturer recommended modifications.

Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.

Single mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with IEC 61280-4-2, One Reference Jumper or test equipment manufacturer recommended modifications.

All single mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm (See Note below).

Links destined to be used with network applications that use laser light sources (under filled launch conditions) shall be tested with test equipment based on laser light sources categorized by a Coupled Power Ratio (CPR) of Category 2, Under filled, per IEC 60825-2.

This rule should be followed for cabling systems to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources. Field test equipment based on LED (light emitting diode) light sources is a Category 1 device per IEC 60825-2 and typically yields high attenuation results.

For Gigabit Ethernet compliant certification (IEE 802.3z application), use test equipment, which uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASE-SX) and an FP laser at 1310 nm (compliant with 1000BASE-LX).

Horizontal cables shall not exceed 90m and backbone cables shall not exceed 2000m, split between 500m for building backbone and 1500m for campus backbone links.

OTDR TESTING

Extended or Tier 2 fibre certification supplements Tier 1 testing with the addition of an optical time domain reflectometer (OTDR) from end to end, an OTDR trace is a graphical representation of the fibres attenuation along its length, this provides an overview of the whole installation including cable, connectors and splices) and the quality of the installation by highlighting the non-uniformities in the OTDR traces. All fibres shall be checked / verified by this method if required/when called upon.

1-39-4 DOCUMENTATION / CERTIFICATION

The test result information for each link shall be recorded in the memory of the field test equipment upon completion. The test result records saved by the test equipment shall be transferred into a Windows based database utility (e.g. Fluke Link Ware or similar) that allows for the maintenance, inspection and archiving of these test records.

The database for the completed job shall be stored and delivered on a capable storage device; this storage device shall include the software tools required to view, inspect, and print any selection of test reports.

A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information: -

- 1) Balanced cabling / Horizontal structured data cabling – The overall PASS / FAIL evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
- 2) Optical fibre cabling / Backbone fibre optic cabling – The overall PASS / FAIL evaluation including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
- 3) The date and time the test results were saved in the memory of the tester.

General Information to be provided in the electronic database with the test results information for each link:-

- 1) The identification of the customer site as specified by the end-user.
- 2) The identification of the link in accordance with the naming convention defined in the overall system documentation.
- 3) The overall PASS / FAIL evaluation of the link-under-test.
- 4) The name of the standard selected to execute the stored test results.
- 5) Balanced cabling / Horizontal structured data cabling – The cable type and the value of NVP used for length calculations.
- 6) Optical fibre cabling / Backbone fibre optic cabling – The cable type and the value of the 'index of refraction' used for length calculations.
- 7) The date and time the test results were saved in the memory of the tester.
- 8) The brand name, model and serial number of the tester.
- 9) The identification of the tester interface.
- 10) The revision of the tester software and the revision of the test standards database in the tester.

The test results information must contain information on each of the required test parameters that are listed above.

Balanced cabling / Horizontal structured data cabling – The detailed test results data to be provided in the electronic database for each tested link must contain the value measured at every frequency during the test. In this case, the PC-resident database program must be able to process the stored results to display and print a colour graph of the measured parameters.

Optical fibre cabling / Backbone fibre optic cabling – The detailed test results data to be provided in the electronic database for each tested optical fibre must contain the following information: -

- 1) The identification of the link/fibre in accordance with the naming convention defined in the overall system documentation.
- 2) The attenuation measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).
- 3) The link length shall be reported for each optical fibre for which the test limit was calculated based on the formulas above.

1-39-5 RECORD DRAWINGS

The Contractor shall provide record drawings that are:

- 1) Based upon the installation drawings.
- 2) An accurate record of the actual installation including any deviations from the working drawings that have occurred on site.
- 3) Include schematic drawings as appropriate for internal building distribution or external distribution between buildings.
 - 1) Fully co-ordinated as detailed elsewhere in this specification Indicative of the layout identity, size and position of all services installed.
 - 2) Provided in electronic format as PDF's and as DWG AutoCAD format

1-39-6 O&M MANUALS

The Contractor shall produce all information necessary for inclusion in the building Health and Safety file, referred to as Operating and Maintenance (O&M) manuals below.

Program for production of O&M manual.

- 3) One electronic copies of the manuals are required, to include record drawing in the standard University of Warwick electronic file format
- 4) Manuals and record drawings shall be compiled during the contract and an initial draft copy shall be available for the first commissioning of the engineering services. (Minimum 21 days before contract completion.)
- 5) Practical completion shall not be given until final copies (without unresolved comments from the Engineer) are provided.
- 6) Allow a minimum of seven days for the Engineer to comment.
- 7) Incorporate all comments, re-issue for comment if substantial change required.
- 8) Prior to Practical Completion supply final copies.

