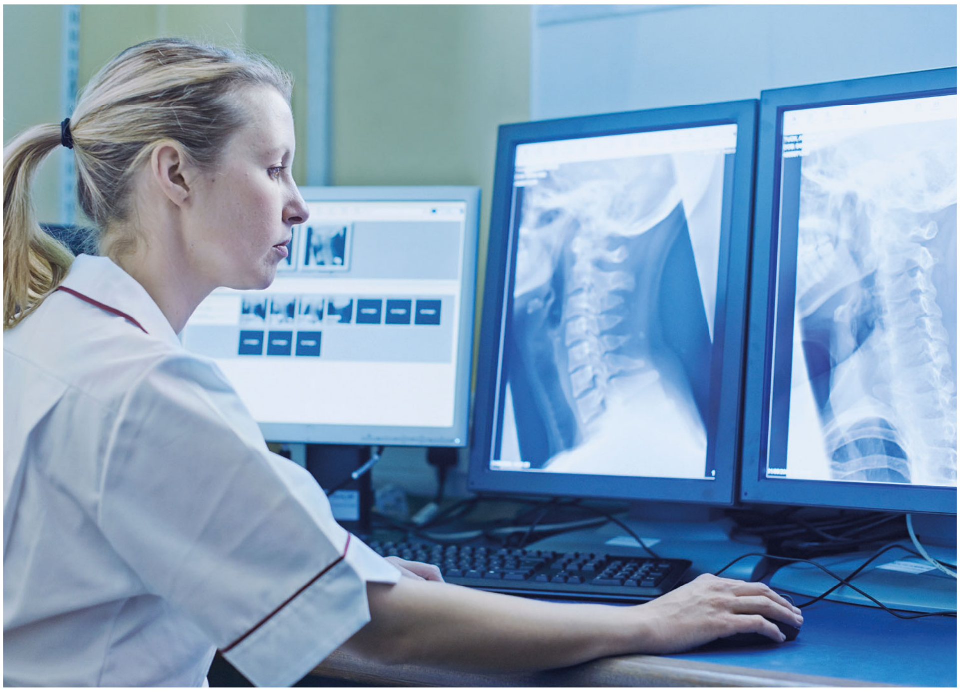
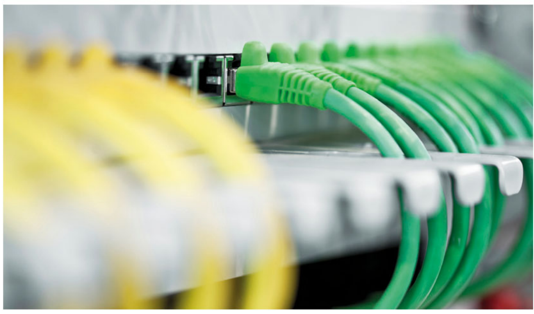
The Institution of Engineering and Technology

NHS Digital

Code of Practice

Building Infrastructures for Healthcare ICT





The Institution of Engineering and Technology

Code of Practice

Building Infrastructures for Healthcare ICT

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Foreword

Our digital health service relies heavily on modern information technology (IT) to deliver services, as healthcare increasingly moves to paperless working. To support this, healthcare buildings require an associated information and communications technology (ICT) infrastructure provision to enable current and future IT investment.

Typically, during their career, health and social care staff only have exposure to a single major build/upgrade project for ICT infrastructure provision. Although ICT infrastructure is subject to comprehensive international European and British standards to support this, there are times new builds have been affected by deployment mistakes.

This Code of Practice has been designed to help support safe, efficient and cost-effective ICT infrastructure in buildings. It provides a solid grounding on the breadth of cables and cable management systems, covering both electrical supply and communications and control technologies, for traditional and special applications.

Clive Star
Lead Technical Architect
NHS Digital

Section 1

Introduction

1.1 Digital technology and healthcare

The delivery of safe, efficient and cost-effective healthcare is critically dependent on digital technology. This dependency is constantly increasing, not only for IT and voice systems, but also for:

(a) medical imaging equipment, such as computed topography (CT), magnetic resonance imaging (MRI) and ultrasound scanners;
(b) medical devices, which are increasingly being networked: examples include patient monitors, infusion devices and point-of-care testing (PoCT) instruments;
(c) patient entertainment systems;
(d) building automation and management systems, including for environmental control and energy management;
(e) surveillance cameras, security and access control systems; and
(f) many others.

The volume of data that is being acquired, processed and stored is growing rapidly. Data is being accessed more frequently, for many reasons. Data exchange or sharing both within and between organizations is rising at a considerable rate, as is the use of cloud-based services. Healthcare organizations need to support their own equipment and devices, as well as the mobile devices of staff, patients and visitors. Demand for both wired and wireless data transmission is also increasing, as a result of constant developments in the Internet of Things (IoT) field.

The building infrastructure for information and communications technology (ICT) consists of all the 'telecommunications cabling', together with the 'accommodation' (such as trunking, ducts, conduit, cabinets and what are commonly termed – informally – 'comms rooms') required both for that cabling and for the associated ICT equipment.

It is of paramount importance that the building infrastructure for ICT is capable of supporting not only existing but also future demands. Furthermore, it is imperative that this infrastructure, as well as meeting functional requirements at all times, is maintainable and repairable.

If these conditions are not met, the operation of networked devices and equipment will be compromised. Under such circumstances, and given the dependency on digital technology in healthcare premises, the quality and efficiency of care can suffer significantly. In extreme cases, patient safety is at risk.

1.2 Background

Considerable numbers of healthcare organizations have good, if not, excellent infrastructures. However, there is plenty of feedback from experts in the field, and other anecdotal evidence, to show that the infrastructures of many healthcare buildings are unable to meet current, let alone the inevitable new, demands.

Older buildings often present challenges because the use of current digital technology was, unavoidably, not envisaged during their design and construction. However, shortcomings are not confined to old premises. There are known to be several fairly new hospitals in which the ICT-related building infrastructure has been seriously compromised.

Although lack of funding is sometimes an issue, it is not necessarily the primary factor. In any case, the recurring costs of rectifying problems almost invariably exceed the investment that would have been needed to set up the infrastructure suitably in the first place. Some of the key causes of the shortcomings are as follows:

(a) there can be a lack of experience in specifying, procuring and maintaining the infrastructure in question as this type of major project is relatively infrequent in considerable numbers of National Health Service (NHS) or healthcare organizations.
(b) accountability and/or responsibilities that are unclear: in many NHS organizations, the relevant infrastructure is typically within the remit of both IT on the one hand and estates/facilities departments on the other. It is often the case that neither has the necessary understanding of the other's area.
(c) cabling installers and other suppliers are frequently required to work to specifications that are incomplete or unclear. This is because many NHS organizations have capability or capacity constraints in this area, or they have relied on contractors and/or consultants, who do not have the necessary expertise, to produce the specifications.
(d) in new building or large refurbishment projects, there are usually many levels of subcontracting and, in some cases, the lead or prime contractors do not pay enough attention to the specification and installation of the infrastructure in question.
(e) installers accustomed to office and similar premises are sometimes unaware of special requirements (such as infection control or 24/7 operation, including occupation of clinical areas) in healthcare. Examples of the consequences are that patient areas have been contaminated during installations and, in other cases, clinical equipment has been switched off without planning or warning. In some of these instances, patients have been very seriously harmed.
(f) the infrastructure is rarely, if ever, audited or subjected to independent scrutiny.

1.3 Purpose of this Code of Practice

Many of the issues outlined can be addressed by following the relevant standards. There are several British Standards, as well as other documents that address building infrastructures for ICT. They are, however, relatively long and need some expertise to apply effectively. Many of the requirements are not relevant to healthcare and there are also many options to select from.

The purpose of this Code of Practice is to provide guidance on applying the standards appropriately in healthcare premises. It is intended to assist all key stakeholders and has been developed primarily for:

(a) personnel in healthcare and/or related organizations (for example, landlords and construction firms) who need building ICT infrastructures specified and installed; and
(b) telecommunications cabling and data centre specialists/experts who are not familiar with the special requirements of healthcare.

The majority of the material is for readers in the first category. The approach taken for them is to outline or summarize the following:

(a) key concepts and terms;
(b) processes that need to be followed by all relevant parties in order to achieve a completed installation that meets the objectives; and
(c) requirements and recommendations of the relevant standards. Particular emphasis is placed on those areas where multi-disciplinary issues arise, for example, the location and mechanical and electrical (M&E) services for comms rooms.

