

Imperial College London

**Information & Communications Technology
Network Infrastructure Group**

Network Infrastructure Standards
January 2018

Appendix F – Horizontal cabling

Version 1.5

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1.0 Introduction

This Section details the required standards for Unshielded Twisted Pair (UTP) cabling. To ensure consistency across the College, a single cabling system is preferred. After extensive testing and evaluation, the Brand-Rex GigaPlus Category 5e system has been chosen. The primary justifications for this policy can be summarised as follows:

- The extensive installed base of Brand-Rex product throughout Colleges buildings on the South Kensington Campus;
- Historically, the willingness of Brand-Rex to provide an Enhanced UTP Category 5 warranty, in advance of the ratification of Enhanced UTP Category 5 international cabling standards;
- The quality and performance of Brand-Rex's Cat5Plus and Gigaplus systems;
- The ability to interchange patch cables between building systems;
- Brand-Rex's 25 Year Applications & Performance Warranty, where applied for and awarded, which protects College's investment by guaranteeing to address and resolve any product, application or performance issues;

As of 2016 all new buildings will be done with CAT6A and any existing location where it can be installed (please contact Imperial ICT for clarification).

The CAT6a solution will be F/FTP and with the lowest CPR (Construction Products Regulation) certification of CCA.

Use of this system manufacturer is mandatory for all structured cabling.

The remainder of this section spells out the performance standards of these and similar systems for information. It should not be interpreted as permitting the proposal of alternative systems.

2.0 Cabling Transmission Standards

As a minimum, the structured cabling solution supports the following transmission requirements:

- IEEE 802.3 Ethernet (10BaseT), Fast Ethernet (100BaseTX) and Gigabit Ethernet (1000BaseT and 10Gbase-T)
- EIA RS 232-D (asynchronous)
- 100 Mbit/s services - i.e. TPDDI/CDDI/TP-PMD
- ATM standards (including 25Mbit/s, 155Mbit/s and 622Mbit/s)
- Analogue and Digital Voice Telephony

3.0 Cable Type

For all locations where the use of the CAT6a installation is not possible or wanted by Imperial College ICT, the cabling system shall be based on a four pair Unshielded Twisted Pair cable that meets or exceeds the transmission performance requirements for an Enhanced Category 5 cable as defined by:

- The Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568-1991 (EIA/TIA-568)
- Technical Systems Bulletin 36 (TSB-36)
- TIA/EIA 568A Addendum 5

All materials shall be new and of types approved by ICT (see information in “Appendix E – Ordering”), BABT and the BSI for their intended use. Particular attention is drawn to the selection of the appropriate cables for each type of installation environment.

The cable sheath must be LSOH and of purple colour.

For all other installations CAT 6a F/FTP should be used and it will be meeting CCA certification for fire safety.

The colour of the cable will comply to manufacturer’s and industry standards (currently light blue).

All installation works must be undertaken in line with applicable standards and manufacturer’s installation instructions:

- British Standards BS6701 Parts 1 and 2
- BS EN 50174
- 17th Edition IEE Regulations

Particular attention should be paid to cable segregation, cable fixing spacing and defined cable routes in under floor routes.

The above standards should be the minimum acceptable standards.

4.0 Installation Requirements

All cables shall be installed in accordance with relevant standards and the manufacturer’s instructions and recommendations. Particular care should be taken to ensure the minimum bend radius is not exceeded thereby preventing kinks in the cable construction.

All 4 pair cables shall be loomed into maximum looms of 24 cables. Looms shall be **velcro** wrapped to cable basket in accordance with manufacturer’s installation instructions. Cable looms should be maintained to the equipment cabinet within the CWC. Care should be taken not to crush cables by over tight fixings.

All rooms will be fed from a single comms room, there will be absolutely no mixing of cabling from two or more comms rooms, into the areas in need of connection.

Any installation requiring replacement of old cabling will imply its removal as an integral part of the work.

Any de-commission of cable or user outlet termination requires the removal of the cable back to the CWC presentation panel as a part of the work.

Any work within ceilings or under floor must be made good prior to completion.

5.0 Cable Lengths

All cables shall not exceed 90 metres in length. CWC's should be strategically located to allow for this requirement (as per item 2.1 Introduction to CWC, "Appendix C - CWC" and "Appendix F – CAT5 specifications and testing").

