TECHNICAL SPECIFICATION

STRUCTURED CABLING SYSTEMS FOR TELECOMMUNICATIONS

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DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
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They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for material specifications, installation practices, testing requirements and project deliverables for the design, supply, installation and commissioning of a structured cabling system for LAN and voice (PABX) systems. This DEP is not intended to cover every aspect of equipment and facility practices, although key areas are highlighted. Building security, electricity, and telemetry requirements are specifically excluded from the scope of this DEP.

This DEP is a revision of the DEP with the same number dated October 1995.

This DEP gives amendments and supplements to ISO/IEC 11801, EIA/TIA 568A and EIA/TIA 606 which are considered necessary. All requirements in this DEP are identified with their source, as follows:

- ISO/IEC 11801, EIA/TIA 568A and EIA/TIA 606 standards. Wording in this DEP indicated with a solid bullet is meant to clarify and/or choose from available alternatives. Consult the appropriate standards document for clarification.
- Shell internal recommendations. Sections in this DEP indicated with a hollow (white) bullet specify installation practices which are not covered within the Standards.

The companion Information and Computing document "Guidelines for Structured Cabling Systems", SIEP report number 98-5514, provides background information and explanatory notes; it is for the use of the Principal and not the Contractor.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group Company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F" as described in DEP 00.00.05.05-Gen.).

This DEP is intended primarily for office facilities as described in ISO/IEC 11801 and EIA/TIA 568A. The specifications herein shall be applicable to other facilities after making necessary minor modifications. Other uses include oil refineries, gas handling installations, chemical plants, oil and gas production facilities, and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than indicated in this DEP, the Contractor shall determine, by careful scrutiny, which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP that is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Cable outlet A fixed socket in a work area (office) where a horizontal cable terminates, typically serving a single user and a single piece of equipment (PC or telephone).

Cross-connect A facility for the interconnection and termination of cabling.

Faceplate The cosmetic flat assemby which covers the outlet box, usually located within the office or work area.

Faceplate blank A solid faceplate used to cover an outlet box when no cable outlet is installed.

Hub Active equipment which provides connectivity between a user's device and the LAN. The hub is situated in a central location on a floor connecting to the horizontal cables.

Multimode fibre Usually powered by light emitting diodes. 62.5/125 micrometre means "core" is 62.5 micrometres (where the light travels), and the cladding is 125 micrometres (refractive glass to enclose light within transparent core and support the brittle core). EIA/TIA standards recommend distances less than 2 km.

Outlet box A hollow receptacle, buried in a wall or floor. The outlet box receives conduits, encloses the cable outlet, and is covered by a faceplate.

Patch panel A cross-connect system of mateable connectors that facilitates easy administration.

Plenum A building space where environmental air moves but cables are allowed, for example a suspended ceiling.

Pull box An accessible box mounted in the path of a conduit which can be opened to access the cables within the conduit. The pull box is used to pull cables through length(s) of conduit.

Service core The part of the building carrying the services between floors and usually offering main structural support. The service core is usually in the centre of the floor and provides elevators, toilets, HVAC equipment, and electrical services.

Single mode fibre Finer specifications than multimode (usually 8.3/125 micrometre) and currently more expensive. Single mode constrains the light "path", and is powered by lasers. EIA/TIA standards recommend distances less than 10 km.

Sleeve A usually circular opening through a wall, floor or ceiling to allow the passage of cables and wires.

Slot A usually rectangular opening through a wall, floor or ceiling to allow the passage of cables and wires. Slots are not permitted (see 2.5).

Systimax Lucent trademark for their cabling system.

Work area An office or space within a building where the occupants use computer and communication equipment. In an office building, this would be the office or desk area.

Work area cable Extension cable running from the work area telecommunications outlet to the user equipment (telephone or PC).

1.4 ABBREVIATIONS

ACR Attenuation Cross-talk Ratio.

ATM Asynchronous Transfer Mode (Cell Relay). Telecommunications

	transmission technology, based on fixed length cells, scalable from less than 25 Mbps to 622 Mbps and above (see Appendix 1).
AWG	American Wire Gauge measurement standard.
BFOC/2.5	Fibre optic cable connector, also known as an ST connector.
EIA	Electronic Industry Association (see Appendix 1).
EMI	Electromagnetic interference
FDDI	Fibre Distributed Data Interface LAN running at 100 Mbps over multimode fibre optic cable.
FOIRL	Fibre Optic Inter Repeater Link standard for connecting devices such as hubs over fibre.
HVAC	Heating, ventilation and air conditioning.
IEEE	Institute of Electrical and Electronics Engineers (see Appendix 1).
ISDN	Integrated Services Digital Network standard for digital telephony service.
IT	Information Technology. Refers either to a department providing computing services to the Principal, or to the discipline relating to computer and information technologies.
LAN	Local Area Network, a data communications system, with moderate to high data rates. Recently, the LAN has become the fundamental backbone of the entire IT infrastructure.
LDC	Local Distribution Centre - secondary wiring closet on a large area floor, where a single closet does not permit 90 m cable lengths.
Mbps	Mega (million) bits per second transmission speed.
MDF	Main Distribution Frame - telephony term for the main building cross-connect panel, terminating external cabling, riser cabling, and PABX cabling in a common location.
NEXT	Near-end Cross Talk, a measure of how much signal cross-couples between receive and transmit pairs.
NIDP	Network Interface Demarcation Point. Telephony term for interface between private network and the public network.
NVP	Nomial Velocity of Propation.
PABX	Private Automatic Branch Exchange. Also called PBX (Private Branch Exchange) or CBX (Computerised Branch Exchange). This is a private telephone switch serving many telephone handsets and limited access trunks to the carrier, and often adding functions like voice mail, inter-PABX routing, speed dialling, etc.
PC	Personal Computer.
PVC	Polyvinylchloride, a material used for cable insulation. PVC is flammable and emits toxic fumes when in a fire.
RJ45	EIA/TIA and ISO standard 8-pin modular connector.
ST connector	Fibre optic cable connector, also known in EIA/TIA standards as BFOC/2.5.
TDR	Time Domain Reflectometer, device that measures cable length and the distance to faults.
TIA	Telecommunications Industry Association, closely affiliated with EIA for cabling standards.
TSB	Technical Systems Bulletin, update to the EIA/TIA standards providing additional specifications.

UTP	Unshielded Twisted Pair cable (usually 4 pairs) without metal shielding.
WAN	Wide Area Network
10BaseT	IEEE 802.3 and ISO/IEC 8802-3 (Ethernet) LAN standard for UTP cables.
10BaseFX	Set of IEEE 802.3 and ISO/IEC 8802-3 (Ethernet) LAN standards for fibre optic cables.
568SC	Fibre optic cable connector, also known as a FDDI connector.

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (5).

1.6 ORDER OF PRECEDENCE

The Contractor shall apply, in order of precedence, all local and national regulations, all modifications specified in the contract, this DEP, ISO/IEC 11801 and EIA/TIA 568A documents, and finally the product installation guidelines from the Manufacturer.

2. DESIGN

2.1 BASIS OF DESIGN

The design shall include the supply, installation, and testing of: cable, faceplates and supporting hardware, connectors to terminate all cables, conduit, cable trays and supporting hardware, electrical grounding, cross-connects, patch panels, equipment racks, and labelling material, from the building access demarcation room to the office inclusive, unless otherwise directed by the Principal.

2.1.1 Standards

The cabling system as designed, supplied, installed, tested and delivered shall comply with and be certified to the following standards:

- ISO/IEC 11801 (1998). Generic Cabling System for Customer Premises, as amended/supplemented by this DEP. Copper cable shall conform to the enhanced Class D requirements of the 1998 amendment.
- EIA/TIA-568A Amendment 5, 1998. Commercial Building Telecommunications Cabling Standard, as amended/supplemented by this DEP. This standard covers overall cabling architecture, cable, connecting hardware, and design. Copper cable shall conform to the enhanced Cat5e requirements of the 1998 amendment.
- EIA/TIA-569 Commercial Building Cabling Standard for Telecommunications Pathways and Spaces, covering building architecture, space allocations and horizontal cable pathways
- EIA/TIA-570 Residential and Light Commercial Telecommunications Cabling Standard
- EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, as amended/supplemented by this DEP. This standards covers administration practices
- IEEE 802.3ab 1000 BaseT addendum 1998
- IEEE 802.3z 1000 BaseF addendum 1998
- IEEE 802.5 / ISO/IEC 8802-5 (Token Ring)
- ISO/IEC 9314-3 (FDDI)
- ATM AF-PHY-0015.000

This DEP specifies a cabling system designed to meet the rigid technical performance criteria of IEEE 802.3/ISO/IEC 8802-3, IEEE 802.5 / ISO/IEC 8802-5, FDDI, and ATM. The intent is to provide flexibility to add outlets, cable and fibre to the desktop; add cable to the backbone; and to change technologies and configurations.

International standards and professional installation practices are stressed. A high performance cable that has been poorly installed, or installed with sub-standard cross-connects or patch cables, will have the qualifications of the lowest common denominator and may not meet the expectations or requirements.

IMPORTANT NOTE:

In September 1997, the technical committee that writes ISO/IEC 11801 announced that it was working on new standards:

Category 6 200 MHz channel performance;

Category 7 600 MHz channel performance (sometimes also known as “Cat 6” before Sept. 1997).

These standards will not be published until 1999 or 2000. The existing Cat 5 specification will also be uprated in 1998 by both ISO and TIA/EIA. The next edition of TIA/EIA 568A, to be known as TIA/EIA 568B, will probably call for an intermediate standard of enhanced Cat 5 to be known as Cat5e. The uprated standards will call for tighter values of NEXT, ACR, Attenuation, Return Loss, Differential Delay and Overall Propagation Delay plus FEXT, ELFEXT and PSELFEXT.

It is essential that "Category 5" is not merely stated as a requirement or early obsolescence will result. The cabling system shall conform to the next generation of enhanced Cat 5. Installers and manufacturers shall explain how they will achieve this in any response to tender for cabling work.

2.1.2 Structure

(Figure 1) shows the structure of the cabling system in a typical office building.

2.1.3 Topology

- The topology shall be in the form of a hierarchical star in all parts of the infrastructure (horizontal, intra-building, inter-building) as shown in (Figure 2).
- There shall be no more than two hierarchical levels of cross-connects in the backbone cabling.