This Code of Practice will assist healthcare organizations with all aspects of projects involving building infrastructures for ICT, including requirements gathering, specification, planning, installation, project and risk management, stakeholder engagement and so on. It will also enable healthcare organizations to deal more effectively with suppliers and reduce the need for consultancy advice.

1.4 Scope

1.4.1 Premises

This Code of Practice is intended to cover all premises (or dedicated parts) the main purpose of which is the delivery of healthcare to service users. The following are therefore included (but the list is not exhaustive):

(a) hospitals;
(b) diagnostic and treatment centres (DTCs);
(c) community clinics;
(d) health centres;
(e) general practitioner (GP) surgeries; and
(f) nursing homes.

Premises may or may not be under the control of the organizations that use them for healthcare. For example, a hospital or GP practice could:

(a) own and manage the buildings it uses;
(b) own buildings, but outsource the facilities management; or
(c) lease (or equivalent) buildings, or parts of them, from a third party.

Furthermore, healthcare premises may be used by:

(a) NHS or other publicly funded organizations;
(b) independent (or private) sector providers;
(c) third-sector (i.e. charitable/voluntary) organizations; or
(d) any combination of the above.

1.4.2 Scenarios

This Code of Practice is intended to cover the majority of scenarios involving the installation of telecommunications cabling (together with associated pathways), rooms for active and/or passive equipment, and data centres in healthcare premises. Typical scenarios are:

(a) new builds;
(b) refits of existing buildings that are unoccupied; and
(c) changes in occupied buildings, such as:
  (i) major additions to existing cabling infrastructure;
  (ii) construction of new data centres; and
  (iii) minor additions or changes to the infrastructure.

1.4.3 Exclusions

This Code of Practice is concerned with telecommunications cabling, together with other building ICT infrastructure. Although such cabling enables a wide range of devices, equipment and appliances to communicate, these are not otherwise within the scope of this Code of Practice.

Cloud computing is also out of scope, but its use is critically dependent on links between networks in healthcare premises and external IT service providers. Within this Code of Practice, there is detailed coverage of connection to cabling outside buildings.

Electrical installations covered by BS 7671 (the IET Wiring Regulations) are out of scope.

The following installations of telecommunications cabling are also out of scope:

(a) installations in proximity to high voltage (HV – defined as over 1,000 V AC or 1,500 V DC) power supplies or cabling (this exclusion reflects the scope of the relevant standards);
(b) specialist installations not included in the relevant standards and/or where other standards or regulations take precedence (this applies, for example, to fire detection/alarm systems and lifts – details of documents providing guidance on these topics in particular can be found in Annex C.1); and
(c) external installations and cabling that are considered to be rare in the healthcare context, such as:
  (i) near railways and motorways;
  (ii) underwater; or
  (iii) into existing piping for other services, such as water, sewerage or gas.

The design or logical architecture of the following is excluded:

(a) dedicated voice cabling (typically using internal CW1308 multicore voice cables or the external equivalent, CW1128); and
(b) coaxial cabling.

These are not covered because they are legacy solutions and not included in the relevant standards. Cabling of either type is not recommended by this Code of Practice, as each is for dedicated purposes, rather than being generic. However, although the design for these is not in scope, their actual installation is not excluded, as the installation standards do allow for them.

1.5 Intended readership

1.5.1 Healthcare organizations

Healthcare organizations vary significantly, but many only undertake major network installations occasionally. As a consequence, some such organizations may not have sufficient expertise or resources to specify or procure the infrastructure in question.

In addition, and as previously mentioned, within an organization accountability and/or responsibility for the relevant infrastructure is not infrequently within the remit of both the ICT department and the estates/facilities department. It is often the case that neither has the necessary understanding of the other's area.

This Code of Practice is therefore aimed particularly at ICT and estates/facilities departments in healthcare organizations. It will also be of benefit to departments with specialist requirements, particularly those with a remit for imaging equipment and other types of medical devices.

1.5.2 Healthcare premises owners, developers and landlords

Providing the required building infrastructure for ICT to deliver safe, effective and efficient care is clearly in the interests of organizations that build, own or otherwise provide healthcare premises.

1.5.3 Building design and construction professionals

This Code of Practice will be of use to architects, healthcare estates and other engineers, as well as builders whose projects involve healthcare premises in which there are networks and/or data centres.

1.5.4 ICT and medical devices industries

With many office premises and commercial organizations having data centres of various sizes, as well as sophisticated networks, there is considerable expertise in the area of building infrastructures in the ICT industry. However, the combination of the necessary experience in that technical domain on the one hand and an understanding of the special demands of healthcare on the other is relatively rare: this Code of Practice will help to address this gap.

In some larger contracts, suppliers of healthcare IT systems either subcontract to, or work in partnership with, third parties responsible for installing cabling and/or data centres. This Code of Practice will benefit the suppliers of such systems. Suppliers of medical imaging systems and other types of networkable medical devices will also have a direct interest.

1.5.5 Other

There are currently no mandated requirements for building infrastructures for healthcare ICT. This Code of Practice will enable the relevant government departments and/or national bodies to set policy and enforce compliance.

Regulators, auditors and similar bodies will be able to use this Code of Practice to scrutinize the infrastructure in question and provide independent assurance against defined criteria.

1.6 Standards

1.6.1 In scope

Figure 1.1 shows the titles of the standards in the EN 50173 and EN 50174 series, as well as their relationship to BS 6701. From the design or logical architecture perspective, this Code of Practice is concerned specifically with the distributed building services of EN 50173-6 and the related general requirements in EN 50173-1. The relevant requirements and recommendations of all three parts of EN 50174, which covers cabling installation, are addressed in some detail.

1.6.2 Requirements and recommendations

Of necessity, official British, European and International standards are drafted in accordance with a strict set of rules, so that there is no doubt as to what their requirements and recommendations are (for requirements, the word 'shall' is used exclusively, while for recommendations, 'should' is used). In order to claim conformance to a standard, the meeting of all the applicable requirements is mandatory.

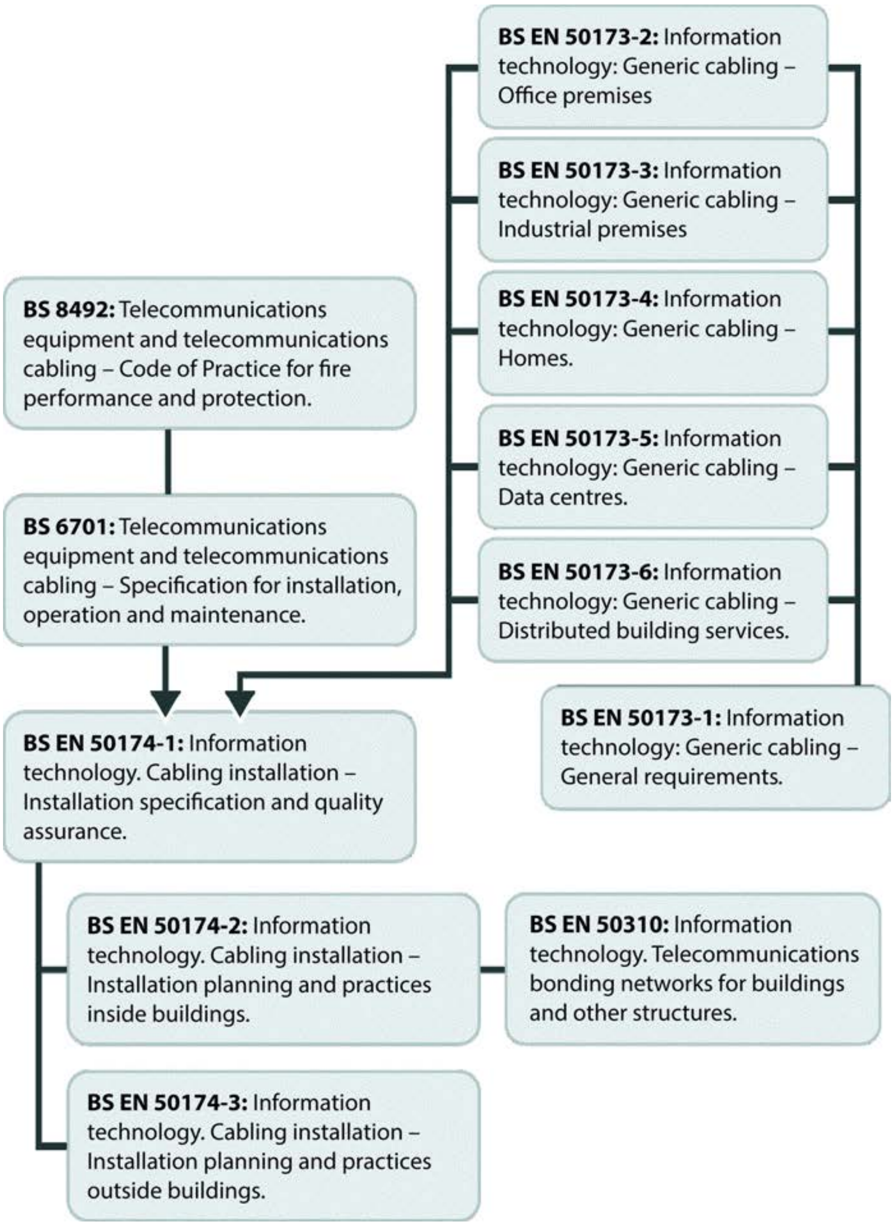
This Code of Practice summarizes many of the requirements and recommendations in the standards. In some instances, there are large groups of similar requirements. Where the overall requirements are being summarized in this Code of Practice, the word 'effectively' is used to convey the general intention of the standards.