6.0 Cable Routes

All cables with their origin and destination within the same building shall be run internally.

All cable routes should be agreed with ICT before commencement of their installation.

All routes will follow public spaces for easy access after project completion and hand-over. Any area that has been cleared by ICT to be left without direct access should have draw wires installed.

All vertical cables shall be secured to installed tray at the intervals recommended by the manufacturer. Contractors should confirm their intended method of securing the cables.

No cables will be left un-supported.

Any installation of cabling in raised floors shall be done in no less than in a space of 300mm of height and within the appropriate containment. Any changes to this specification should be explained to and accepted by ICT.

All containment will have labels saying "ICT DATA CABLES" every 5 metres and every concealment point.

No other cables are permitted in the containment.

Within a CWC the cables will be installed in such a way that they will allow cabinets to be moved if required.

6.1 Containment

Steel wire cable Tray (a "basket" system) will be used.

SCOPE

Cablofil Steel Wire Cable Tray conforming to the material and performance of this specification.

GENERAL

Cable basket shall be manufactured from steel wires, welded together and bent into final shape prior to surface treatment.

Surface Treatments:

- i). Electro zinc plated to EN 12329
- ii). Hot Dipped Galvanised to EN ISO 1461
- iii). Stainless Steel to EN 10088-2 - AISI 316L and EN10088-2 AISI 304L

Steel Wire Cable Tray Widths & Depths

- i). Cable Tray dimensions are all internal.
- ii). Depths of 30mm, 54mm, 80mm, 105mm & 150mm.
- iii). Widths of 50mm, 100mm, 150mm, 200mm, 300mm, 400mm 450mm, 500mm & 600mm for depths of 30mm & 54mm.
- iv). Widths of 100mm, 150mm, 200mm, 300mm 400mm & 500mm for Depths of 105mm & 150mm
- v) All trays are of 3000mm Nominal long

SPECIFICATION

Trays will be manufactured with a longitudinal 'T-welded' safety edge along the top wire of the sidewall (excluding 30x50)

Trays will be constructed with a 50mm x 100mm mesh configuration.

All tray fittings (e.g. changes in direction, level and size) shall be constructed on site, to the manufacturer's instructions, using side action bolt croppers and fastened using 25mm and 30mm counter clamps with M6 bolts and nuts, all surface treated as the tray.

Trays will be coupled together using the recommended fixing methods as stated in the catalogue

Trays shall be supported at a maximum span of 2.5m by trapeze, wall, floor or channel mounting methods and will not exceed maximum loads as specified by the manufacturer.

All welds will be manufactured to an average minimum tensile strength of 500Kg per weld.

TESTS, CERTIFICATION AND CONFORMITY

Loading and deflection characteristics of the tray should be tested and the results published in accordance with the European Standard CEI 61537.

Suitability for the support of Cat6a data cabling should be demonstrated by way of independent test verification.