FIGURE 1 CABLING INFRASTRUCTURE MAJOR COMPONENTS

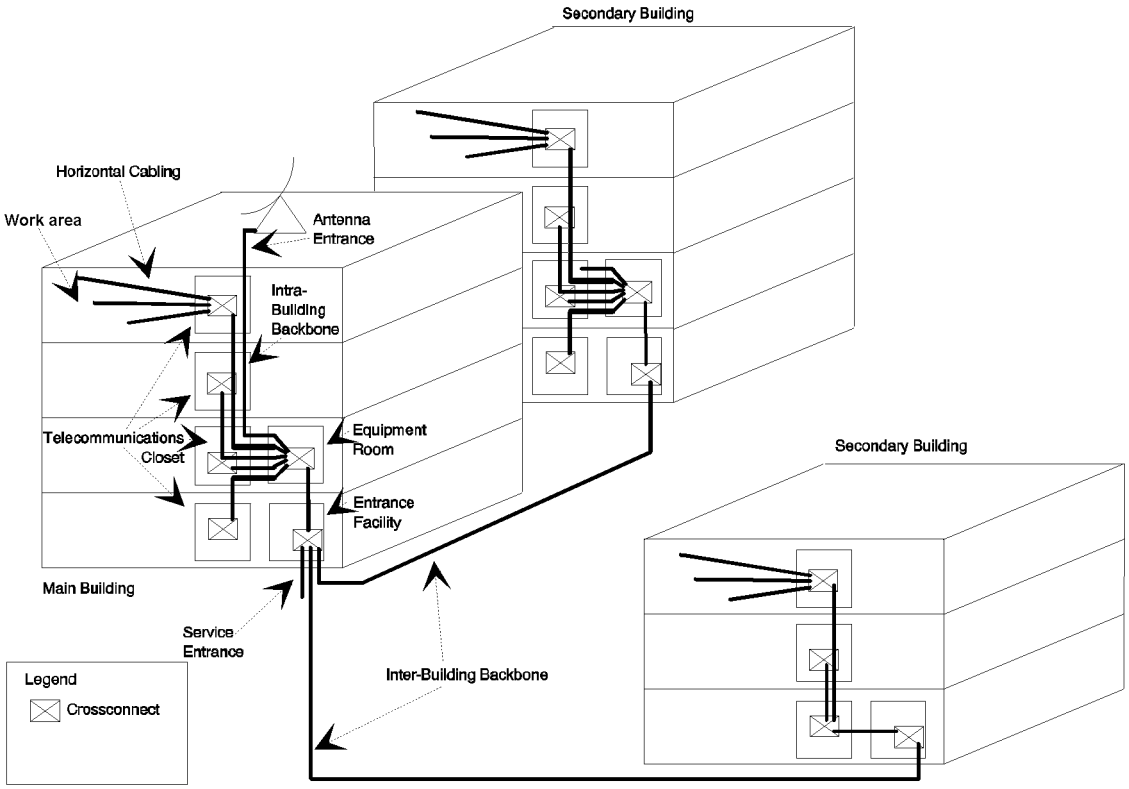
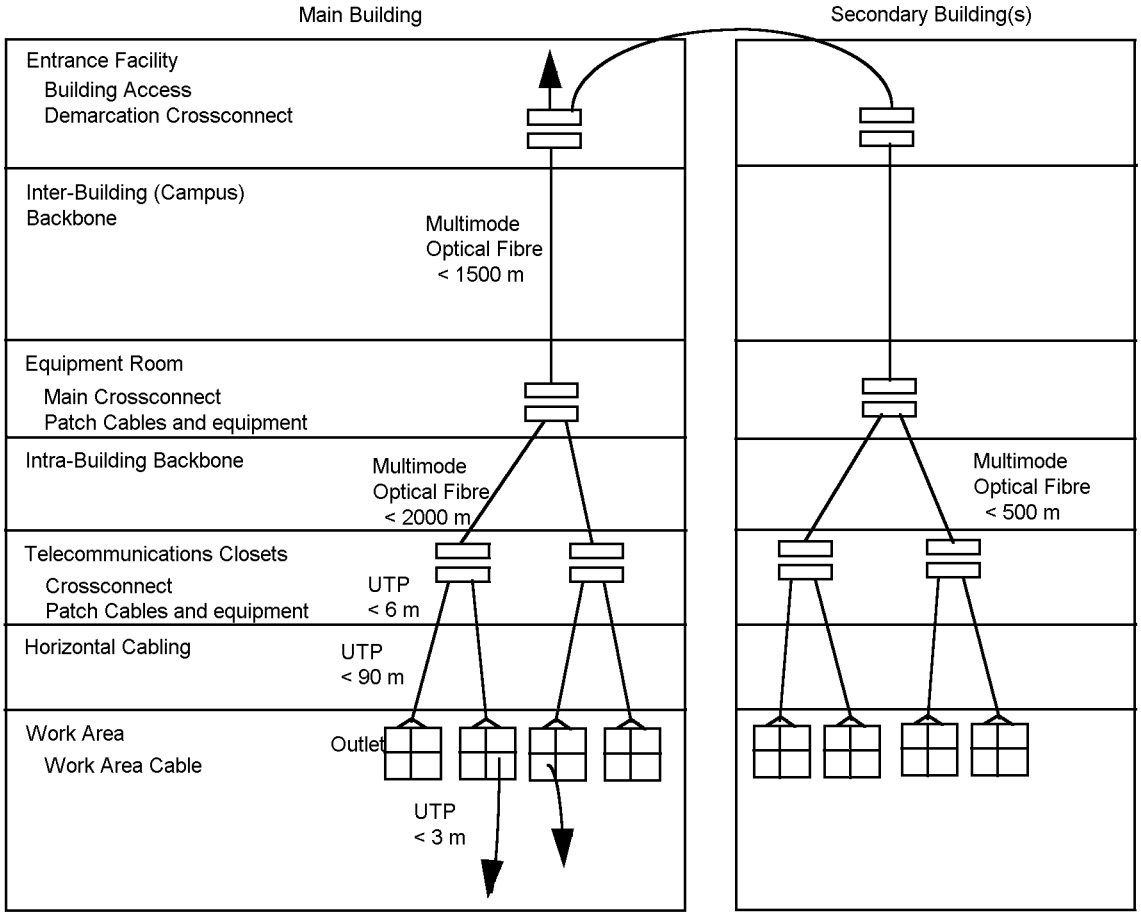


FIGURE 2 HIERARCHICAL STAR TOPOLOGY



2.2 WORK AREA

- ❍ Many installations are site-specific. The following shall be specified by the Principal: cable outlet location and mounting methods (such as wall or floor mount), faceplate design, colour and the quantity per office or "zone".
- ● Three cable outlets per work area shall be provided: two for data and one for voice.
- ❍ Wall mount outlets should normally be used. In open office areas utility columns shall be used. Horizontal cables shall not be terminated within furniture, instead only work area cables shall be used.
- ● Each work area cable outlet shall have a minimum of one associated power outlet. In new buildings and where possible in old buildings, power outlets shall be mounted near to and at the same height as the cable outlet. Electrical power outlets shall not terminate in the same outlet as the communications cable.
- ● Cable outlet boxes shall be no smaller than 50 mm wide, 75 mm high and 64 mm deep.
- ❍ Cable outlet boxes shall be securely mounted. Adhesive fixing is not acceptable.
- ❍ Faceplates shall be flush, vertical, and square to the wall panels. Outlet boxes shall be tested with a mock-up to ensure that the cable termination and faceplates can be installed easily within tolerance specifications. Some products do not lend themselves to correction of any box mis-alignments.
- ❍ A minimum separation of 5 cm shall be maintained between the faceplate and the floor, corner, or ceiling.
- ● All UTP cables shall be terminated with ISDN-standard 8-pin modular (RJ45) connectors, Enhanced Category 5 compliant (T568A jacks). The Contractor shall verify that the existing PABX and handsets can be adapted to T568A jacks or with the use of external adapters.
- ❍ Punch-down tools designed for the cable and connectors employed shall be used to ensure that all conductors are properly seated in connectors.
- ● Adapters shall be external to the outlet.
- ❍ Unused outlet boxes shall be covered by a faceplate blank, and labelled "For Telecommunications Use".
- ❍ Dust covers shall be installed over all edge connector assemblies.
- ❍ In harsh environments, cables outlets shall be enclosed in a protective case to protect against impact, spills and the ingress of moisture.

2.3 HORIZONTAL CABLING

Horizontal cabling refers to the cable and pathways between the telecommunications closet and the work area.

2.3.1 Distribution methods

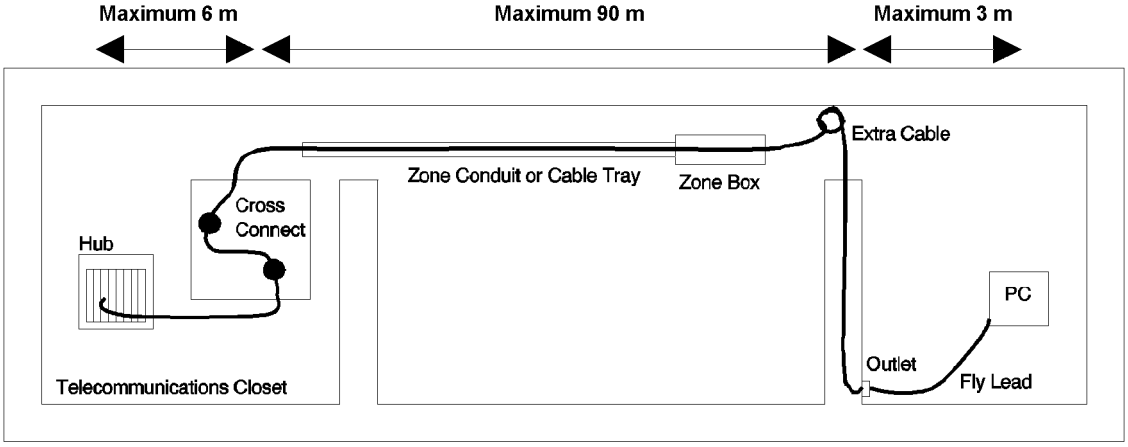
- The floor space shall be divided into coverage areas or zones which are approximately square. The area of each zone shall not exceed 90 m^2. A distribution system using conduit or cable tray shall carry the horizontal cable from the telecommunications closet to the centre of the zone. Individual cables shall continue to the work area outlets.
- Several distribution methods are possible from the work area to the telecommunications closets. The Principal should state the preferred method from the following alternatives. Zoned conduit method shall be used by default.
  - Zoned conduit. The ceiling space is divided into areas (zones) for the cables. One conduit shall run from the closet to a zone box in the centre of the area. Individual cables shall run to each work area through the zone box.
  - Raceways (open or closed metal trays) shall be suspended in the ceiling area. Large header raceways shall bring cables into the area. Lateral raceways branch off the header raceways to provide services to the work area. Cables shall then run into utility columns or partition walls through short lengths of conduit.
  - Raised floor: a false floor shall be installed above the structure floor. Cables shall be routed below the false floor, and enter the work area through floor mounted outlets.
  - Other methods: floor trench, embedded zoned conduit within the structure and cellular floors.
- The distribution system shall be designed to support future cable density of six outlets per work area. Horizontal conduit sizing and cable trays shall be designed to accommodate twice the initial installation capacity. For planning purposes, assume 10 m^2 per work area.
- Conduit fill limits shall not be exceeded.
- ❍ Where the cable is delivered from the ceiling, conduit shall be used within the wall from each individual outlet box to the top of the wall. The conduit shall be sized to accommodate six outlets per work area and engineered to support both Category 5 UTP as well as multi-mode fibre optic cabling. Conduit or other trunking hardware shall be used where cables run vertically along pillars.
- Conduit shall be electrical metallic tubing, rigid metal conduit or rigid PVC. Conduit attachments to walls shall be mechanical, not adhesive. Flexible metal conduit shall not be used.
- Inaccessible ceiling areas, such as lock-in type ceiling tiles, drywall or plaster shall not be used as distribution pathways. If possible, all cable trays and conduit shall be installed invisibly within wall and ceiling space.
- Cable trays shall be sized according to the number of cables installed and weight loading, with allowance for maximum density. At least 650 mm^2 cross-sectional area of tray per 10 m^2 of usable floor space shall be provided.
- ❍ Trays and conduit shall take as direct a route as possible within the guidelines of EIA/TIA-569 to minimise cost and distance. Routing shall be along corridors where possible for ease of access.
- ❍ Conduit from the telecommunications closet to each zone box shall be designed to support 60 outlets. Allowance shall be provided for pulling future cables within partially full conduit. Installation of two conduits is recommended (one is "spare" and used only when the other is "full"). The diameter of each conduit shall be at least 5 cm.