The O&M manuals shall be presented as a complete and coordinated package and shall include:

- 9) An Index.
- 10) A description of the works completed including incoming services, primary distribution routes, comms room locations, method of local cable distribution to workstations

- 11) Schedule of manufacturers' names, addresses and telephone numbers.
- 12) Detailed instructions on the starting up, running and shut-down of all systems
- 13) Information to facilitate the ordering of spares and replacements
- 14) A final copy of the report(s) prepared during testing and commissioning, including all test certificates.
- 15) Test results for all cable testing
- 16) Interconnections between items of equipment, including those provided by others and terminal numbering and cables core identification for all alarm and control circuits
- 17) The location and depth of buried services etc.
- 18) Detailed Schedules of installation and/or diagrammatic presentations to amplify the drawings where necessary for clarification.
- 19) CAD drawings (Latest AutoCAD version) and PDF copies of all Record and 'As Fitted' drawings
- 20) PDF copies of all manufacturers O&M manuals (in separate directory, named and cross referenced to match O&M manual descriptions).
- 21) PDF Copies of all certificates, commissioning results, test certificates etc.

1-39-7 FORMAL WITNESSING OF TESTING

UoW reserves the right to formally witness the testing of installed channels, permanent links and link segments. The person(s) undertaking the testing works shall give reasonable notice of all tests to permit them to be witnessed by UoW. The required period of notice shall normally be 10 days, but shall be variable at the discretion of UoW.

Preliminary testing shall be undertaken prior to any formal witnessing by UoW. The test results shall be provided to UoW in draft certificates before inviting UoW to attend formal witnessing along with a schedule of install identifying data outlet locations and formal ID's to reflect the test results. UoW will then witness the formal tests in full or selectively as deemed necessary to verify the draft test results.

The proportion of tests to be witnessed by UoW will 10%. UoW has the right to ask for a higher proportion of witnessing should the verification or witnessing exercise be unsuccessful e.g. a failure is found. In this instance the Contractor / Voice & Data Specialist shall bear all costs associated with this additional work.

1-39-8 CONTINUITY OF CABLE SUPPORT AND CONTAINMENT SYSTEMS

All metallic cable support and containment systems shall be equipotential bonded for protective earthing and to avoid / reduce electromagnetic disturbances.

The electrical continuity of cable support and containment systems shall be tested as follows: -

- 1) Cable ladder rack, cable tray and cable basket shall be tested in accordance with the relevant clauses of BS EN 61537.
- 2) Cable trunking shall be tested in accordance with the relevant clauses of BS EN 50085.
- 3) Cable conduit shall be tested in accordance with the relevant clauses BS EN 61386.

It shall also be verified that all connections between cable conduit (e.g. conduit take-off plates, conduit boxes) and cable tray / basket / tray have adequate electrical continuity.

The Contractor shall provide written clarification that the cable support and containment systems have electrical continuity characteristics as defined in the above standards

1-39-9 REFURBISHMENT PROJECTS

The voice / data specialist shall take the following into consideration with respect to refurbishment projects

- 1) The voice / data specialist shall allow to isolate and strip out all redundant voice / data cabling, from outlet back to source of supply.
- 2) Where existing data outlets are to be re-used / repositioned, the voice / data specialist shall:
 - Validate / test the existing data point before removal
 - Carefully remove the outlet plate and cabling and store / protect the cabling, so that the cable is not damaged / crushed / water damaged, should any cable be damaged it shall be replaced at the contractor's cost
 - On re-installation of the cabling / outlet point, the cabling shall be re-tested in accordance with the standards set out in this document

APPENDIX I – VOICE AND DATA SYSTEMS – ELECTRICAL EQUIPMENT AND SPECIALISTS SCHEDULE

ELECTRICAL EQUIPMENT	SPECIALIST / MANUFACTURER / PRODUCT RANGE/ MATERIAL
Voice / Data Specialist	Subject to Agreement with University of Warwick Enterprise IT infrastructure Information and Digital Group
General equipment and cabling	Leviton WWW.leviton.com R&M Cabling Solutions Salesuk@rdm.com Excel Sales@mayflex.com.uk
Power distribution units (PDU's)	Typical equipment rack – 16-32A Units. Excel Ltd – single phase vertical intelligent PDU complete with minimum 12 x total socket outlets typically as cat no 555-1V-COM16-INTX-8UKL-4C13. Pre-tender design to specify range requirement for technical submission.
Server rack(s)	Minkels Ltd
Equipment rack(s)	CPI Frames https://catalog.chatsworth.com/rack-systems/two-post-racks
Communications (Comms) rack(s)	CPI Frames https://catalog.chatsworth.com/rack-systems/two-post-racks these are the default type and manufacturer, there is an option, which need to be agreed pre-tender submission to utilize alternate cabinets as Excel Ltd 542-4288 range.
Backbone fibre optic patch panels	System specific – consult design team
Backbone fibre optic cabling, including patch leads and pigtails	Refer to specification clauses / manufacturers to be Leviton / R&M /Excel cabling solutions - consult design team
Horizontal structured data cabling patch panels	System specific – consult design team
Horizontal structured data cabling, including patch leads	Brand-Rex/Leviton WWW.leviton.com R&M Cabling Solutions Salesuk@rdm.com Excel Sales@mayflex.com.uk
Dado trunking –	Marshall Tufflex MK Schneider Electric
Cable Transitions	System specific – consult design team
Fire stopping / Proprietary cable transit systems	CABLOFIL EZ Path: https://www.cabcononline.co.uk/product/cable-management/management/legrand-ez-path-fire-resistance-devices?product[supplier][]=13 Hilti Cable Transit
<p>IMPORTANT: Sub-Contractor Quality.</p> <p>The University is keen to ensure that the quality of its infrastructure meets a consistently high standard. The following details are for the University's IDG preferred supplier. This contractor has been vetted and meets the quality standards for installation required by the University of Warwick Enterprise IT Infrastructure Information & Digital Group and we would be happy if your bid includes them as a sub-contractor for these works.</p>	<p align="center">Appointed named supplier detail to insert here once awarded.</p>