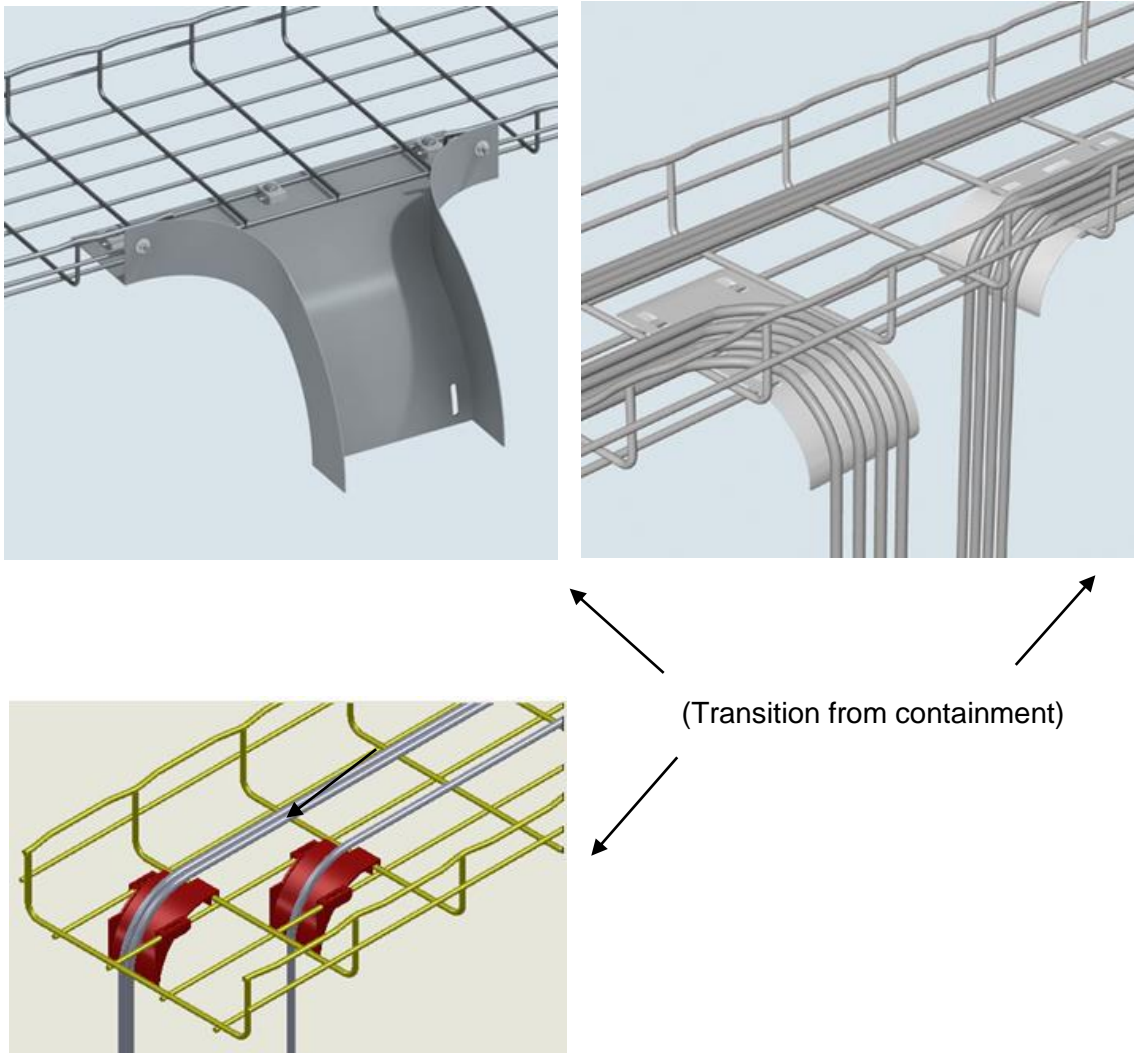
Fire test certification published in accordance with the DIN4102-12 standard to achieve E30 to E90 for temperatures up to 1000oc

Electrical continuity across a coupling should be demonstrated by means of a published test method and result as specified in IEC61537

<https://www.legrand.co.uk/products/cable-management/cablofil/>

http://www.cablofil.co.uk/sites/default/files/Cablofil_low_res_0.pdf

Cables will be protected in their transition out of the containment. This will happen both being placed into flexi-duct, as per images just below, or into the cabinets, in the image just after.