This Code of Practice also makes recommendations of its own. These are clearly indicated, to distinguish them from those of the standards.

Where appropriate, the consequences of not following particular recommendations or guidance are outlined in this Code of Practice. A frequent consequence is increased operational costs as a result of inadequate initial investment.

This Code of Practice recommends that, in each case where a decision not to follow recommendations or guidance is taken, the reasoning or justification is fully documented.

Figure 1.1 BS 6701 and related standards



1.6.3 Enforcement of the standards

The standards that are the subject of this Code of Practice can (and should) be enforced in relevant contractual documents when undertaking any project that includes installation of telecommunications cabling and related building infrastructure for ICT. Such projects are often, but not exclusively, part of a larger programme, such as a building construction or refurbishment.

Further information on referencing standards in contracts and procurements can be found in Section 3.6.3.

Whilst a healthcare organization can enforce the standards on installers and other contractors or suppliers, there are requirements that it is obliged to meet itself, not only during a procurement and subsequent installation project, but also during the lifetime of the installation.

As explained in Section 3.3.2, conformance to BS 6701 and, in turn, the EN 50174 series cannot be claimed unless installation has been carried out in accordance with an 'installation specification' that meets the requirements of EN 50174-1. The production of the 'installation specification' is the responsibility of the premises owner. Conformance, by the owner, to the parts of the standards that apply to the premises is a prerequisite and cannot be avoided.

In addition, healthcare organizations are required to conform to BS 7671 (the IET Wiring Regulations): failure to do so is generally considered indefensible. Conformance to BS 6701 is a requirement of BS 7671; therefore, any healthcare organization claiming to conform to BS 7671 must also conform to BS 6701 (and the EN 50174 series).

1.6.4 References to standards

The EN 50173 and EN 50174 series are European, but have been endorsed by the UK, so are formally designated as BS EN 50173 and BS EN 50174, respectively. In this Code of Practice, the shorter references to these and other relevant European standards are used to aid readability.

1.6.5 Guidance and supporting documents

Health Technical Memoranda (HTMs)

HTMs are freely available documents published (in England) by the Department of Health and Social Care. Although the technical content is very similar, different versions of HTMs are produced by each of the relevant bodies in England, Scotland (SHTMs) and Wales (WHTMs).

HTMs "give comprehensive advice and guidance on the design, installation and operation of specialized building and engineering technology used in the delivery of healthcare". Of particular relevance in the context of this Code of Practice is HTM 06-01 which covers electrical services supply and distribution.

Fibreoptic Industry Association (FIA)

Despite the organization's name, the Fibreoptic Industry Association publishes guidance not only on optical fibre cabling but also on many other aspects of telecommunications cabling including external installations, fire and laser safety, and regulatory matters.

1.6.6 Changes to standards and guidance documents

Standards are subject to revision: the precise versions to which this document refers are listed in Annex B. The EN 50173 standards have been refined over many years, with the last extensive revision completed in 2018. They are now considered to be highly mature and stable so are unlikely to be changed significantly in the foreseeable future. The EN 50174 standards were thoroughly revised at around the same time as the EN 50173 series and the 18th Edition of BS 7671 was also issued in 2018. As this Code of Practice was developed not long after all these standards were updated, it is expected to be valid for some time.

It should be noted, however, that at the time of writing, some of the guidance documents to which this Code of Practice refers had not been updated to reflect the revisions to the standards mentioned. Whilst the guidance documents remain useful, some inconsistencies with the revised standards and this Code of Practice are inevitable.

1.7 Document structure

The rest of this document is structured as shown in Table 1.1.

Table 1.1 Structure of the Code of Practice

Section	Content
2	In order to set the context for the rest of the Code of Practice, this section outlines the main concepts and briefly explains the key terms that are used in the relevant parts of the EN 50173 and EN 50174 series.
3	This section covers how projects that involve building infrastructures for healthcare ICT should be managed. It addresses project phases, roles and responsibilities, governance arrangements and documentation requirements. There is also detailed consideration of potential risks and issues.
4 to 7	Sections 4 to 7 are intended for more technical readers and particularly those in healthcare organizations rather than cabling industry professionals for whom much of the information will be familiar.
4	Section 4 outlines the logical design or architecture of telecommunications cabling, with particular reference to the relevant EN 50173 standards.
5 and 6	Once building infrastructures for ICT have been designed, they need to be specified and their installation has to be planned. Following planning, the installation itself takes place, and after that, the infrastructure goes into operation. Sections 5 and 6 provide detailed information on each of these phases and, for reference purposes, summarize the vast majority of the relevant requirements and recommendations in the standards.
7	Section 7 takes a similar approach to Sections 5 and 6, but is for installation of cabling outside buildings. As with Sections 5 and 6, this summarizes, for reference, the vast majority of the relevant requirements and recommendations in the standards.
8	Sections 4 to 7 focus on technical requirements, many of which apply to all building ICT infrastructures. Section 8 is concerned specifically with the specialized requirements of healthcare premises.

Section 2

Concepts and terms

2.1 Purpose of section

In order to set the context for the rest of the Code of Practice, this section outlines the main concepts in the relevant parts of the EN 50173 and EN 50174 series. It also briefly explains key terms that are used in the standards.

This section provides only background information. Subsequent sections provide details of relevant requirements in the standards. These other sections also include recommendations and guidance from the standards, as well as advice specific to this Code of Practice.

Coverage of relevant concepts and terms used in the healthcare context can be found in Section 8.

2.2 Generic terms

The terms IT (information technology), ICT (information and communications technology) and 'telecommunications' are used in many different ways. Generally, and depending on the context, at one extreme the terms are considered interchangeable and, at the other, to have quite different and specific meanings.

For consistency with the British Standards with which this Code of Practice is primarily concerned, 'telecommunications cabling' is used as an overarching term and encompasses cabling for the transmission of any data or other signals.

To avoid any doubt, in the standards and this Code of Practice, telecommunications cabling supports data transfer for the widest possible range of systems and equipment, including (in no particular order and not exclusively) the following:

(a) IT and voice systems;
(b) medical devices and equipment;
(c) nurse call systems (provided at patients' beds to alert staff when necessary);
(d) systems used for facilities and estates, including those for building and energy management and for environmental control;
(e) security, including access control, alarms and closed-circuit television (CCTV);
(f) patient entertainment systems; and
(g) asset management systems, including radio-frequency identification (RFID) equipment.

To assist with planning and deployment, a more comprehensive list can be found in Section 8.10; however, the key point is that almost all digital communications can be supported using the same shared telecommunications cabling. This applies both to wired and wireless devices. Equipment using Wi-Fi signals, in particular, communicates with wireless access points (WAPs); telecommunications cabling provides the wired connections they need.

2.3 Cabling architecture

2.3.1 General

The EN 50173 standards specify:

(a) the structure and configuration of cabling systems;
(b) transmission and environmental performance; and
(c) test procedures.

The standards cover a very wide range of options. For reasons explained elsewhere, the sections that follow on cabling architecture are focussed on distributed building services and, specifically, Type A generic cabling in EN 50173-6.