- Pull boxes are required for long or indirect conduit runs. Any conduit longer than 30 m, or containing more than two 90° bends, or having a reverse bend, shall have a pull box. Pull boxes shall be placed in a straight section of conduit and not used in place of a bend, and the corresponding conduit ends should be aligned with each other.
- A pull string shall be installed and left within each conduit. Used pull strings shall be replaced during the pull.
- All cable trays shall be of an open construction such as ladder construction or U-shaped. All parts of the cable tray shall be joined together. Cable shall not run unsupported. Cable trays shall be supported by metal hangers and bonded to ground. The maximum distance between adjacent hangers on straight runs shall be 1.5 m. Where there are bends within the cable tray, the tray shall be supported by hangers on both sides close to the bends. All junctions shall be supported by hangers. No cable trays shall be permitted to move relative to each other. The inside of a cable tray shall be free of burrs, sharp edges or projections.

2.3.2 Cabling (see Figure 3)

- Each outlet shall terminate one Enhanced Category 5, four-pair UTP cable.
- Voice and data shall not share the same cable concurrently.
- At least 4 m of extra cable should be coiled in the ceiling unless this creates a run longer than 90 m. The coil of extra cable shall be fastened to the under-slab of the floor above. The additional cable is to allow future cable moves, ensure easy termination and minimise cable strain.
- Where building regulations permit, cable in ceiling voids shall be suspended without conduit or trays from the zone box or cable tray to the top of the wall conduit. Cables shall be supported by hanging cable supports no more than 1.5 m apart. Cable shall not be taut.
- Each horizontal run shall be less than 90 m from outlet to termination in the telecommunications closet. All run lengths shall be minimised.

FIGURE 3 CABLE LENGTHS



- Cables within cable trays shall be run in bundles and fastened to the trays at regular intervals so that no section of the cable can become detached from the cable tray. Multiple cables of a different type and purpose shall not be bound together, but shall be individually fastened to the tray.
- All cables shall be laid and handled in accordance with Manufacturer's technical, mechanical, or environmental instructions such as for bending radius or allowable pull tension.
- No kinks, bends or cuts shall be permitted during or after installation.
- Cables shall not be mishandled and shall be contained within conduit or supported in such a manner as to eliminate mechanical stress or strain and ensure reasonable protection from fire and other outside damage.
- Methods of binding cables together or fixing to cable trays shall not crimp or damage the cables and shall be accessible and removable.
- Cable bend radius shall be not less than 8 times the cable diameter; conduit bend radius shall be 6 times the internal diameter (10 times for conduit greater than 50 mm).
- Cables shall maintain separation from electrical cables and electrical appliances according to the EIA/TIA standards (the following table has been extracted as a summary from the EIA/TIA 569 standard). In addition, cables shall be located at least 30 cm from adjacent runs of standard 110 volt AC or 230 volt AC power lines, power buses and AC voltage transformers. Cable shall not run parallel to electrical cables for more than 50 m.

Condition	< 2 kVA	2-5 kVA	>5 kVA
Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	127 mm	305 mm	610 mm
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway	64 mm	152 mm	305 mm
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway	-	76 mm	152 mm

NOTE: Within the countries of the European Union, the spacing requirements of EN 50174 (Cabling System Installation) should be followed.

- Proximity to other potential sources of electrical noise such as electrical lift (elevator), motor and fluorescent lighting cables shall be avoided, including radio frequency transmission devices, so as not to include electromagnetic interference coupling. Cables shall be at least 12 cm from fluorescent light fixtures.
- Every cable run from the telecommunications closet to outlet shall have both end points on the same floor, including floor-mounted outlets. Small buildings with a maximum of 2 floors and 100 outlets are exempted from this requirement.
- Cables shall run continuously from the closet to outlet without intermediate terminations, connectors, bridged taps or splices, unless specifically authorised by the Principal. Intermediate cross-connects shall not be used as a point of administration. Active equipment shall not be located at the intermediate cross-connect.
- Plenum return, free air or conduit fire code requirements shall be complied with as dictated by building construction and local, provincial, state or federal building or fire codes.
- Extreme hot or cold heat sources shall be avoided. For example, a 20 K rise in temperature can add 10% dB loss, and cables with a PVC jacket are even more susceptible. If cables run along outside walls or through potentially hot ceilings, add a safety margin of 6 dB to the attenuation measurement during acceptance testing.
- UTP insulation and twists shall be maintained intact to the termination point as specified in the ISO/IEC 11801 specifications to maintain the electrical characteristics necessary for high speed data communications. Twists at the connectors shall not be disrupted for more than 13 mm. All cable pairs including spares shall be terminated.

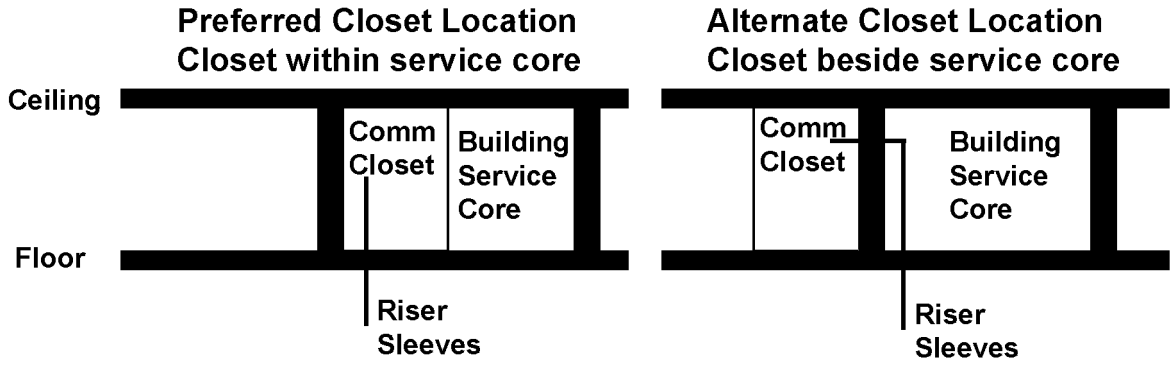
2.4 TELECOMMUNICATIONS CLOSET

The telecommunications closet shall serve individual floors and contains telecommunications equipment, cable terminations, and cross-connect cabling. The closet is the recognised transition point between the backbone and the horizontal cabling.

2.4.1 Closet construction (see Figures 4, 5 and 6)

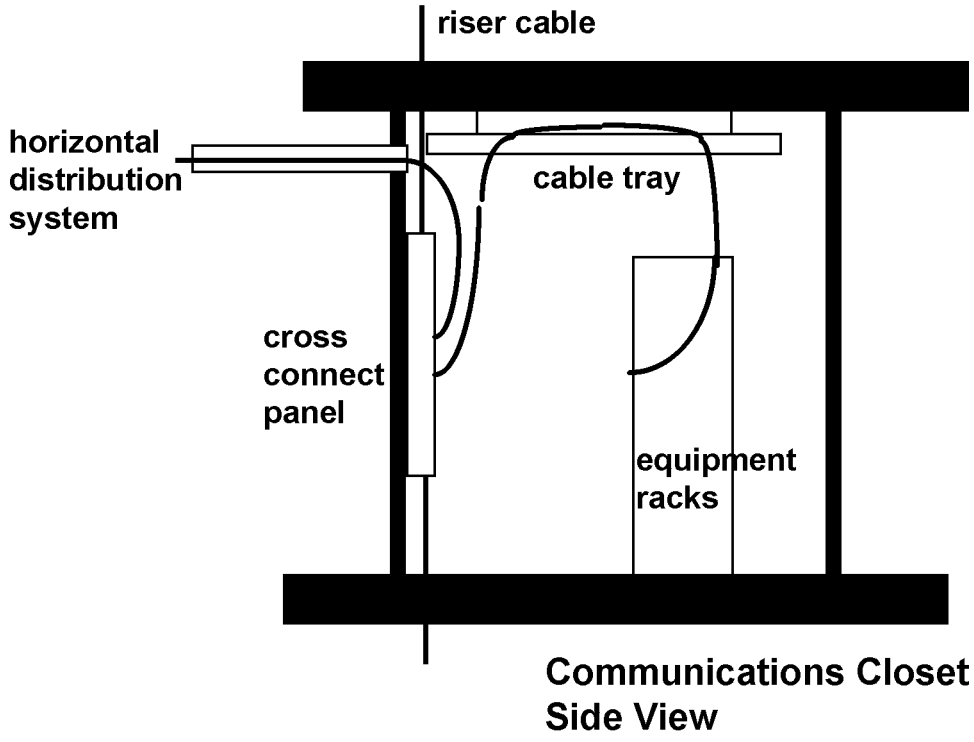
- The number, size and location of closets shall meet requirements of the ISO or EIA/TIA specifications and shall be approved by the Principal.
- There shall be at least one telecommunications closet per floor and one closet per 1 000 m^2 of floor space (or part thereof), whichever is greater.
- Large floor areas, cable distances, obstacles, congestion or building shape may require additional closets to meet cable distance specifications. The number of such closets shall be minimised. One closet per floor shall be designated as the "main closet". The main closet is where all horizontal and intra-building cables interface. The additional closets are referred to as a LDC (local distribution centre). The LDC is similar to the telecommunications closet, except that it shall not contain equipment, vertical cable or a riser. See (2.5) for inter-LDC cabling requirements.
- Each closet shall be centrally located with respect to the work area of each floor to minimise horizontal cable lengths. The closet should be located within the building service core to facilitate riser cabling. An alternative location, if space within the service core is not possible, should be immediately adjacent to the service core. In all cases, vertical cabling shall use the service core to avoid riser shafts in the occupied portion of building.

FIGURE 4 TELECOMMUNICATIONS CLOSET LOCATIONS



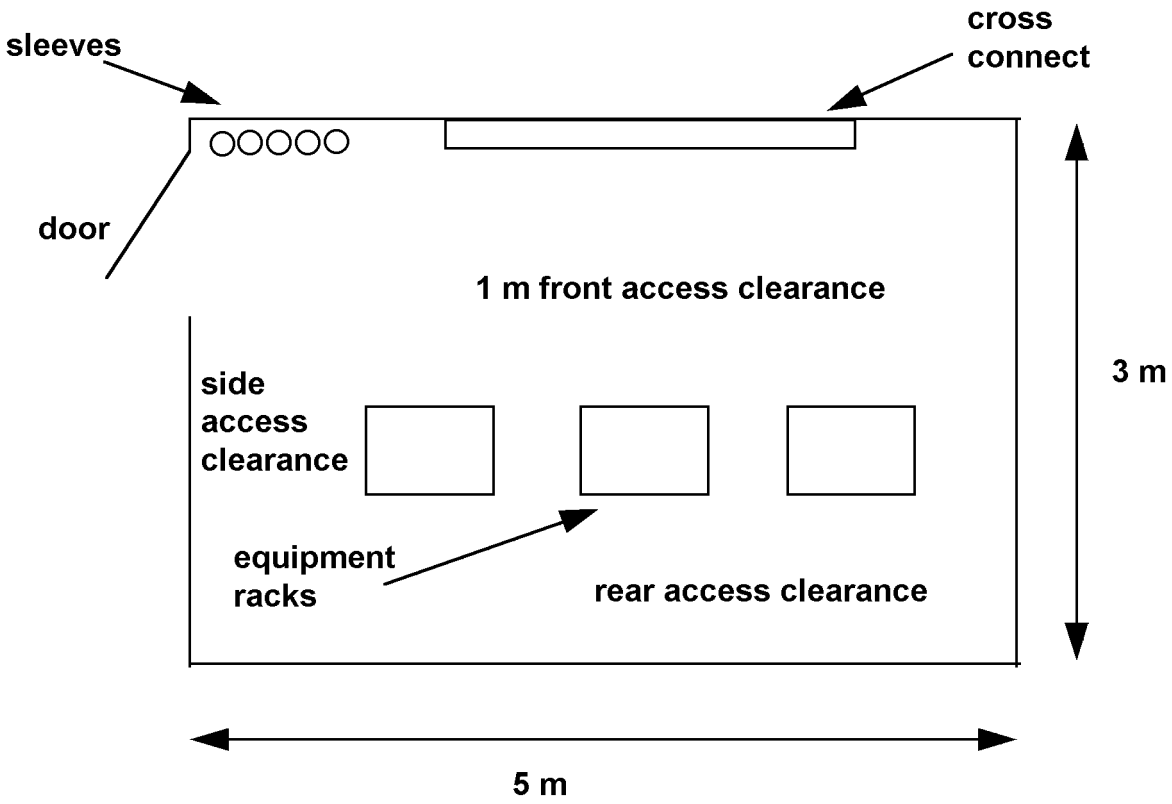
- Telecommunications closets shall be vertically aligned with a minimum 30 cm by 45 cm overlap for continuity of riser cabling sleeves. Closets shall be located on all occupiable floors.
- Closet walls shall run from the structural floor to the structural ceiling.