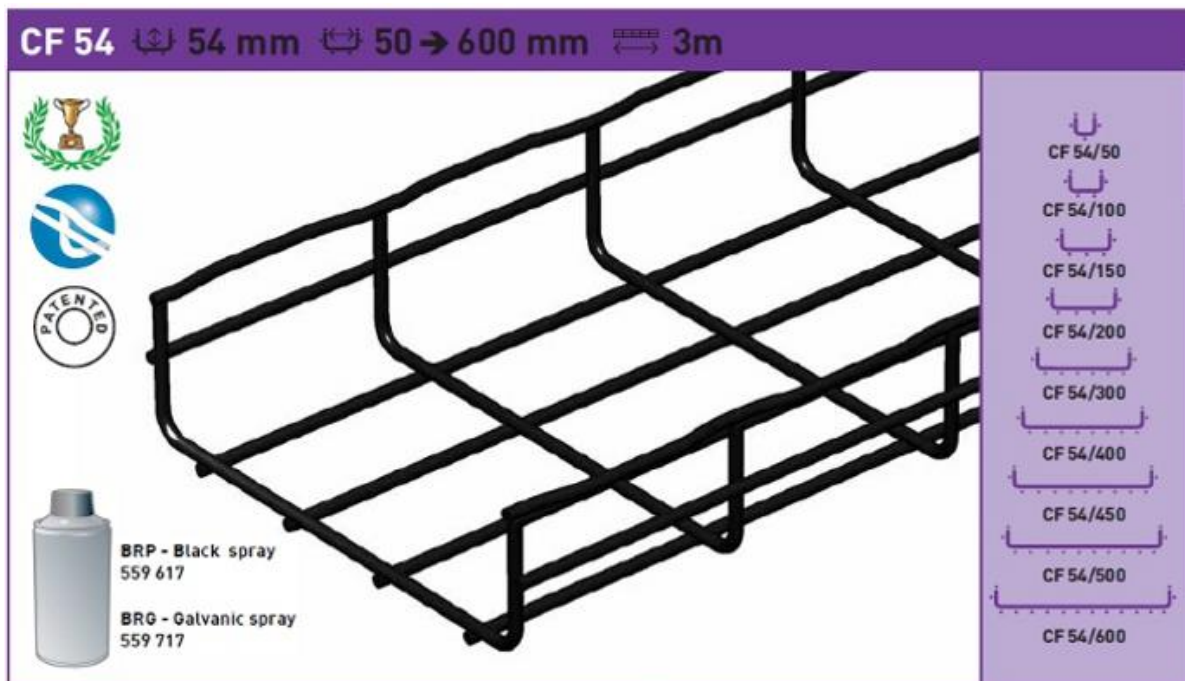


(to flexi ducts, etc...both from the bottom and sides) ↙ ↘



In areas, for aesthetic/architectural reasons, if there is need for black containment the Cablofil 54 EZ+ cable basket can be used. This is also used in harsh environments

<http://www.cablofil.biz/product/standard-cable-trays/cf-54-ez>



Please see “Appendix E – Ordering” for more information.

7.0 Mechanical Protection

Holes drilled through walls or floors for the routing of cables shall be suitably sleeved to prevent damage to installed cables. Where cables pass through floors such protection shall be extended to at least skirting height.

Waterfall systems and others are to be used on exit of the basket into cabinets and appropriate supports used for any flexible ducting used to link any main cable runs to rooms.

8.0 Electrical Protection

Notwithstanding the compliance to BS6701 and the issues of cable segregation, additional care should be taken to ensure cables are not routed adjacent to other services where electromagnetic emissions may be generated. Cables should have at least 300mm air gap/separation to any main electrical distribution.

9.0 Cable Joints

All 4 pair cables should be continuous between the Patch Panel in the CWC and the user outlet at the User Connection Point. All cables should be installed within the containment provided or specified.

10.0 Electromagnetic Compatibility

All cabling components should have been successfully tested for EMC compliance as specified in the European EC Directive 89/336/EEC as amended by Directive 92/31/EEC.

11.0 Installation within Equipment Cabinets

All cables should be neatly installed and secured collectively to the Equipment Cabinet or Frame side from the point of entry to the point of distribution across the rear of the patch panel.

All cables installed from the bottom will run to the top of the cabinet and then to the patch panel, providing a service loop to increase flexibility in cabinet relocation or movement (emergency or unforeseen events).

All the cables installed from the top of the cabinet will run to the bottom of the cabinet and then to the patch panel for the same reasons as mentioned above.

All panels will be grounded for electrical safety.

12.0 Patch Panel Specification

All patch panels should meet or exceed the enhanced Category 5 transmission performance requirements for Twisted-Pair Connecting Hardware defined by the

standard or the BS EN 50173 Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568A where this standard exceeds BS EN 50173.

Patch panels, outlets, main link and patch cables should be selected from a single manufacturers system.

13.0 Patch Panel Terminations

All four pairs of the UTP cables shall be terminated onto the rear of the patch panel via Insulation Displacement Connection (IDC) techniques.

The horizontal cables shall be terminated as per the EIA/TIA 568B wiring scheme so that the presentation of the cable pairs on the RJ45 socket are as follows:

Pair	Pin Outs
Pair 1	Pin 5 and Pin 4
Pair 2	Pin 1 and Pin 2
Pair 3	Pin 3 and Pin 6
Pair 4	Pin 7 and Pin 8

To ensure the transmission performance requirements of an enhanced Category 5 system are maintained, the amount of untwisting in a cable pair to achieve a termination onto the rear of the patch panel should be no greater than 13mm. In addition, the stripping back of the outer sheath shall also be limited to the minimum amount required to achieve a successful termination.