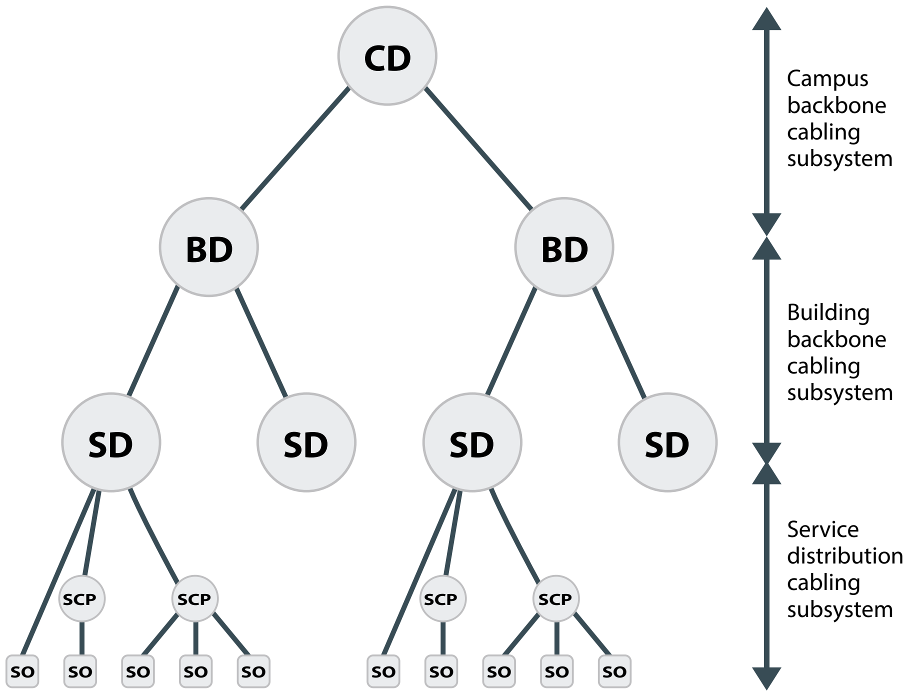
2.3.2 Cabling systems and subsystems

A cabling system in accordance with EN 50173-6 can have up to three cabling 'subsystems' (as the standard terms them), which are arranged in a hierarchy:

(a) 'campus backbone subsystem';
(b) 'building backbone subsystem'; and
(c) 'service distribution subsystem'.

Each subsystem consists of at least one 'distributor' (where termination and connection of cabling takes place) and the cabling associated with the subsystem. Figure 2.1 shows an example of how subsystems are arranged. The 'campus distributor' (CD) is connected to 'building distributors' (BDs), which in turn are connected to 'service distributors' (SDs). 'Service outlets' (SOs) are connected to service distributors either directly or via 'service concentration points' (SCPs).

Figure 2.1 Example of cabling subsystems



Taking BDs as an example, these typically consist of:

(a) equipment;
(b) patch cords;
(c) equipment cords;
(d) panels presenting the campus backbone cables; and
(e) panels presenting the building backbone cables (to the SDs).

Similarly, SDs consist of equipment, patch cords, equipment cords and panels. The panels in the SDs present the building backbone cables (to the BDs) and the service distribution cables.

'Cords' are cables that are not permanently installed (further explanation can be found in Section 2.3.3). As outlined in Section 2.6, the items in a distributor will be housed in one or more cabinets or other suitable accommodation.

Service distribution cabling subsystems consist of:

(a) SDs;
(b) service distribution cables;
(c) SCPs;
(d) SCP cords; and
(e) SOs.

SCPs are optional. User equipment (such as PCs) and other devices are connected to SOs with 'service area cords', but the cords themselves are not part of the service distribution cabling subsystem.

It is not necessary for all the cabling subsystems to be present and distributors can be combined. Such combination is common in small buildings, where single distributor cabinets can serve all the outlets and provide the other necessary functionality.

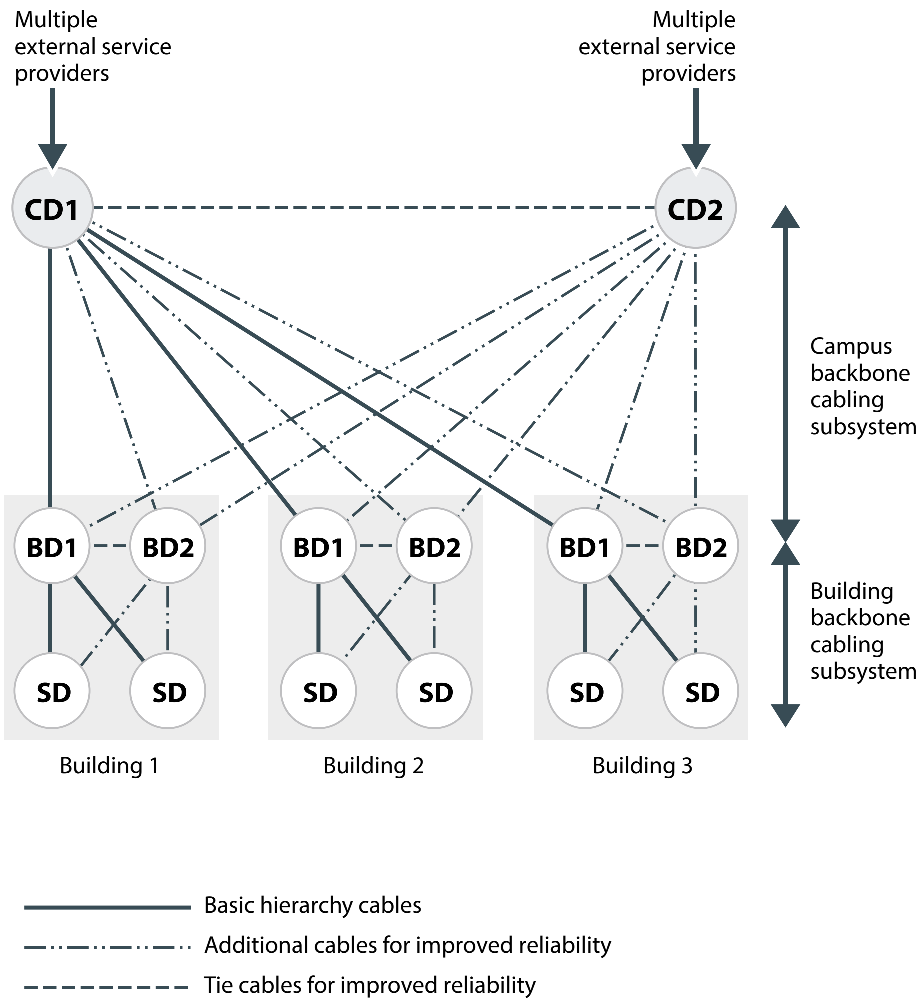
In Figure 2.1 there is neither resilience nor redundancy. However, the EN 50173 standards permit other cables between distributors:

(a) 'additional hierarchical cables' (from CD to BD or BD to SD); and
(b) 'tie cables': these connect distributors at the same hierarchical level.

Figure 2.2 provides an example where there are additional hierarchical cables and tie cables. Tie cables are permitted between SDs but, in the figure, the only tie cables are between BDs.

Additional hierarchical cables and tie cables are both means of improving reliability.

Figure 2.2 Example of cabling implementation for increased reliability



2.3.3 Cables, cords and jumpers

General

'Cabling', in accordance with the EN 50173 standards consists of 'cables', 'cords' and connecting hardware. These terms have rigorous definitions, but for the purposes of this section, the following is guidance on their meaning and use in the standards.

Cables are enclosed in an overall sheath and, for the transmission of signals, contain metallic conductors or at least one optical fibre. They are usually permanently installed in a building and are terminated (or connected up) as part of the installation process.

Usually, cords are not permanently installed and have connectors at both ends. Examples of common types of cords are:

(a) 'equipment cords', which connect equipment to a cabling subsystem in a distributor;
(b) 'patch cords', which are used, for example, in 'panels'; and
(c) 'service area cords', for example, between a desktop PC and an outlet in a wall or a floor box.

'Jumpers' do not have connectors and are used to make connections between terminated cables.

Balanced cables and cords

Metallic cables and cords (which are, strictly, a type of cable) in accordance with EN 50173-6 have to be of the 'balanced' type (coaxial cables are allowed in some of the other EN 50173 standards).