FIGURE 5 COMMUNICATIONS CLOSET SIDE VIEW



- The telecommunications closet floor area shall be not less than 1 m^2 for every 250 m^2 of floor area to be served and shall never be less than 10 m^2. The height shall be at least 2.6 m. Two continuous walls of approximately 1.5 m in horizontal length shall be provided for mounting of hardware. A greater floor area for the closet should be provided for irregularly shaped space.
- Each closet shall be designed to house network electronics, such as LAN hubs, terminal servers, controllers, gateways, routers, bridges, and power conditioners. Each closet shall permit easy addition of network topology, or changes to networking equipment.
- Closets should be accessible from within the secured building area of the Principal, but outside the separately secured user floor areas and accessible without disrupting work.

FIGURE 6 TELECOMMUNICATIONS CLOSET TOP VIEW



- Doors shall open outwards, shall be at least 91 cm wide and 200 cm high and shall not have a door sill. Doors shall not cause obstruction or impact on escape routes.
- Telecommunications closets shall be classified as restricted access areas. The doors shall be secured by a locking device. Locks shall engage automatically when the door is closed but shall be openable from the inside. The door should have a warning sign reading "Warning - Qualified Personnel Only". Windows should be avoided.
- Floors, walls and ceilings shall be treated to eliminate dust. Finishes shall be light in colour. Vinyl, non-static, non-slip surfaces are permitted.
- Two walls shall be covered with 2 cm plywood 2.4 m high, coated with fire-retarding paint. The plywood shall be used for mounting cross-connect panels, fibre optic connection hardware and cable strain relief hardware.
- The plywood specified in the preceding clause shall be fitted on 25 mm to 30 mm thick battens to the walls to allow breathing between the wall and the plywood.
- Each closet shall be air-conditioned or ventilated to remove the heat load of the initial and future projections of electronic equipment, 24 hours per day, 7 days per week. A positive pressure shall be maintained with a minimum of one air change per hour. The heat load of the closet should be assumed to be 4 kW for ventilation purposes. Operating temperature shall be maintained between 10 °C and 40 °C. A simple grill in the ceiling space should be adequate, depending on air flow.
- Fire protection shall be provided as required by fire regulations. Sprinkler heads shall be fitted with wire cages to prevent accidental operation.
- Overhead fluorescent lighting shall be provided in the closet mounted 2.6 m above the floor. The lighting level shall be 540 lux measured 1 m above floor level. Emergency lighting should be provided in the closet if emergency lighting is provided for the building as a whole.

- A false ceiling shall not be installed in the closet.
- Telecommunications closets shall be separated from the electrical riser and electrical distribution rooms.
- The closet floor loading shall be designed for at least 2.4 kPa (50 lbf/ft^2). Concentrations of equipment that exceed the minimum floor loading shall be verified with the building owner.

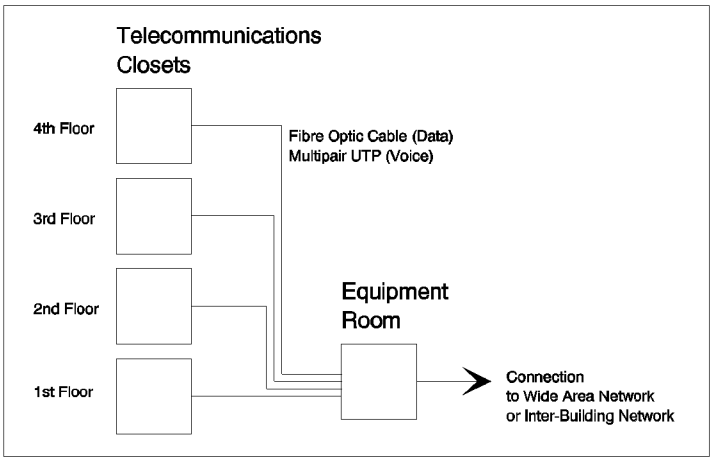
2.4.2 Cabling

- Overhead cable trays shall be installed to carry cable from riser and horizontal entrances to the cross-connect panels and distribution panels. Cable trays shall be at least 2.13 m from the floor. Cable trays shall exhibit the same properties as specified in (2.3).
- One 19 inch EIA rack or equipment cabinet shall be installed in each closet for every 100 outlets (or part thereof). There shall be a minimum of two cabinets or racks. Racks shall be secured to the floor, with a minimum of 1.0 m clearance in front of any electrically exposed equipment. Clearance for access shall be provided along the rear and sides. In the case of enclosed cabinets, extractor fans shall be mounted on the top of the cabinet with intake grills at the bottom.
- A minimum of three dedicated separately circuited 15A, 230 Volt AC duplex electrical outlets, or equivalent depending on country, shall be provided for equipment power. These shall be mounted on the EIA racks. In addition, convenience duplex outlets shall be placed at 1.8 m intervals around the perimeter walls, at a height of 1.1 m above the floor. It is desirable that a dedicated power panel be installed to serve the closet.
- The estimated closet power load shall be 4.5 kVA.
- A separate building electrical ground bus for telecommunications shall be provided to ground cable racks, cabinets, cross-connect frame, and provide a Telecommunications Functional Earth for PABX and telephone instruments. The ground bus should be bonded to the building telecommunications grounding electrode. The grounding bus from each riser closet shall be extended to each satellite closet. All electrical grounding wire should be no less than 4 mm (6 AWG) solid annealed copper wire and shall be capable of connecting multiple bonds.
- All equipment racks shall be grounded. Separate removable parts such as doors shall be fitted with suitable earthing straps.
- All wall and riser penetrations into telecommunications closets shall be firestopped to maintain the closet fire rating and the heating and cooling design.
- Voice and data interconnection equipment shall be separated. Voice and data cables shall be terminated in different cross-connect panels.
- Closet layout and patch panels shall be located to provide the maximum ease of access, require the shortest patch cables, and result in the neatest installation in consideration of the requirement for connection to active equipment.
- Termination specifications shall be as specified in (2.2) and cabling handling specifications shall be as specified in (2.3).

2.5 INTRA-BUILDING BACKBONE

The intra-building backbone is the portion of the cabling infrastructure that includes all cabling between the telecommunications closets, local distribution centres, equipment rooms, and entrance facilities (see Figures 7 and 8).

FIGURE 7 INTRA-BUILDING BACKBONE



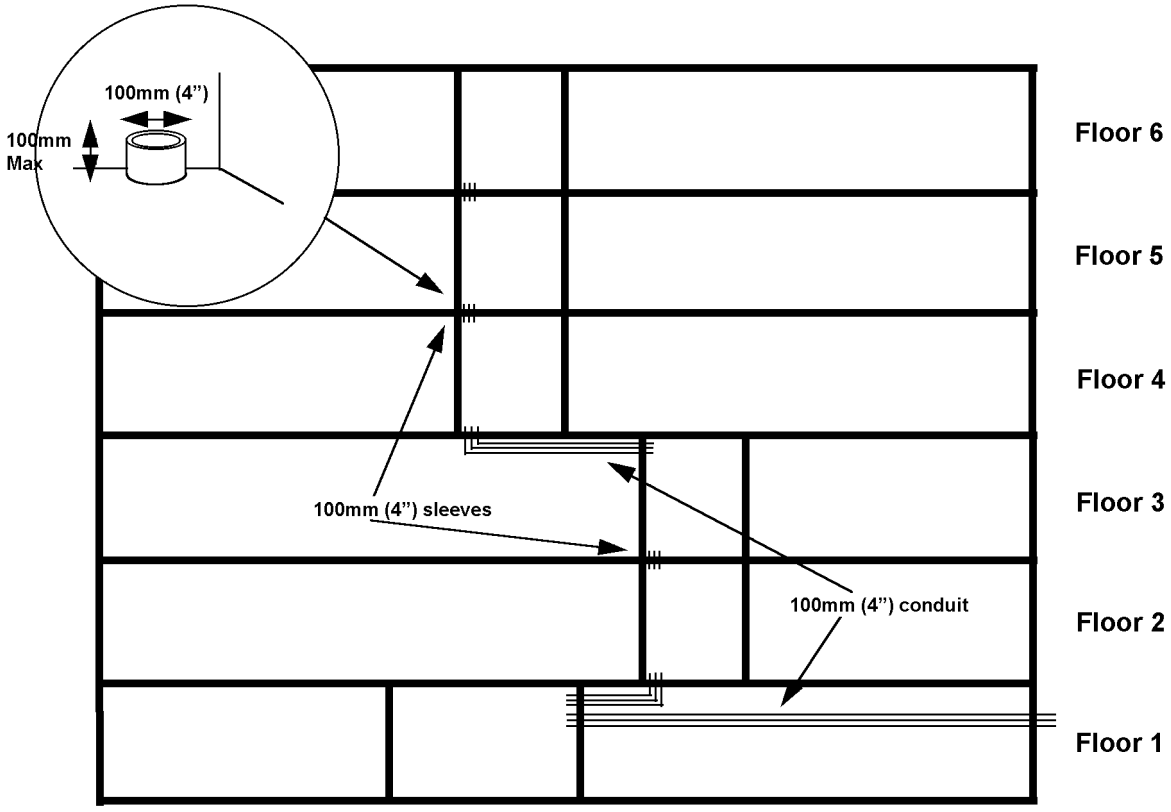
- Multipair UTP cable shall be run from each closet to the main distribution frame in the equipment room for voice communications. A minimum of 30% extra capacity shall be provided.
- Two 12-pair multimode optical fibre cables shall be run from each closet to the main equipment room for data communications. Each cable shall be run in a separate conduit and sleeve. Install single mode fibre for distances greater than 2 km. Up to 200 m the fibre should be 62.5/125 or 50/125 multimode. For 200 to 2 000 m the fibres should be a mix of multimode and single mode, e.g. 8 multimode and 4 single mode.