APPENDIX II – VOICE AND DATA SYSTEMS – RESPONSIBILITY MATRIX

(see accompanying document)

APPENDIX IV– VOICE AND DATA SYSTEMS – UNDERGROUND DUCT SEALING

FiloSeal+ Duct Seal



Duct sealing system FiloSeal+ is a universal solution for sealing cables and pipes in ducts or bore holes.

FiloSeal+ is suitable for sealing several cables or pipes contained in one duct and also allows re-entry of the seal to add or remove cables or pipes as required.

Telstra Approved Duct sealing kit in accordance with Telstra document ID TM00042A01

Features

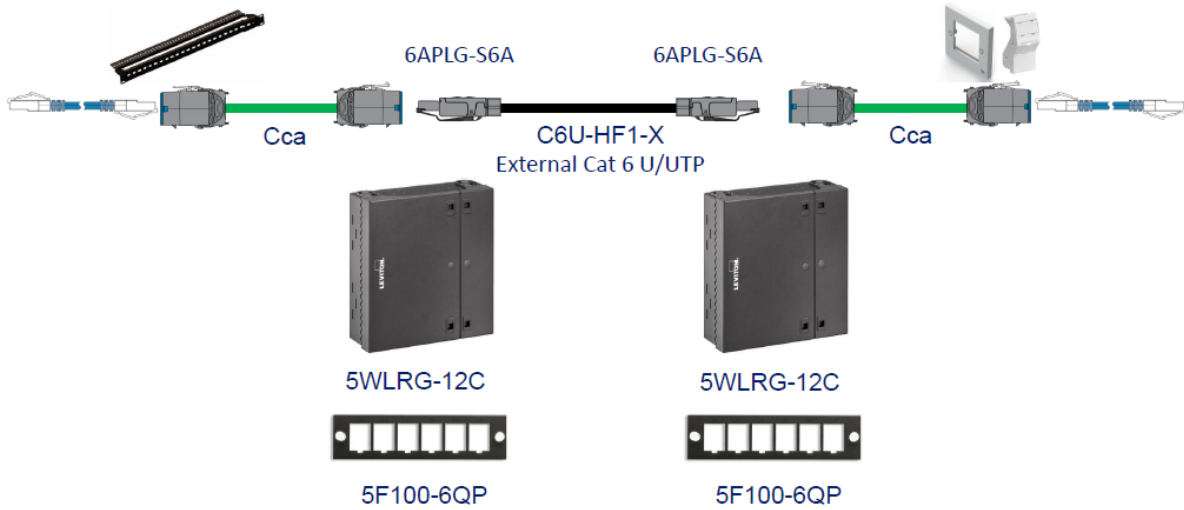
- Flexible, one component, adhesive and sealing compound in a cartridge - (310ml)
- High levels of Gas and Water tightness
- Excellent adhesion
- Shows Fire resistance properties
- Resistant against Water, Alkaline, Chemical agents
- Resistant to, Petrol, Diesel, Ethanol, ASTM oil, LPG & Many more.
- Suitable for sealing underground cable ducts set out within the APEA 'Blue Book'
- Resistant to Hydrogen Sulphide / Methane and many other Gases (NedLab)
- Non-corrosive
- Solvent-free
- Shock absorbing
- Non-toxic, neutral and almost odourless
- Also suitable for limiting the EX-zones during transitions (observe chemical resistance)
- Complies with 2011 NEC Articles 225.27, 230.8, 300.5(G), 300.7 (A) on Raceway Seals, and 501.15 (B)(2)
- WIMES Compliant, (3.02 clause 7.4.3.2, d & e)
- Suitable for any shaped duct /borehole/opening
- Quick and easy installation
- A complete kit for one duct
- Seals all know materials, PVC & PE sheathed cables, PILC, (HD) PE pipes
- Suitable for renovations, can be installed retrospectively
- Over 25 years of operational experience
- Thames Water Approved
- Welsh Water Approved
- Severn Trent Water Approved
- Southern Water Approved
- Anglian Water Approved
- South East Water Approved
- Yorkshire Water Approved
- Bournemouth Water Approved
- Scottish Water Approved
-



View this product at: <https://www.filoform.co.uk/afdichtingen/re-enterable-duct-seals/filoform-re-enterable-duct-sealing-system>

APPENDIX V- VOICE AND DATA SYSTEMS – TRANSITION POINT FOR THE CONVERSION OF EXTERNAL TO INTERNAL GRADE CABLING

Channel



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