Balanced cables and cords normally consist of four sets of 'twisted pairs'. To maintain performance, it is important that the twists are preserved as far as possible when cables (and any cords) are terminated. Although it is normal for (permanent) cables to be terminated during installation, cords are usually terminated (at both ends) during manufacture.

The conductors in permanently installed balanced cables are solid. Cords are normally required to be flexible, as they are not permanently installed and may be reconnected from time to time. The conductors in cords are therefore stranded in most cases. However, there are circumstances where cords are unlikely to be flexed or reconnected (for example, to a fixed surveillance camera), except very occasionally, and in such cases, cords constructed from solid conductors are sometimes used.

Optical fibre cables and cords

The EN 50173 standards allow for optical fibre cables and cords that are: multimode or single-mode.

2.4 Remote powering

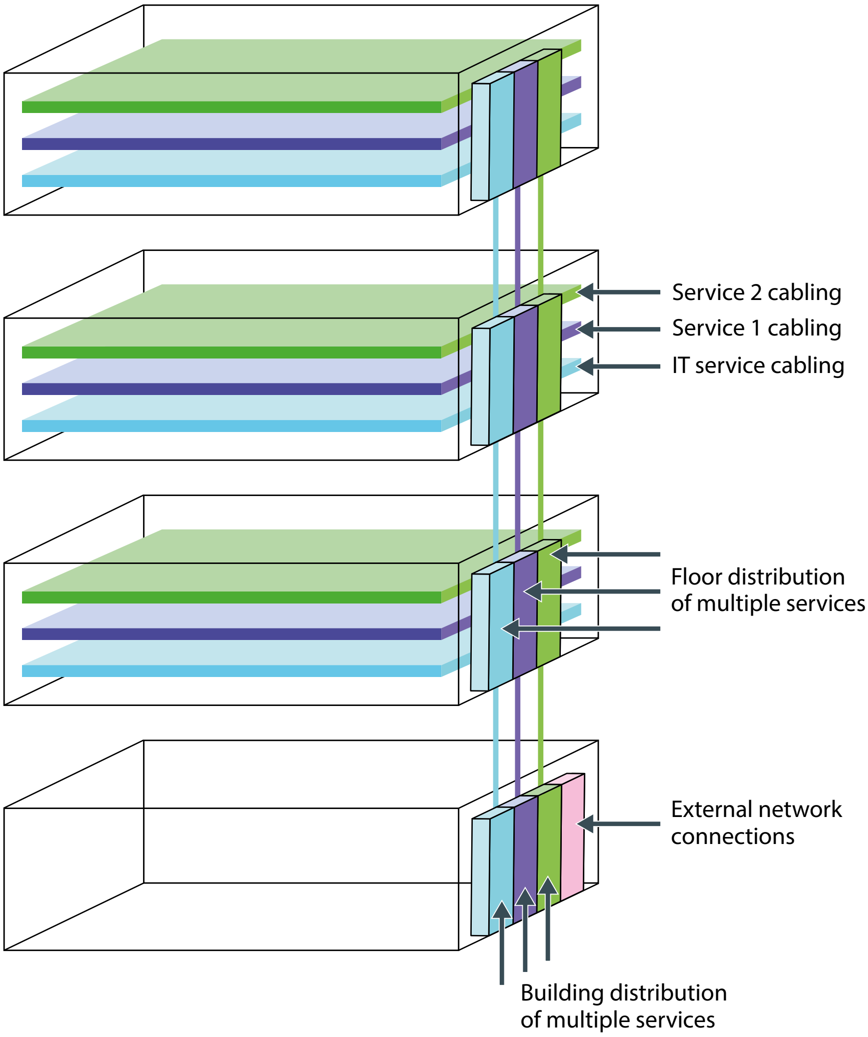
Metallic telecommunications cabling is increasingly being used not only to transmit data but also to provide low voltage (LV) power. The most widely used standard for this purpose is IEEE P802.3bt, which specifies Power over Ethernet (PoE), but there are other standards in this area, as well as proprietary technologies. 'Remote powering' is the term used in the telecommunications cabling standards to encompass PoE as well as other solutions.

Remote powering offers many potential benefits, but, as discussed in Section 5.11, its implementation presents a number of challenges.

2.5 Distributed building services

The concepts of 'structured cabling' and 'flood wiring' have been established for some time and need no explanation here. However, in many buildings, cabling systems have been installed not only for 'standard' IT, but also (and separately) for other services, such as access control and building management. Figure 2.3 shows an example of this. In addition, even in cases where existing cabling systems are suitable, in some buildings there may also be ad-hoc cabling for further services (for example, for security cameras).

Figure 2.3 Example of multiple cabling systems in a building



Distributed building services enable virtually all services to share the same cabling system. There are numerous major benefits from this approach, including, as shown in the example of Figure 2.4, reductions in the number of distributors and cabling complexity. Other advantages include the following:

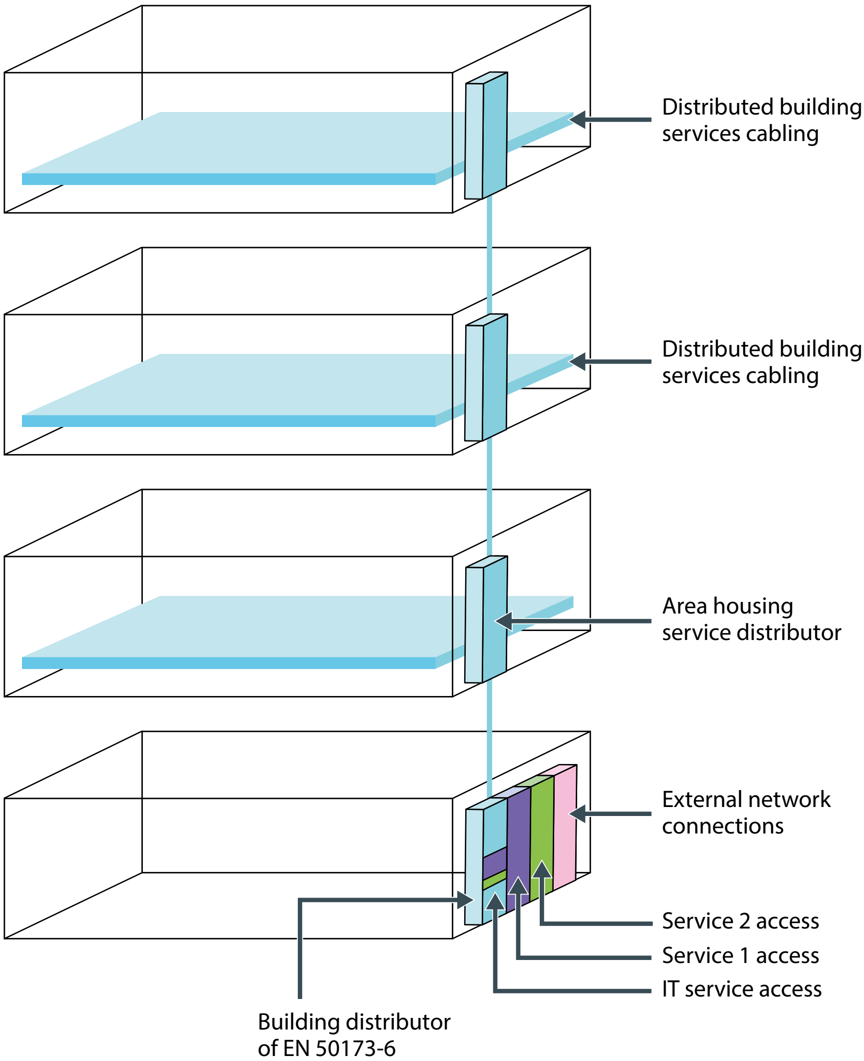
(a) the accommodation of the cabling can be considered as part of the initial design and planning for a building before the occupation or use of spaces has been determined and/or the systems to be deployed are known.

(b) whether before initial occupation or subsequently, changes to the use of a space are easier and less costly than would otherwise be the case. This is particularly advantageous in healthcare where, in some areas, changes of use are quite frequent and/or relatively urgent.

(c) cabling for different services can be installed in separate phases. This is helpful, for example, during building construction, as certain services are needed sooner than others.

Once a building is in use, services may be operated by different groups within an organization (in hospitals, for example, by estates and facilities, IT, medical engineering and security departments), so appropriate segregation or demarcation and security arrangements need to be in place.