  Install a minimum of twice the number of fibres initially required, with an absolute minimum of 12 strands. Alternatively blown fibre multiduct can be installed. A seven tube multiduct will give a capability of at least 28 optical fibres to be installed at a later date.
- Maximum lengths for intra-building cable depend on the medium and building.
  For the main building: 2 000 m for multimode optical fibre cable, 800 m for Category 3 voice copper cable, and 100 m for Category 5 data copper cable. For auxiliary buildings in a campus environment, maximum cable length of intra-building multimode fibre shall be 500 m (see Figure 2).
- All cables shall be neatly tied down.
- ❍ Stress, shearing and crushing of optical fibre cable during transport, storage and installation shall be prevented.
- ❍ Optical fibre cables shall be terminated upon completion of all construction and installation work. Termination points shall be located where there is space to undertake the task.
- ❍ Optical fibre cables shall not run vertically for more than 20 m without a loop to counteract the flowing and stretching properties of glass.
- All optical fibre cables shall be terminated on termination panels. Slack shall be left in the cable to allow re-termination of the cable.
- Riser sleeves in each closet shall protrude 10 cm above the floor. Sleeve location, visibility and design shall protect from hazards such as tripping and accidental penetration if load bearing is less than surrounding floor.
- Three riser sleeves 100 mm diameter for every 5 000 m^2 of work area and 50 percent

excess capacity shall be installed. Risers shall have the same number and diameter throughout the height of the building. It shall be possible to easily add more cable. Cable slots are not recommended and often prohibited.

- All sleeves shall be firestopped. A cable strut shall be mounted behind the sleeves.
- Communications cable risers shall be separated from risers serving elevators or electrical equipment to minimise electrical interference.
- ❍ Many buildings have multiple tenants. Riser space that passes through floors not controlled by the Principal shall be secure from unauthorised access.
- If more than one closet per floor is necessary, LDC closets on the same floor shall be interconnected to the main closet using 78 mm conduits with quantity sized to accommodate initial cable requirements and with 50% excess capacity. If the LDC has its own riser, optical fibre cables and voice UTP cables shall be installed between the main closet and each LDC, with two 12-strand optical fibre cables, or two 4-duct blown fibre multiduct cables, and voice UTP cables numbering 10% of the riser pairs. If the LDC does not have its own riser, inter-closet conduit shall be used to route LDC riser cables to the main closet riser.
- Conduit bend radius shall be 10 times the conduit internal diameter for conduit greater than 50 mm internal diameter, or 6 times the internal diameter for smaller conduit, and never less than 8 times the cable diameter.
- Optical fibre cable splices should be avoided. There shall be no more than two splices per cable. The resulting cable attenuation shall not exceed the standard specifications of 3.75 dB/km and 1.5 dB/km for 850 nm and 1 300 nm wavelengths respectively. Each fusion or mechanical splice shall not exceed an optical attenuation of 0.3 dB. There shall be no connection points outside the telecommunications closets.
- ❍ The intra-building backbone design shall be as specified in (2.1) to (2.4).

FIGURE 8 INTRA-BUILDING BACKBONE SLEEVING



Riser System

2.6 EQUIPMENT ROOM

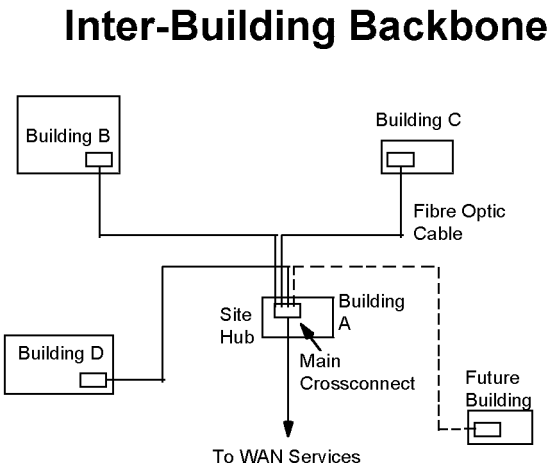
The equipment room shall be designed to support common telecommunications equipment serving the occupants of the entire building or group of buildings, including the main cross-connect facilities between the intra-building, inter-building, and access cabling. It is usually part of, but separated from, a computer room. The equipment room shall be separate from the building access room.

- The equipment room shall have a minimum floor area of 14 m^2. In smaller buildings this space shall be shared with a telecommunications closet.
- Equipment such as the voice PABX, microwave and satellite electronics, modems, and multiplexors shall be installed in this space. Equipment not directly relating to the telecommunications infrastructure or its environmental support systems shall not be installed in this space. Equipment such as photocopiers shall be located no closer than 3 m from the equipment room.
- Computing equipment such as file servers, gateways, voice mail servers and voice interactive response units shall not normally be located in the equipment room, but situated within the adjoining computer room. In small buildings, shared space with the equipment room is permitted.
- The voice MDF shall be wall-mounted, terminating all trunk cables from the carrier entrance, PABX cables, multi-pair voice intra-building cables, and multi-pair cables running to modem racks.
- UTP Category 5 data cable, fibre cable, and other data cables may terminate either on standard 19" EIA racks, data cabinets, or wall mounted in a similar fashion to voice cables.
- Distributed floor loading capacity shall be greater than 12 kPa (250 lbf/ft^2) and the allowable concentrated loading shall be greater than 4.4 kN (1 000 lbf) over the area of greatest stress.
- The equipment room shall not be located below the ground water table. The equipment room shall be free of unrelated water pipes and a floor drain shall be provided if risk of water ingress exists.
- The PABX console shall be located no further than 50 m from the PABX unless a longer distance is supported by the PABX Supplier.
- Portable fire extinguishers shall be provided and located by the exit.
- The equipment room should be located so that future expansion is not constrained.
- The equipment room should be located as near as possible to the intra-building backbone to reduce cable runs.
- The equipment room shall be as specified in (2.4) regarding HVAC, power, lighting, security, and grounding.

2.7 INTER-BUILDING BACKBONE

- Install single mode fibre for distances greater than 2 km. Up to 200 m the fibre should be 62.5/125 or 50/125 multimode. For 200 to 2 000 m the fibres should be a mix of multimode and singlemode, e.g. 8 multimode and 4 singlemode. Install a minimum of twice the number of fibres initially required, with an absolute minimum of 12 strands.
- Optical fibre cable shall be continuous between building entrance facilities. Splicing shall be as in (2.5).
- A minimum of 12 optical fibre cable strands shall be used or all initially used optical fibre strands shall have one spare optical fibre strand, whichever is greater. Alternatively blown fibre multiduct can be installed. A seven tube multiduct will give a capability of at least 28 optical fibres to be installed at a later date.
- The inter-building backbone shall be star topology (Figure 9).
- Conduit and associated hardware shall be corrosion-resistant, metal pathways shall be bonded to earth and separate from electrical earthing.
- Physical security precautions shall be considered when extending through space not controlled by the Principal.
- Where copper cable is used for voice applications the copper cable shall be protected from voltage surges or sneak currents induced by nearby power lines by utilising active protection devices or earthing.
- The inter-building backbone design shall be as specified in (2.5).

FIGURE 9 INTER-BUILDING BACKBONE



3. INSTALLATION

The Contractor's scope of work shall include fixing all outlet boxes, fixing cable tray and conduit, necessary modifications to existing installations and building construction, opening and closing of ceilings where required, laying of all cables, firestopping, termination of all cables and furbishment of cabinets and patch panels. The final scope of work shall be specified by the Principal.

3.1 INSTALLATION REQUIREMENTS

- All installers, including subcontractors, shall be properly certified and trained in the installation of ISO/IEC 11801 and EIA/TIA 568/569/606 compliant infrastructures and shall obtain a copy of the these Standards for reference (see Appendix 1). BICC Brand-Rex or Lucent Technologies certification is recommended.
- Installations in Europe shall be compliant with prEN 55105 Electromagnetic Compatibility (in preparation by CENELEC) when issued.
- The Contractor shall apply appropriate project management and quality control. The Contractor shall provide a project manager responsible for all work.
- The Contractor shall comply with all safety requirements of the Principal and property management.
- The installation shall comply with local telephony regulations.
- The Contractor shall provide cable system warranty for a minimum of one year against all defects in workmanship and conformance to specifications. Installations shall be registered with the Supplier for the extended warranty and systems assurance. Warranties commence on the date of final acceptance.
- Any necessary modifications to existing installations or building constructions shall be subject to approval by the Principal.
- Any damaged cables shall be replaced in their entirety.

3.2 TESTING REQUIREMENTS

All cables and cable pairs shall be tested according to the following requirements and the Manufacturer's specifications. At such time as the ISO, EN and EIA/TIA testing standards are complete, those testing and performance specifications shall also apply.

- Testing apparatus and connectors shall be Category 5 compliant, including test lead flexing, restraints and bends, spacing of leads, lead lengths and separation from ground planes, and EMI.
- Functional testing of the distribution cable shall be performed prior to system use. Testing shall include cable and termination hardware.
- Tests shall be performed by the use of handheld testers and visual inspections.
- Any component failing a test shall be rectified and re-tested prior to final acceptance.
- All test results shall be recorded, printed and documented for the Principal.

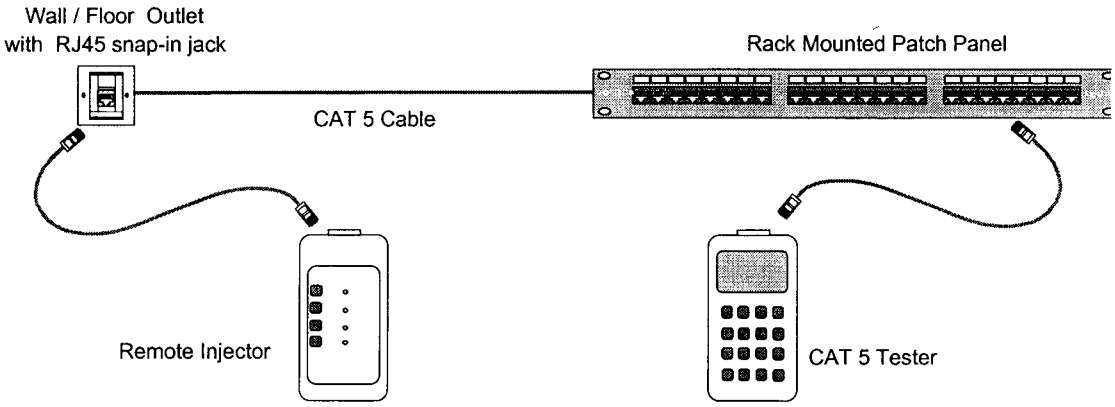
3.2.1 Category 5 copper UTP cable

Following installation, all cable shall be tested for the following characteristics:

- Compliance with Category 5, TIA/EIA 568, TSB 67.
- End to end continuity (open and short circuits) within and between pairs using a time domain reflectometer (TDR).
- Crossed pairs, reversed pairs, split pairs, or incorrect wire sequences in the punch-down block (cross-connect panel) and connectors.
- NEXT against each of the pair combinations. Measured from both ends of the cable system. The maximum step size between measurements shall be 200 kHz.
- Signal attenuation (signal loss) at frequencies including 4, 10, 16, 25 and 100 MHz. Measured from both ends of the cable system. Ensure that proper types of connectors have been used, that connectors are mated properly, and that wires are tightly twisted.
- Noisy cables shall be relocated away from the source. Attention shall be given to "bursty" noise such as that from an elevator shaft or industrial equipment.
- The actual cable length using a TDR.
- All wires are properly seated and all connectors are secure inside the installation kits of wall receptacles.
- All labels are properly installed and legible.

The link to be tested is the “Basic Link” as described in TSB 67 (Technical System Bulletin no. 67 of the EIA/TIA 568A standard), i.e. it is the snap-in jack at the floor or wall outlet, the length of CAT 5 cable attached to it and the patch panel at the other end. It includes 2 m of test patch lead at each end. See Figure below.