14.0 Patch Panel Capacities

1u 24 way patch panels should be used throughout the installation.

15.0 Patch Panel Cable Management

Patch panel cable management will be provided as per "Appendix C - Cabinets".

16.0 User Outlet Specification

All user outlet panels should meet or exceed the enhanced Category 5 transmission performance requirements for Twisted-Pair Connecting Hardware defined by the standard or the BS EN 50173 Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568A where this standard exceeds BS EN 50173.

Patch panels, outlets, main link and patch cables should be selected from a single manufacturer's system.

The examples provided in Annex B indicate in the formulas for initial budgeting. Imperial College currently specify 4 sockets per square meter of the GIA of the building or refurbished area.

Though GIA includes fallow space we must consider that Security (cameras and others), BMS equipment and wifi will be installed and will be included into the calculations. From experience, we have seen that this is the right approach to the calculations and budgeting and initial design expectation.

- Imperial College staff will have 4 data outlets installed per desk.
- Each WAP (Wireless Access Point) will have two data outlets installed per unit.
- In labs and other specialised areas it will be considered on an individual basis.

Please contact ICT to confirm requirements. ***The final numbers will be defined by ICT*** based on end user requirements and known usage from the group(s) in other areas.

17.0 Faceplate

The user outlet faceplate should meet the following requirements:

- All outlets shall be provided with spring loaded shutters that automatically close when patch leads are removed;
- All IDC connector blocks shall be permanently fixed to the faceplate;
- All unused faceplate apertures shall be provided with blanking plates;

18.0 User Outlet Terminations

All four pairs of the UTP cable shall be terminated onto the rear of the faceplate via Insulation Displacement Connection (IDC) techniques.

The cables shall be terminated as per the EIA/TIA 568B wiring scheme so that the presentation of the pairs on the RJ45 socket is as follows:

Pair	Pin Outs
Pair 1	Pin 5 and Pin 4
Pair 2	Pin 1 and Pin 2
Pair 3	Pin 3 and Pin 6
Pair 4	Pin 7 and Pin 8

To ensure the transmission performance requirements of an enhanced Category 5 system are maintained, the amount of untwisting in a cable pair to achieve a termination onto the rear of the faceplate shall be no greater than 13mm. In addition, the stripping back of the outer sheath should also be limited to the minimum amount required to achieve a successful termination.

Sufficient slack should remain on the cable to allow the termination to be remade at least twice.

19.0 User Outlet & Patch Panel Labelling Scheme

All outlets should be labelled in accordance with ICT standards:

All bundles will have labelling on all concealment points (i.e. in risers and through holes). This labelling will be done in the following format:

ICT CAT5e/6a (as applicable)
<Installer company name> - <date>
<CWC ID>

All UTP outlets should be labelled in accordance with ICT standards:

AAA/BB/CC

Where:

AAA = The Cabling Wiring Centre Number
BB = The patch panel identifier where the first digit identifies cabinet ID and second the panel ID (i.e. AB would be cabinet A panel B)

CC = The outlet reference number (01, 02, 03....24)

Each individual 1U x 24 way Patch Panel should have its own Patch Panel identifier. Upon reaching 'Z', the next panel should be labelled 'AA' then 'AB' etc.

For example, the fourth outlet from Patch Panel 'A' within Wiring Centre 127 would be labelled 127/A/04 and the and the fourth outlet from Patch Panel 'C' would be labelled 127/C/04 etc.

All labelling is to be done with modified acrylic (trifoliate style) laser engraved labels to withstand the passing of time and duration of the CAT 5e/6a warranty (under normal conditions of office use).

All cables will be labelled at patch panel and outlet side for easier identification. This will be placed in the cable sheath and be done as so it won't fall off or smudge but do not require to be as per above requirement.

20.0 Patch Cables

All patching between active data equipment ports, voice services ports, peripheral services ports and terminated outlets should be accomplished using RJ45 patch cords.

The patch cords should be a part of the proposed cabling system and should be included within the cabling systems application and performance warranty.