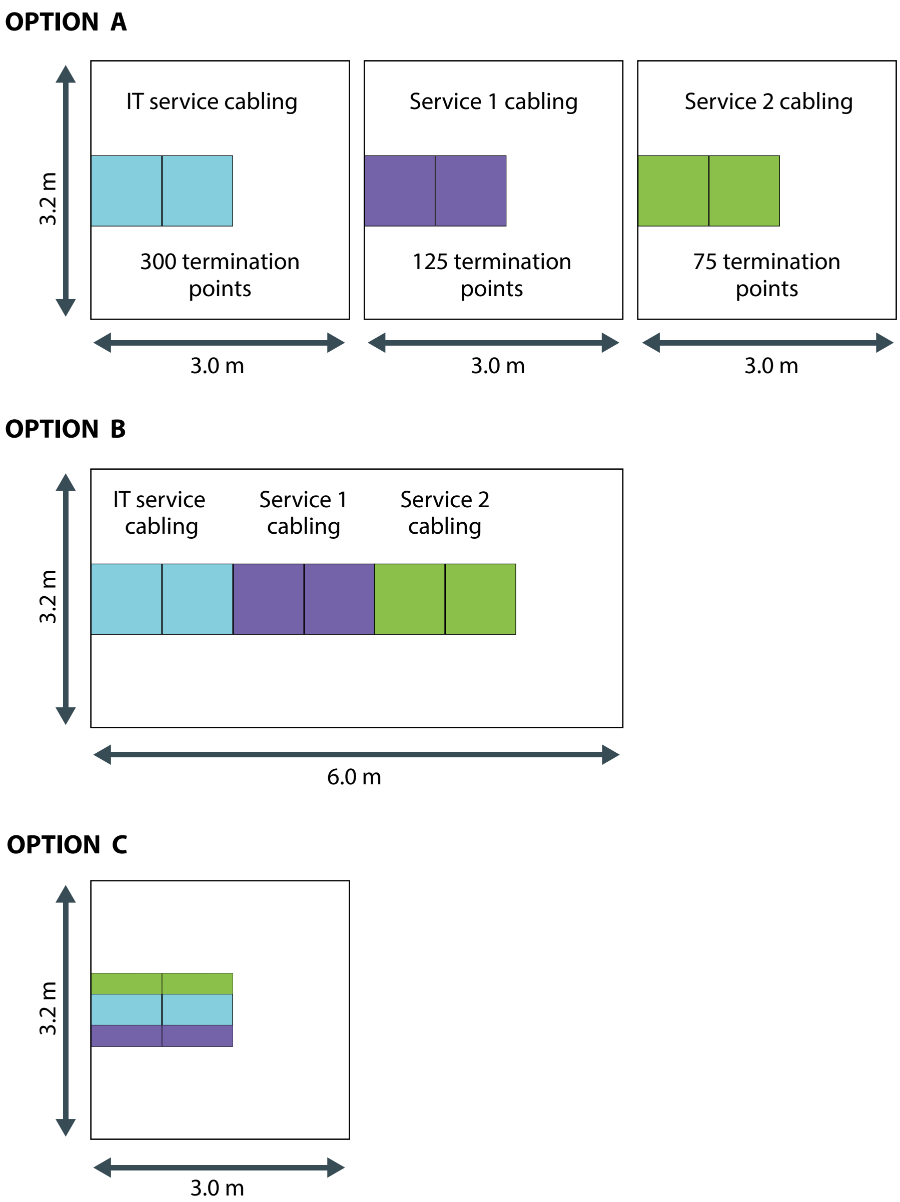
Figure 2.4 Example of distributed building services



In Figure 2.3, the distributors for each service on a floor could be in separate rooms. These rooms could be adjacent to each other, as shown in the first example (option A) of Figure 2.5. However, less space would be needed if all the required cabinets were in the same room, as shown in option B, and there would be no issues with demarcation between different groups or departments, as the cabinets could be locked. If the necessary arrangements are in place, distributed building services can be exploited even further, with different services sharing the same cabinet, as option C illustrates.

The distributed building services approach is not confined to new buildings or major refurbishments where existing cabling is being largely replaced. Distributed building services can be implemented as an 'overlay' to existing cabling that is in accordance with the EN 50173 standards.

Figure 2.5 Examples of options for sharing spaces



2.6 Accommodation of cabling and equipment in buildings

2.6.1 General

Installed cables have connectors such as plugs and sockets fitted to them at 'termination points'. A 'pathway' is the defined route of a cable between termination points, for example, under a floor or above a ceiling. 'Pathway systems' are the means by which the pathways are defined.

'Cable management systems' provide one or more of: support, containment, retention or protection for all types of cabling. This includes electrical power cables, although, as explained later, such cables have to be kept in separate compartments and/or a suitable distance apart from telecommunications cables, for various reasons.

'Closures' house termination points, with examples including faceplates and (patch) panels for metallic or optical fibre cables. When they are implemented as panels, closures (together with other ICT equipment) can be housed in:

(a) 'cabinets': enclosed construction;
(b) 'frames': open construction, typically wall-mounted; and
(c) 'racks': open construction, typically self-supporting and floor-mounted.

A 'space' is a defined volume allocated to telecommunications cabling infrastructure. Examples include a cage or simply a designated area in a larger room. Spaces are connected by pathways.

Terms such as cabinets, frames, racks and cable management systems are common and well-understood in the industry. It is predominantly the standards that use certain terms – particularly pathway, pathway system and space – in the specific ways noted here.

2.6.2 Cable management systems

There are various types of cable management system but the key ones in this context are based on the following:

(a) ducting (of the type specifically for cables, not, for example, the type for ventilation);
(b) conduit (usually circular and a type of duct);
(c) trunking;
(d) tray (trunking without a cover); and
(e) ladder.

Some types of cable management system, such as conduit, trunking and tray, are available in both plastic and metallic materials. The advantages of non-metallic materials include:

(a) lower weight;
(b) simpler installation; and
(c) corrosion resistance.

Metallic cable management systems provide electromagnetic screening, but have to be bonded (see Section 2.9) to earth. The selection of appropriate cable management systems in an installation is dependent on a range of factors and is discussed in later sections of this Code of Practice. As noted in Section 8.8, there are also specific requirements for 'medical supply units'.

Examples of rigid conduit and flexible conduit (both non-metallic) can be seen in Figure 2.6.

Figure 2.6 Examples of non-metallic conduit (Source Marshall-Tufflex Ltd)

Examples of rectangular and D-line trunking (both non-metallic) are shown in Figure 2.7.

Figure 2.7 Examples of non-metallic trunking (Source Marshall-Tufflex Ltd)

Figure 2.8 Example of metallic conduit

2.6.3 Pathway systems

Cable management systems are pathway systems, but any area or volume that provides a defined cable route is also a pathway system. For example, if cables are run under a raised floor, a painted line on the sub-floor that shows the cable route is a pathway system.

The standards distinguish between the following:

(a) 'closed pathway systems' such as a conduit or duct: cables can only be installed by applying a tensile load – typically by pulling.
(b) 'open pathway systems' such as tray or basket: cables can be installed by laying without a tensile load.
(c) 'openable pathway systems' such as trunking: restrict access to installed cables, but can, for example, have removable covers. Cables can be installed by laying without a tensile load provided that such pathway systems have been opened.

2.7 Environmental conditions

Cabling can be affected by a wide range of environmental conditions. The following text summarizes the coverage in the standards. Guidance specific to healthcare where, for example, ionizing radiation such as x-rays is a factor, can be found in Section 8.

EN 50173-1 features the MICE (mechanical, ingress, climatic and electromagnetic) environmental classification. It covers:

(a) mechanical effects: shock/bump, vibration, tensile force, crush, impact, bending and flexing;
(b) ingress of contaminants: immersion;
(c) climatic and chemical effects:
  (i) the ambient temperature range within pathways and spaces;
  (ii) the rate of change of temperature;
  (iii) the humidity range, including condensation and icing effects;
  (iv) solar radiation; and
  (v) liquid or gaseous chemical pollution; and
(d) electromagnetic effects.

Other specific factors that the EN 50174 series considers include:

(a) biological attack (for example, mould or fungal growth);
(b) accidental or malicious physical damage, including that caused by animals;
(c) the presence, or potential presence, of hazards (such as contaminating, toxic or explosive materials);
(d) the movement of air (for example, caused by fans or heating and ventilation systems);
(e) meteorological effects (such as atmospheric pressure and wind); and
(f) the impact of natural events (for example, lightning strike and lightning-induced overvoltages).