BASIC LINK



Testing shall be from both ends. The hand-held tester shall test at least:

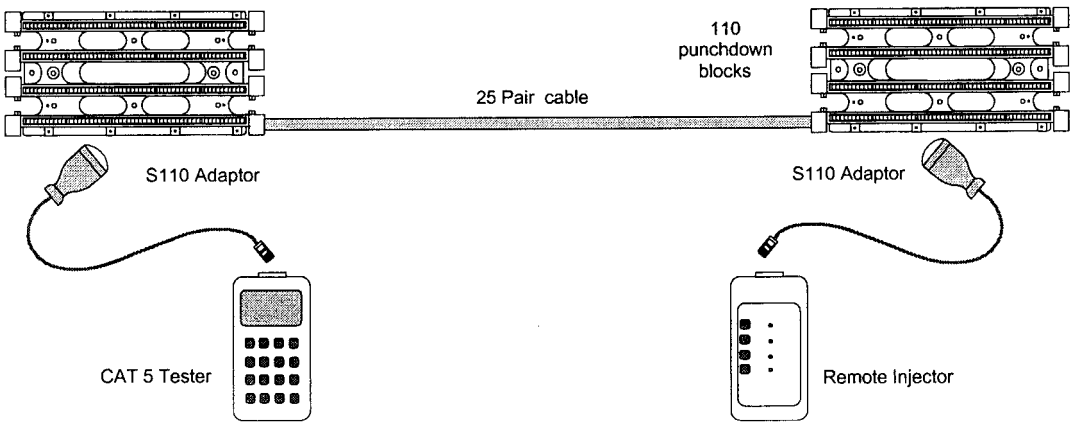
- NEXT
- Attenuation
- ACR *Remember, NVP shall be set to 69% !*
- Length
- Wire Map

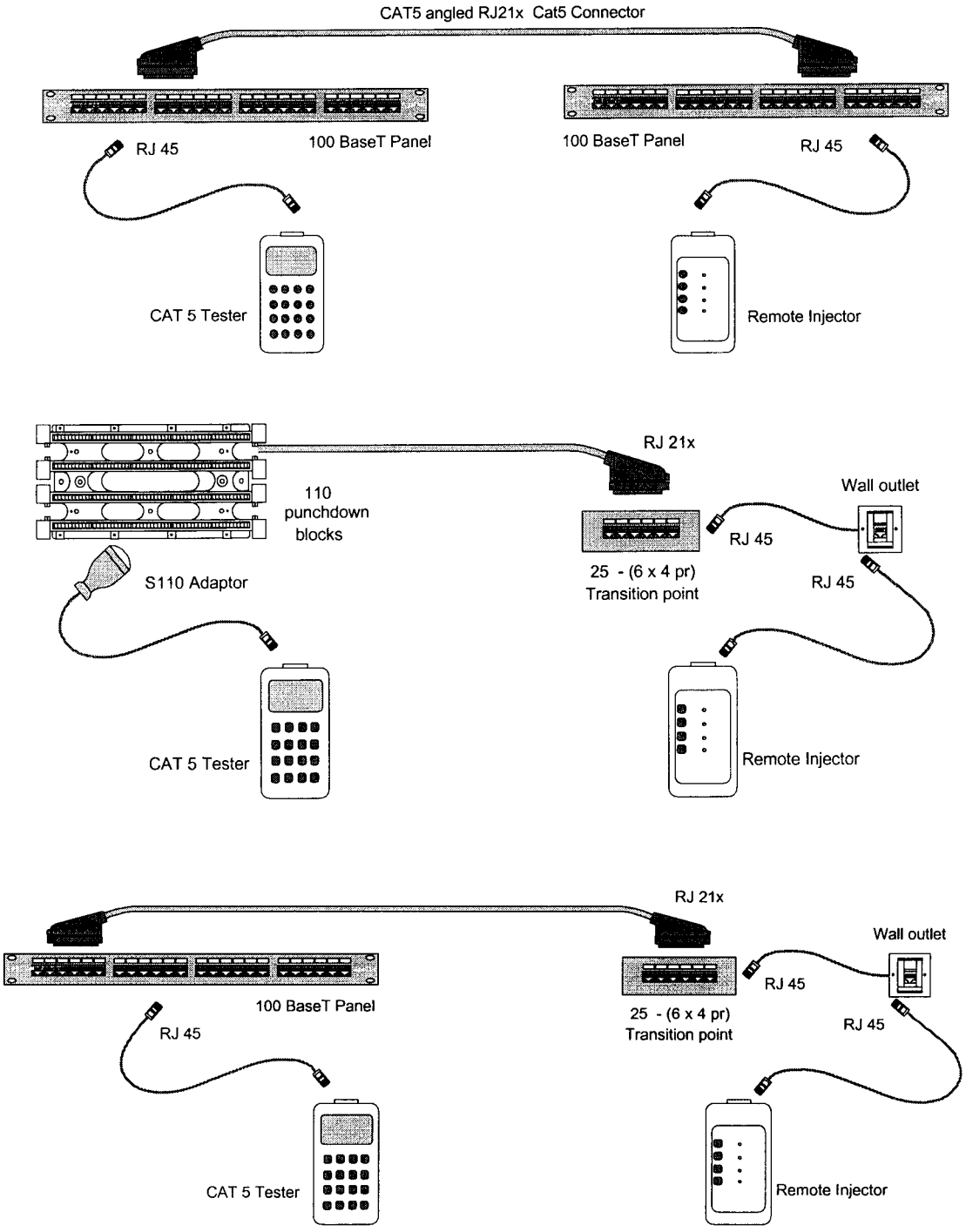
Enhanced CAT5 testers - (June 1998):

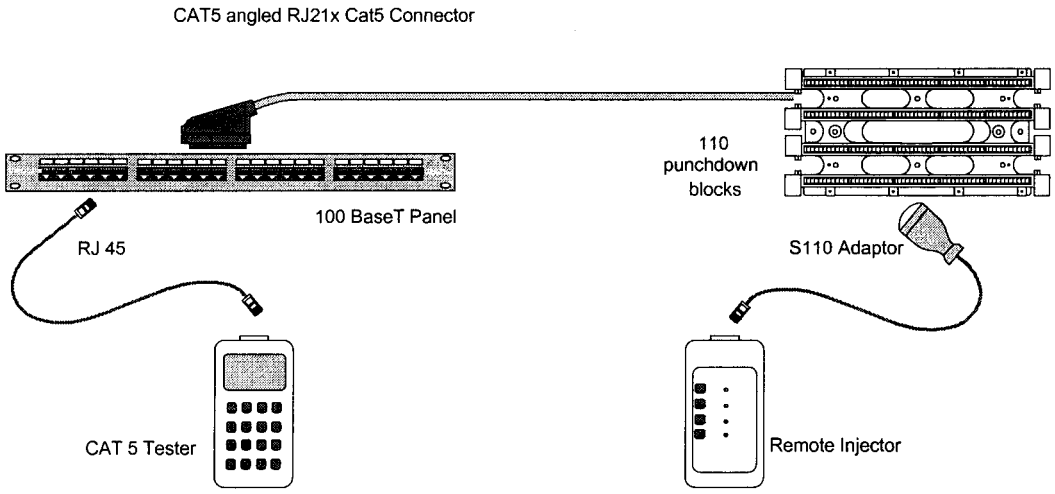
- Fluke DSP 100 / 2000 s/w V5.4
- Fluke DSP 4000
- Datacom Technologies Inc LANcat System 6
- Microtest Pentascanner+ / 350 s/w V5.0
- Microtest Omniscanner
- Wavetek LT8155 / 8350

3.2.2 Testing 25-pair, PowerPlus 155 installations

The 25-pair cable can be terminated on 110 strips or the 100BaseT panel via the 25-pair RJ21x Cat 5 connector. Use the S110 adaptor or RJ45 test lead on the hand-held tester according to the following circumstances:




CAT5 angled RJ21x Cat5 Connector
RJ 45
100 BaseT Panel
100 BaseT Panel
RJ 45
CAT 5 Tester
Remote Injector
RJ 21x
110
punchdown
blocks
Wall outlet
RJ 45
S110 Adaptor
25 - (6 x 4 pr)
Transition point
RJ 45
CAT 5 Tester
Remote Injector
RJ 21x
Wall outlet
100 BaseT Panel
RJ 45
RJ 45
25 - (6 x 4 pr)
Transition point
CAT 5 Tester
Remote Injector



3.2.3 Optical fibre cable

Following installation, all cable shall be tested for the following characteristics:

- Optical fibre cables shall be tested using an optical time domain reflectometer or other appropriate optical fibre testing device. All fibre cores shall be tested in both directions.
- Termination integrity, end to end connectivity, correct sequence of cores within the cables.
- Actual cable length.

3.2.4 Testing optical fibre installations

Optical cable links may be tested using an optical time domain reflectometer (OTDR), or by optical power meter and light source. Single-mode results shall include OTDR traces. In practice it is much simpler to use an optical power meter, and just use an OTDR for fault finding. For larger projects the Principal may insist on OTDR trace results. For short haul datacom links, however, the optical power meter method is quickest and cheapest and allows for the fastest interpretation of results. All optical applications shall include a table of link loss results, either from a power meter or derived from OTDR traces. If a problem does arise the installer shall have access to an OTDR for fault finding purposes.

Every fibre link shall have a total link attenuation equal to or less than the total attenuation allowed for that class of link as detailed in ISO/IEC 11801. The installer shall first calculate what the maximum allowed loss (attenuation) is for the link by adding up the sum total of optical elements in the link i.e. the cable, connectors and splices, and then measure that link to ensure that the installed results are equal to or less than the calculated attenuation.

3.2.4.1 Link parameter rules (a)

	MULTIMODE		**SINGLEMODE**	
Parameter	**850 nm**	**1 300 nm**	**1 310 nm**	**1 550 nm**
Fibre attenuation dB/km	3.5 max	1.0 max	0.45 max	0.3 max
Fibre bandwidth MHz.km	200 min	500 min	n/a	n/a
Connector insertion-loss dB	0.75 max	0.75 max	0.75 max	0.75 max
Connector returnloss dB	20 min	20 min	26 min	26 min
Splice loss dB	0.3 max	0.3 max	0.3 max	0.3 max

3.2.4.2 Link parameter rules (b)

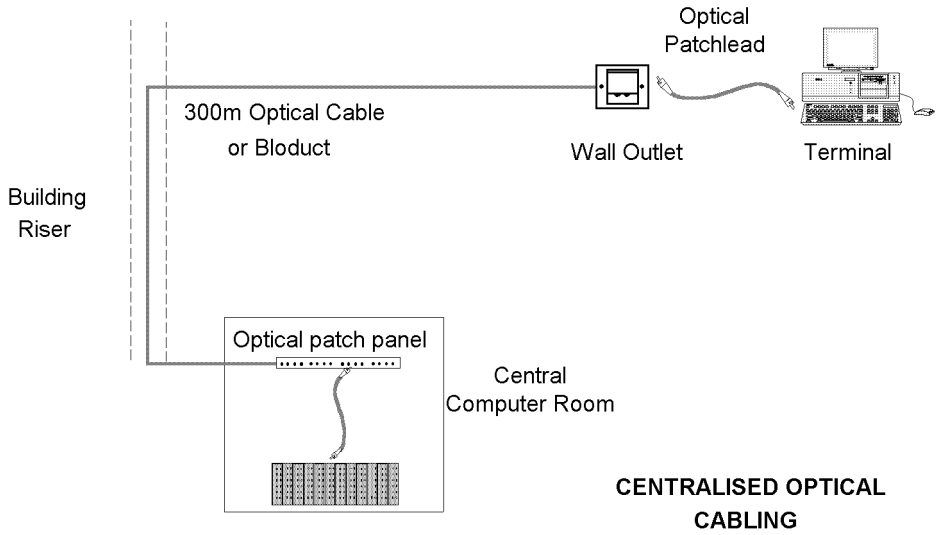
		Attenuation dB max			
		MULTIMODE		SINGLEMODE	
Cabling subsystem	**Link length max**	**850 nm**	**1 300 nm**	**1 310 nm**	**1 550 nm**
Horizontal	100 m	2.5	2.2	2.2	2.2
Building Backbone	500 m	3.9	2.6	2.7	2.7
Campus backbone	1 500 m	7.4	3.6	3.6	3.6

3.2.4.3 Link parameter rules (c)

The maximum optical attenuation between any two items of opto-electronic transmission equipment should not exceed **11 dB** at 850 nm or 1 300 nm.