These patch cords will be as defined in the ordering information (Appendix E - Ordering)

All patch cables should meet or exceed the Enhanced Category 5 transmission performance requirements for Twisted-Pair Connecting Hardware defined by BS EN 50173 or the Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568A where this standard exceeds BS EN 50173.

Different colour patch cables should be used to differentiate between service types:

Data – Blue

Voice – Green for PABX services and Blue for VoIP (as data)

Wireless – Blue (as data and labelled. The label will say “WAP <WAP ID>”

AV – Blue (as data and labelled. The label will say “AV <room name/nbr>”)

Special services (Security, fire and other) – Red

Where flood patching is requested (Lecture theatres and others) as well as DR (Disaster Recovery) the patch leads must be labelled at both ends of the lead (labels to be 2x number of patch leads).

Information needs to be provided to ICT’s network team and the labels will be provided.

For calculation of patching requirements please see “Appendix B – Examples”

21.0 Cable Testing

Following completion of the installation, there are two forms of testing that shall take place:

- *Installation testing* – to be undertaken by the Contractor.
- *Acceptance testing* – to be undertaken by the Contractor but shall be directed and witnessed by ICT. It should be noted that acceptance testing will involve retesting up to 10% of the entire installation.

22.0 Installation Testing

Installation testing should comprise a 100% exhaustive test of the installation by the installation Contractor. All ports should be tested. The testing will be carried out in accordance with the manufacturer’s recommended testing procedures, shall prove the link performance characteristics defined within EN50173 and shall be compliant with EIA/TIA Technical Services Bulletin 67 (TSB67).

23.0 FTP or UTP Testing

Subsequent to the installation and termination of the cables, all cables shall be tested. The test results shall be tabulated in a neat and legible form and signed by the installation Contractor’s representative as a true and accurate record of the installation. This should be a 100% test.

The tests for each cable run out should, as a minimum, comprise:

- End to end connectivity (continuity, pair reversals, short circuits)

- Correct pin out (all eight wires)
- Length
- Near end crosstalk
- Attenuation
- Enhanced Category 5 (pass/fail)
- Maximum data transmission speed
- Tests must be undertaken at frequencies up to and including 100MHz.
- Tester settings should also be recorded for each test so that results can be faithfully repeated.
- 100% of cables must be tested from both ends.

The results form should record:

- The unique identifiers of the cable pair and direction (Tx/Rx) and of the patch panels on both sides of the patching system;
- The name of the person conducting the test;
- The date of the test;
- The type and manufacture of all cable being tested;
- The results to be recorded on each form shall be;
- All setting of the test equipment, in order that the test may be exactly recreated if necessary;
- The end of the cable at which the source is located;
- The measured cable length;
- Attenuation (dB);
- A plot of the near end cross-talk (dB) across the frequency range 1 to 100 MHz, measured in steps of 500 KHz, which shall be attached to the results form;
- The measured DC resistance of the cable;
- A copy of the latest calibration certificate for the tester used;

Individual cable test results should not be provided in paper format. The results should be provided in electronic format. It is, however, mandatory that the results are formatted in a data-base type structure on the disc and that a means of searching for individual results is provided. A printed summary of results should be provided with the completion documentation.

24.0 Completion Documentation

The installation Contractor should, on completion of their works and prior to acceptance by ICT, submit two copies of all records and schematics for the installation.

Schematics will detail all cable runs and termination points. The installed cable capacity, cable identification reference, length and type of cable shall be identified.

Records will show clearly all cable terminations and cross connections together with cable capacity and installed length.

The following documentation is required:

- Cabling schematics
- As fitted drawings
- Test results
- Cabinet Layouts

- All relevant operating and maintenance manuals
- All documentation and drawings will be required in machine readable format, i.e. CD-ROM disk. Full details of CAD formats will be provided. All drawings shall be “as fitted” and shall take account of all changes and variations.

25.0 Drawings

All drawings should be provided in accordance with Imperial College’s AutoCAD strategy, in digital format.

Please refer to Support Services Engineering Team CAD Strategy (Estates Department).

26.0 Fire protection

Where cables, trunking, tray work, or conduit pass through floors or walls, suitable fire sealing shall be provided in accordance with IEE 17th Edition Wiring Regulations (BS7671:1992).

On all fire walls (to be checked with the fire strategy) EZ-Paths will be installed where physically possible.