2.8 Safety, protection and segregation

Safety is concerned with the prevention of harm to people. Protection can also be concerned with people (and, for example, the phrase "protection against electric shock" appears often in BS 7671). However, in BS 6701 and the EN 50174 series it is specifically used in the context of preventing damage to the function of the telecommunications cabling or attached equipment.

Protection of telecommunications cabling and attached equipment from the voltages of electricity supply cabling is achieved by 'separation'.

Electromagnetic interference (EMI) from electricity supply cabling or other sources is mitigated by 'segregation', which is achieved by physical separation (not necessarily by the same distance as for protection) and/or by earthed electrically conductive barriers.

The requirements of BS 6701 and the EN 50174 series with respect to safety, protection and segregation are aligned with those of BS 7671 (although they are not expressed in the same way).

2.9 Bonding and earthing

The terms 'earthing' and 'bonding' have their conventional electrical meanings when used in the standards but the differences between them are not always well understood.

Earthing is the connection of the 'exposed-conductive-parts' of an installation or an item of equipment to earth and is primarily for safety purposes.

Bonding (or 'equipotential bonding') is the electrical connection of exposed-conductive-parts and 'extraneous-conductive-parts' (i.e. metal work that is not part of an electrical installation or item of equipment – for example, a structural member such as a beam).

The use of bonding networks for telecommunications infrastructures is specified in EN 50310. The bonding networks are connected to the protective earthing system of the building, which is installed in accordance with BS 7671.

Earthing and bonding are, of course, required not only for telecommunications equipment and cabling, but also for many other types of equipment (including certain medical devices) and parts of buildings. Further information can be found in BS 7671 and in Health Technical Memorandum (HTM) 06-01: *Electrical services supply and distribution*.

It is important to note that many areas of healthcare premises will constitute 'special installations or locations' under the BS 7671 definition of 'medical locations'. Within such areas, there are specific equipotential bonding requirements for patient safety. More information is available in the IET's Guidance Note 7 to BS 7671, covering special locations, and in Section 8 of this Code of Practice.

2.10 Cabling outside and entering buildings

2.10.1 General

Telecommunications cables outside a building follow external pathways. These pathways can be below, at or above surface level. Examples of external pathways include those that are:

(a) underground;
(b) in the air, or 'aerial' as the standards term them (these can be dedicated or shared with overhead power supply cabling);
(c) underwater (for example, for crossing rivers or canals);
(d) attached to the outside of buildings or other structures; or
(e) along piping infrastructure (such as sewers).

In the healthcare setting, the most common pathways are underground and aerial (between nearby buildings) and only these are considered in detail in this Code of Practice. EN 50174-3 itself should be consulted for other types of pathway.

Underground pathways can be:

(a) dedicated to telecommunications cabling and directly buried or in duct/conduit; or
(b) shared with other services, for example, in utility tunnels.

In addition to the requirements of EN 51074-3, there are UK-specific regulations for installing cables underground. As described in Section 7.7.4, these are the Street Works UK guidelines, although the former name of the organization, the National Joint Utilities Group (NJUG), is often still used.

To enable cabling installation and/or to house closures, pathways use 'spaces and structures' such as:

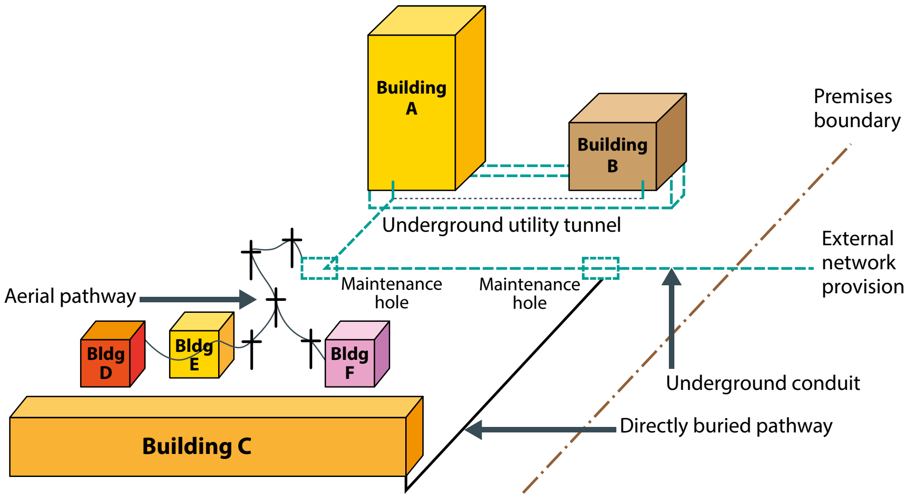
(a) 'maintenance holes';
(b) 'hand holes'; and
(c) 'telecommunications cabinets'.

Figure 2.9 illustrates several types of pathway, together with related spaces and structures.

Maintenance holes and hand holes, as well as other spaces and structures, are examples of 'access points'. Maintenance holes are large enough for a person to enter in order to work, whereas hand holes are not.

In practical terms, installation is typically achieved with ducts, chambers, cabinets and splice closures (in which optical fibres – or conductors – are jointed).

Figure 2.9 Examples of cabling outside buildings



'Premises cabling' is under the control of the 'customer'. Depending upon the complexity of a healthcare facility, premises cabling may be:

(a) within a single building;
(b) interconnecting buildings within premises; or
(c) interconnecting buildings to equipment on the premises, but external to the buildings (such as cameras, etc.).

There may also be cables, owned and specified by the customer, that connect one or more premises but cross third-party property.

Most premises are connected to 'access networks', which are owned by 'access providers', to obtain external service provision. Interfaces of premises cabling to such provision are 'external network interfaces' (ENIs). The nature of an ENI depends upon the configuration of the external service provision.

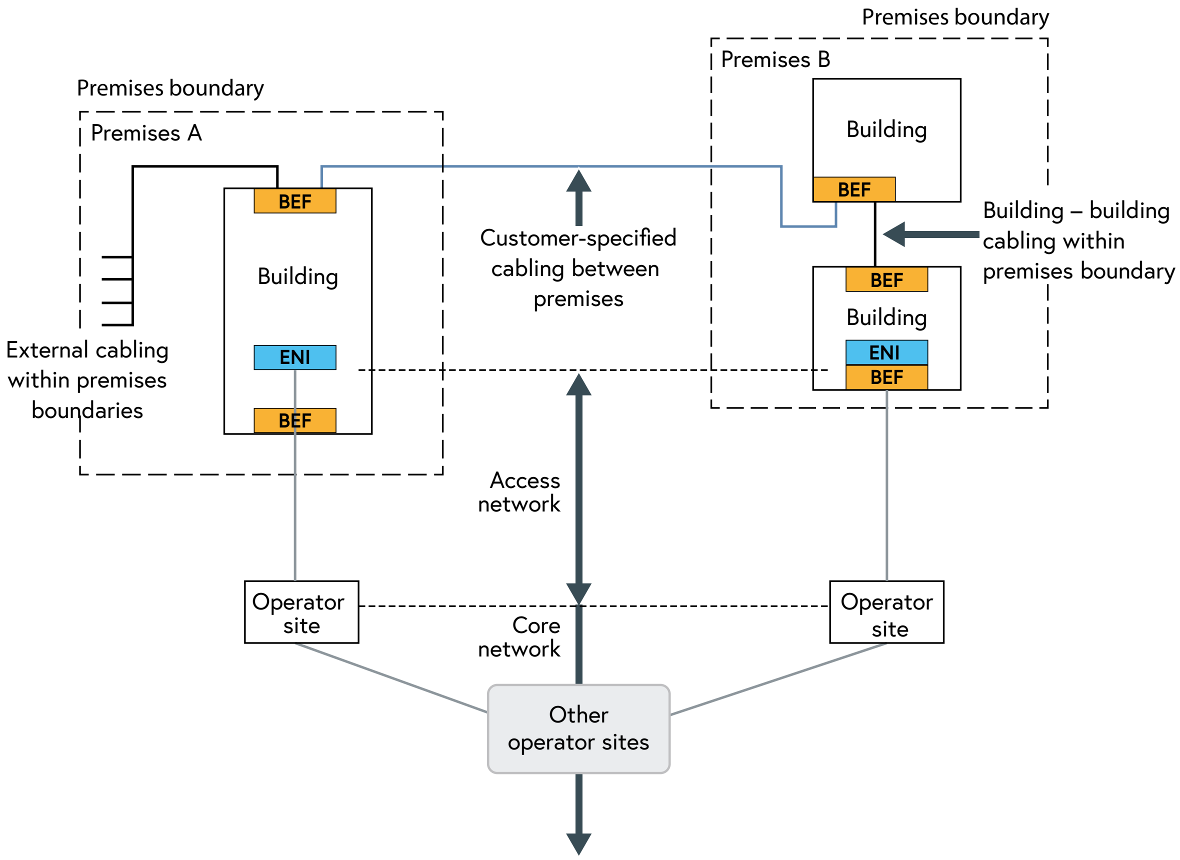
'Service providers' deliver telecommunications content (transmissions) over access provider facilities; a given access network may be used by one or more service providers. Some companies or organizations are both access providers and service providers.