3.2.5 Centralised optical cabling

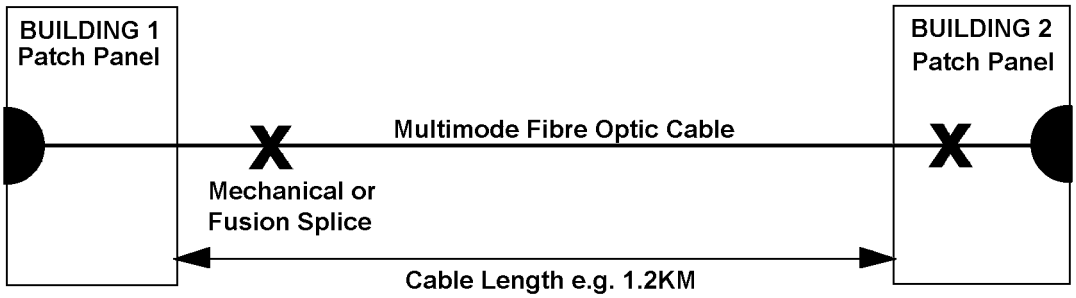
MillenniuM (BICC BrandRex) optical cable systems support the 300 m home run cabling schemes as described in TSB 72, Centralized Optical Fiber Guidelines, October 1995 and ISO/IEC JTC 1/SC25 PDTR 14763-2, Part 2, Implementation and operation of customer premises cabling, November 1997 (see Figures below).



CENTRALISED OPTICAL CABLING

3.2.6 Calculating acceptable optical loss

To calculate the optical loss of an optical cable link it is best to draw a diagram of the link and then ascribe the maximum allowed loss for each item, and then add up each item loss to arrive at the total allowed loss for that link, see example below (Note that the following calculations allow for either 50/125 or 62.5/125 fibre when multimode fibre is referred to).



Patch Panel 1 with	Patch Panel 2 with
directly terminated	a tail cable spliced
connector fitted onto	onto the main cable
a bulkhead adapter	and fitted onto a bulkhead adapter

To calculate the total allowed attenuation in the above example, add the individual loss components are added. Note that the loss of the fibre is different for each wavelength of light used, so one must be specific. In this example 850 nm is chosen first and then 1 300 nm (see also 3.2.4.1).

Loss across the first connector pair	= 0.75 dB
Loss across the fibre cable (1.2 x 3.5)	= 4.2 dB
Loss across the splice in the main cable	= 0.3 dB
Loss across the splice in the 2nd patch panel	= 0.3 dB
Loss across the second connector pair	= 0.75 dB
Total link loss at 850 nm	= **6.3 dB**
Total link loss at 1 300 nm (1.2 x 1)	= **3.3 dB**

Is this acceptable under the design rules?

First of all the link type must be defined. As it goes between buildings it is a campus backbone, so the cable run length should not be greater than 1 500 m. The 1.2 km link depicted is therefore acceptable. (3.2.4.2) states that the total loss for a Multimode campus backbone link should not exceed 7.4 dB at 850 nm and 3.6 dB at 1 300 nm. So the figures of 6.3 and 3.3, respectively are totally acceptable. Finally (3.2.4.3) states that the total loss between the electronic transmission equipment should not exceed 11 dB. If it is presumed that the electronics are plugged directly into the optical patch cords coming out of the patch panels, then the criteria of (3.2.4.3) are also met. The design of the above example is therefore acceptable within the limitations of ISO/IEC 11801.

NOTE: The effect of the patchcords themselves is discounted. This is for two reasons:

- the attenuation of the fibre in a patchcord is negligible; and
- the loss across the connector as it goes into the opto-electronic equipment is already accounted for in the launch conditions presumed by the Manufacturer.

The designer of the cabling system shall be wary of multiple patch panels within the optical link as it will be seen that the total link attenuation will rapidly rise as patch panels are added in series in the optical circuit.

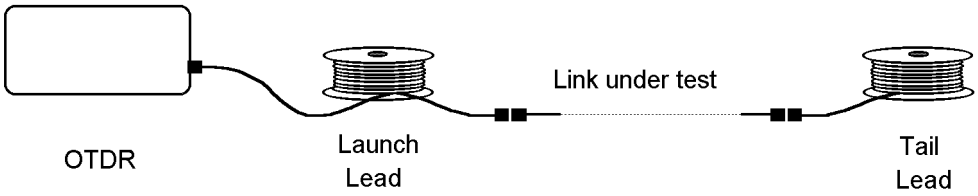
3.2.7 Testing the optical link

Having calculated the maximum attenuation in the link and determining that it does indeed fall within the rules, the next step is to test the link to ensure that the installed cable system has the same or lower attenuation.

3.2.7.1 OTDR

Set up the OTDR according to the Manufacturers' instructions. Ensure that the correct refractive index is set for the fibre being used, i.e.

	850 nm	**1 300 nm**	**1 310 nm**
50/125	1.481	1.476	-
62.5/125	1.495	1.490	-
Singlemode	-	-	1.472



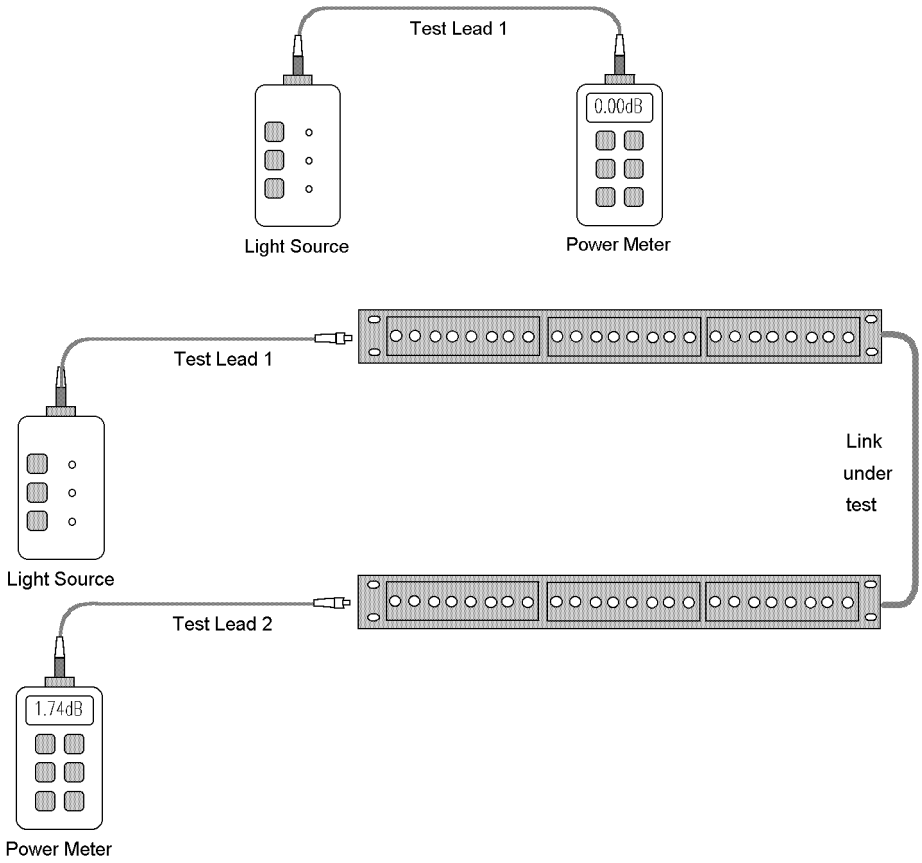
Setting up the equipment in the configuration shown above, employing a tail lead, will allow the simultaneous measurement of local and remote connector pairs.

Launch the test signal into one of the bulkhead adapters via the test lead to ensure that the whole link is being tested. It is preferable to test at 850 nm and 1 300 nm for multimode and 1 310 nm for singlemode. Print out or record the overall link attenuation. In the case of anomalous results, such as a negative attenuation, the link shall be tested from both ends and the results averaged to give a meaningful reading. If traces are to be submitted as part of a warranty application, they shall be presented at a scale that will allow meaningful interpretation of the data.

3.2.1.2 Power meter and light source

This is the simplest and cheapest method of testing a short haul datacoms link. Set up the power meter and Light source according to the Manufacturers' instructions. The power meter and light source are first calibrated by plugging the light source directly into the meter and setting the meter to read zero dB, see upper part of Figure below. For the rest of the testing session the test lead should not be unplugged from the light source nor should either instrument be switched off. The meter and light source should not be calibrated by connecting the two test leads together using a connector adapter in the middle, because this has the effect of discounting the loss of one of the bulkhead adapters in the cable system under test. i.e.

Calibration



3.2.7.3 Network link testing

Ensure the Light Source and power meter are both set to the same wavelength. Note also that the optical fibre is characterised at 850 nm and 1 300 nm for multimode, but some test sets do not use exactly these same wavelengths. If this should be a significant problem then table A1 of BS 7718 gives advice on correction factors.

3.3 LABELLING

- All cable, conduit, telecommunication closets, equipment rooms, entrance facilities, patch panels, and cross-connects shall be labelled as specified in EIA/TIA-606.
- EIA/TIA-606 specifies labelling requirements; the label format shall be agreed with the Principal.
- Each label identifier shall be unique.
- Labels shall be affixed to:
  - In work area: outside of faceplate, inside outlet box (where it can be viewed with the cover off), and on cable where it enters the outlet box
  - On horizontal run: on cable inside zone boxes and pull boxes
  - In closet: on patch panel (outside of faceplate, inside outlet box, on cable where it enters outlet box), on distribution panel, and on punch-down blocks
  - Zone boxes, pull boxes, and each end of conduit.
- All labels shall have permanent, non-fading markings, and shall be attached by adhesive, insert or fastening methods as described in EIA/TIA-606.
- Labels shall be colour-coded and include alphanumeric text 8 to 10 characters long.
- Cables shall be labelled to indicate:

  Closet identification of originating end;
  Office identification or geographical coordinates identification of destination end;
  Floor number and building number;
  Drop number;
  Individual cable type;
  Patch panel termination coordinates (block number, position number).
- Each cable shall be uniquely colour-coded as to type and usage. Types of cable include Category 3, Category 5, multimode, and single mode fibre.
- All cross-connect panels shall be colour-coded to designate their use.
- All blocks and panels shall be labelled with panel, block and position.
- All closets shall be labelled with building, floor and closet identifiers.
- Conduit labels shall indicate the destination closet, sequential number and conduit length.

3.4 AS-BUILT DELIVERABLES

- The original Manufacturer and/or Contractor's certification shall be delivered to the Principal.
- All specified Manufacturer's warranties shall be delivered to the Principal.
- For cable management purposes, the information defined below shall be delivered to the Principal. Electronic format suitable for the cable management package shall be provided if requested by the Principal.

  The Contractor shall provide cable identification, testing results, cable length, cable type, name of person conducting test, date, Manufacturer, part numbers, date of installation and the name of Contractor for each cable and cable pair.

  The Contractor shall provide floor plans showing cable termination locations and cable routing. Separate diagrams shall be provided for each type of cable, each floor, patch panels and vertical cable with a scale no smaller than 1:100. Where the Principal uses a CAD/CAM system the information supplied shall be compatible.

3.5 ACCEPTANCE

The Contractor shall demonstrate to the Principal's satisfaction that the scope of work has been accomplished in accordance with the contract conditions.

- Acceptance shall be on a pass or fail basis, and the work shall only be considered to pass the test if all the acceptance criteria of the test are met.
- In the case of a failure, the test shall be repeated after any necessary corrections have been made. Modifications are not acceptable during the test. Repeated tests shall be conducted on any part of the system that may be affected by the modifications.
- All necessary modifications as a result of a failed test shall be the responsibility of the Contractor.
- The Principal has the right to be present during the testing.
- The Principal is responsible for accepting or rejecting the test (pass or fail judgement).
- All work which will be hidden or inaccessible shall be made available to the Principal for inspection before it is hidden.
- The Contractor shall prove to the Principal that make and quality of components and the resultant scope of work (original contract plus all approved change orders) are in accordance with the contract and attached specifications. The Contractor shall provide documentation of the material's ability to meet the performance criteria.
- The test procedures used and results from (3.2) shall be reviewed for acceptance.
- The Principal shall have the right to re-test an agreed percentage of the installation at random to verify accuracy of the documented test results.
- All deliverables (drawings, documentation) shall be inspected for completeness.

4. MATERIALS

4.1 CABLE SPECIFICATIONS

- Horizontal UTP cable shall be ISO and EIA/TIA Enhanced Category 5 rated, 24 AWG four-pair unshielded twisted cable with thermoplastic insulated conductors and enclosed within a thermoplastic jacket as dictated by building construction and local fire codes. Screened cables shall be used where local regulations dictate or if required by the Principal.
- Backbone voice UTP cable shall be minimum ISO and EIA/TIA Category 3 rated, 24 AWG unshielded twisted multipair cable with thermoplastic insulated conductors and enclosed within a thermoplastic jacket. The cable shall have 25 pairs or multiples of 25 pairs.
- Optical fibre cables shall be single mode fibre for distances greater than 2 km. Up to 200 m the fibre should be 62.5/125 or 50/125 multimode. For 200 m to 2 000 m the fibres should be a mix of multimode and singlemode, e.g. 8 multimode and 4 singlemode. Install a minimum of twice the number of fibres initially required, with an absolute minimum of 12 strands. Alternatively blown fibre multiduct can be installed. A seven tube multiduct will give a capability of at least 28 optical fibres to be installed at a later date. Multimode optical fibre cables shall have a core of 62.5 or 50 micrometres, cladding of 125 micrometres, graded-index and consist of twelve strands. Numerical aperture 0.275, attenuation less than 1.5 dB per km at 1 300 nm (FDDI), and less than 3.75 dB per km at 850 nm. The modal bandwidth shall be 500 MHz.km at 1 300 nm (FDDI) and 200 MHz.km at 850 nm. The cable shall meet requirements of FDDI, FOIRL, 10BaseF, 100Base FL, 1000BaseSL and 1000BaseSX and comply with EIA/TIA 568A and ISO/IEC 11801.

Fire safety Performance of cables

Class	Flammability	Halogen Content	Smoke Generation
PVC	IEC 332-1	-	-
HF-1	IEC 332-1	IEC 754-1	IEC 1034
HF-3	IEC 332-3-c	IEC 754-1	IEC 1034
PLENUM	UL 910	-	UL 910

For indoor cables, IEC 332-1 must be seen as an absolute minimum legal requirement. The HF-3 class of cables is generally recommended. In the USA, the National Electrical Code dictates which style of cable may be used where.

4.2 ACCESSORY SPECIFICATIONS

- UTP work area connectors shall be 8 pin ISDN (RJ45), also known as ISO/IEC 8877. Connectors shall meet Enhanced Category 5 requirements in EIA/TIA 568A Cat5e addendum 5 and ISO/IEC 11801 Class D (1998).
- UTP cross-connects shall use the 110 cross-connect system. Barrel IDC (Insulation Displacement Contact) connections shall be used. Screw-type terminations shall not be used.
- Patch cords shall maintain Category 5 cable specifications, ribbon cables are not permitted. In telecommunications closets, the maximum length of patch cords shall be 6 m, in the office 3 m, and in the MDF 20 m. Use pre-terminated patch cords which are part of the cross-connect system.
- Optical fibre cable connectors shall be either ST-II-type bayonet (BFOC/2.5) or 568SC connectors. Do not mix connector types. ST to FDDI (568SC) adapters are available. SMA or Biconical connectors shall not be used. Although EIA/TIA 568 specifies 568SC connectors, BFOC/2.5 connectors (ST) are permitted.
- Optical fibre cable patch panels shall be of a type suitable for use with ST connectors and 568SC connectors, where conversion of any one connector can be easily changed to the other type within the same panel. The box shall include a cover to protect the fibre

from physical damage, exposure to moisture or other corrosive elements. The patch panel shall have a high density to conserve space but shall be consistent with cable management requirements, and terminate no more than 144 fibres within a wall area of 610 mm x 610 mm.

- Where data cabinets are used, all such cabinets shall have removable and hinge reversible doors with glass panels for observation of any visible indicators or alarms. Removable sides shall be furnished to permit access to cables and equipment. All equipment shall be connected to the earth busbar. Enclosed data cabinets shall have ventilation roofs and fans.

5. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.

AMERICAN STANDARDS

Commercial Building Telecommunications Cabling Standard.	EIA/TIA 568A
Commercial Building Cabling Standard, for Telecommunications Pathways and Spaces.	EIA/TIA 569
Resendential and light Commercial Telecommunications Cabling Standard.	EIA/TIA 570
Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.	EIA/TIA 606
Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems	TSB 67
Centralized Fiber Optic Cabling Guidelines	TSB 72
Additional Horizontal Cabling Practices for Open Offices	TSB 75

Issued by:
Electronic Industries Alliance
2500 Wilson Blvd
Arlington VA 22201-3834
United States

Standard for Safety test for Flame-Propagation and Smoke-Density Valves for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air. Fourth edition.	UL 910

Issued by:
Underwriters Laboratories Inc.
333 Pfingstein Road
Northbrook IL 60062
United States

BRITISH STANDARDS

Code of Practice for Installation of Fibre Optic Cabling	BS 7718

Issued by:
British Standards House
389 Chiswick High Road
London W4 4AL
United Kingdom

EUROPEAN STANDARDS

Information Technology - Cabling System Installation (3 parts)	prEN 50174
EMC immunity requirements for Information Technology Equipment	prEN 55105

Issued by:
Comité European de Normalisation
Secrétariat Central
Rue de Stassart 36

B-1050 Brussels
Belgium

INTERNATIONAL STANDARDS

Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications	ISO/IEC 8802-3 (Ethernet), 10BaseT addendum. 1000BaseT, 1000BaseSX & 1000BaseLX
Information Technology - Local and Metropolitan Area Networks - Part 5: Token Ring Access Method and Physical Layer Specifications	ISO/IEC 8802-5 (Token Ring)
Information Technology - Telecommunications and information exchange between systems; interface connector and contact assignments for ISDN basic access interface located at reference points S and T	ISO/IEC 8877
Information Processing Systems; Fibre Distributed Data Interface (FDDI); Part 3: Physical Layer Medium Dependent (PMD)	ISO/IEC 9314-3
Information technology - generic cabling for customer premises.	ISO/IEC 11801 (1998),
Inplementation and operation of customer premises cabling, Part 2	ISO/IEC JTC 1/SC25 PDTR 14763-2, November 1997

Issued by:
International Organisation for Standardization
1 Rue de Varembé
CH-1211 Geneva 20
Switzerland.

6. BIBLIOGRAPHY

NOTE: The documents listed below are for information only and do not form an integral part of this DEP.

1.	Guidelines for structured cabling systems	SIEP 98-5514
2.	Commercial Building Grounding and Bonding Requirements for Telecommunications	EIA/TIA 607
3.	Generic Emission Standard (2 parts)	EN 50081
4.	Generic Immunity Standard (2 parts)	EN 50082
5.	Information Technology - Generic Cabling Systems	EN 50173
6.	Radio disturbance characteristics of Information Technology Equipment	EN 55022

APPENDIX 1 GLOSSARY OF STANDARDS AND STANDARDIZING BODIES

ATM is a new base technology for private and public networks. The ITU-TS (International Telecommunications Union, Telecommunication Standardization sector, formerly CCITT) adopted the first set of thirteen recommendations on ATM in 1990. Regional bodies like ETSI in Europe, T1 in North America and TTC in Japan have contributed to these achievements. The ATM Forum is a body of users and vendors who have a close co-operation with the standards bodies. The ATM Forum is not a standards body.

BICC Brand-Rex MillenniuM/GigaPlus Cabling System. A structured cabling system offering screened and unscreened Enhanced Category 5 cabling, plus conventional and blown optical fibre backbones. The system exceeds all ISO and TIA/EIA specifications and comes with a 25 year warranty.

EIA (Electronic Industry Association) was established in 1985. TIA (Telecommunications Industry Association) was established in 1988. Although TIA is a separate organisation, its standards are coordinated through the EIA, hence the combined EIA/TIA designation.

EIA/TIA 568A Commercial Building Telecommunications Cabling Standard specifies how to design a generic structured cabling system supporting a wide range of transmission methods, not all presently in use or offered. The standard structures cabling infrastructures into components: backbone, cabling closets and horizontal cabling, and specifies topology, cable, installation methods and termination techniques. Originally issued in July 1991, a number of Technical Systems Bulletins (TSBs) have been issued since to provide additional information not addressed in the original standard.

EIA/TIA 569 Commercial Building Cabling Standard for Telecommunications Pathways and Spaces. This standard covers cable trays, conduits and telecommunications closets.

EIA/TIA 606 Administration Standard for Telecommunications Infrastructure of Commercial Buildings. EIA/TIA 606 establishes the minimum requirements for asset inventory and management; cable records, room, parts and equipment; labels; and how to maintain work orders and trouble logs.

IEEE (Institute of Electrical and Electronics Engineers) is an international professional institute that defines network standards and is a member of ANSI. IEEE 802 is the Local Area Network standard dealing with the physical and link layers of the ISO reference model for OSI. IEEE 802.3 is for CSMA/CD Ethernet and IEEE 802.5 is for Token Ring systems. ISO equivalent numbering for IEEE 802.3 is ISO/IEC 8802-3, and for IEEE 802.5 it is ISO/IEC 8802-5.

Lucent Systimax Premises Distribution System (PDS) is a product and set of installation guidelines based on industry standards. Lucent provide Vendor testing, Contractor certification, installation certification, audits, training, and systems assurance.

Underwriters Laboratories (UL) is a North American approvals organisation which certifies cable according to performance specifications. UL has now adopted the EIA/TIA Categories. UL certification is now well established and many cable manufacturers have had their cables certified under the UL certification programme.