Each service provider uses 'terminal equipment' (TE) to configure its services for use by the customer. The ENI(s) of the premises cabling are connected to the network termination points (NTPs) of the access provider or to the TE of the service provider.

A 'building entrance facility' (BEF) provides all necessary mechanical and electrical services for the entry of telecommunications cables into a building and can enable transition from outdoor to indoor cable. BEFs are required whenever cables (including those from antennae) enter buildings. As interfaces to premises cabling, ENIs can be located some distance into a building rather than in proximity to a BEF.

Figure 2.10 provides examples of these concepts.

Figure 2.10 Examples of BEFs and ENIs



2.10.2 External cabling for healthcare

The majority of healthcare organizations are obliged to use approved service providers for access to secure NHS ICT services. The service providers, in turn, rely on access providers for the installation of external cabling.

Access to the (public) Internet is typically via NHS network connections, although a small number of healthcare organizations opt to make their own arrangements for direct connection to the Internet. Teaching hospitals and other healthcare organizations with academic departments may also have direct connections to JANET (the Joint Academic Network).

In England, the Health and Social Care Network (HSCN) provides secure connections to NHS and related organizations. Elsewhere, some healthcare organizations have direct connections to secure government networks. An example is the Scottish Wide Area Network (SWAN).

In many cases, the relevant third parties will arrange the installation of external cabling up to a healthcare organization's internal network. The number of instances where healthcare organizations will directly commission installation of external cabling themselves is therefore limited. However, healthcare organizations may require links:

(a) between buildings on the same premises or campus; or
(b) between one location on a premises or campus to a point, typically at a boundary, where external service provision is terminated.

In such cases, the healthcare organizations may well commission links themselves, but need to have suitable permissions from the relevant third parties (such as landowners or landlords), unless they own the relevant land themselves.

'Wayleaves' are agreements, between land-owners or occupiers and third parties, which give third parties permissions such as access to land in order to perform installations or maintenance. An 'easement' is a right to use the property of another without possessing it. Whereas wayleaves are agreements between parties that can be terminated, easements relate to land and are usually permanent. 'Licences' are needed for any works on public highways: further information on these can be found in the *FIA Shortform Guidance on External Installations: Licences and Wayleaves*.

2.10.3 Alternatives to external cabling

If there is a direct line of sight, various types of wireless technology – including those based on laser or microwave transmission – can sometimes be used to provide network bridges between buildings. However, such links are outside the scope of this Code of Practice and use proprietary technologies. Wi-Fi signals can be transmitted over longer distances than would otherwise be the case by using directional antennae and/or other specialist equipment. Such solutions are also out of scope.

Some of the factors that should be taken into consideration when considering alternatives to external cabling include:

(a) environmental and atmospheric conditions (rain, snow and fog can attenuate all the types of signal mentioned and high winds can affect equipment alignment);
(b) potential signal interference/obstruction or damage to equipment that can be caused by birds and/or rodents;
(c) unforeseen temporary or permanent obstructions to lines of sight;
(d) the electromagnetic environment (electrical installations, or equipment in the locality, can cause signal interference in some cases, or there may be other wireless telecommunications systems sharing the environment);
(e) health and safety considerations and/or restricted access, particularly for microwave equipment;
(f) maintenance and/or cleaning requirements, including access to equipment that may be on roofs or high up on buildings; and
(g) security.

Expert advice should be sought with regard to the selection of appropriate equipment, solution design and installation when external cabling is not being used.

Section 3

Project management and governance

3.1 Purpose of section

This section covers how projects that involve building infrastructures for healthcare ICT should be managed. It addresses project phases, roles and responsibilities, governance arrangements and documentation requirements. There is also detailed consideration of potential risks and issues.

3.2 Project objectives

The objective of projects is to ensure that building infrastructures for healthcare ICT are:

(a) functional, maintainable and repairable; and
(b) that these, as well as other requirements, are met throughout the planned lifetimes of the infrastructures.

To support requirements for service outlets (and allowing for maximum lengths of cables), this involves ensuring that there is appropriate provision of:

(a) service concentration points; and
(b) service distributors.

In turn, this means taking into account:

(a) needs for both wired and wireless connection;
(b) rapidly increasing demands for remote powering;
(c) external network provision; and
(d) resilience and redundancy.

Projects need to address accommodation of the cabling and equipment and, in particular, the necessary:

(a) rooms and spaces;
(b) pathways and pathway systems; and
(c) cabinets frames and racks.

Also of critical importance are mechanical and electrical (M&E) services, specifically:

(a) power supply; and
(b) heating, ventilation and air-conditioning (HVAC).

All these matters have to be addressed while meeting requirements and recommendations for:

(a) safety;
(b) physical and environmental protection;
(c) minimum dimensions and capacities;
(d) separation of cables and other measures required for electrical safety, protection against electromagnetic interference and heating effects;
(e) the provision of remote powering;
(f) testing of the installed cabling; and
(g) administration.

These technical topics are covered in detail in the following reference sections:

(a) Section 4 (Logical design and architecture);
(b) Section 5 (Implementations in buildings – common principles); and
(c) Section 6 (Implementation in buildings – additional factors).

Section 7 takes a similar approach to Sections 5 and 6, but is for installation of cabling outside buildings.

3.3 Processes in the installation standards

3.3.1 Phases

To set the context, Table 3.1 shows the phases in the standards and indicates which phases each standard applies to.

Key: ✓ = standard applies to indicated phase

Table 3.1 Phases in the standards

Phase	BS 6701	EN 50173 series	EN 50174-1	EN 50174-2 EN 50174-3	EN 50310
Building design					✓
Generic cabling design		✓			
Specification	✓		✓		
Planning	✓			✓	✓
Installation	✓			✓	✓
Operation	✓		✓		

3.3.2 Roles and responsibilities in the standards

BS 6701 and the EN 50174 series distinguish two primary roles, which are those of:

(a) the premises owner (who may delegate selected responsibilities to designers, specifiers, operators and maintainers); and
(b) the telecommunications cabling installer.

It is fundamental that an installation cannot conform to BS 6701 and the EN 50174 series unless the following have taken place:

(a) the premises owner (or appointed representative) has provided an 'installation specification' (see Section 3.4);
(b) the installer has developed a 'quality plan' (see Section 3.5) and prepared an installation schedule; and
(c) the premises owner (or appointed representative) and the installer have, before installation commences, agreed both the installation specification and the quality plan.

All of these documents are subject to change control.

3.4 Installation specifications

3.4.1 General

The installation specification is required to provide a detailed set of documentation for the installer. A full checklist of the information to be provided can be found in Annex D.

It is a requirement that the installation specification includes a 'technical specification' and a 'scope of work'. In addition, the installation specification is required to provide details of the following:

(a) how other building infrastructures have been taken into account;
(b) applicable legislation, regulations and compliance statements; and
(c) site contacts.

It is recommended that the installation specification also includes:

(a) information on foreseeable expansion (for additional users or network traffic) and predicted lifetime requirements; and
(b) relevant information from the organization's ICT strategy.

3.4.2 Technical specification

Key items that are required in the technical specification include:

(a) safety information;
(b) performance and configuration information, including:
  (i) remote powering requirements;
  (ii) cabling termination and accommodation requirements; and
  (iii) bonding requirements;
(c) 'ancillary information', including requirements for:
  (i) lifetime objectives, security and external network interfaces; and
  (ii) administration, handover documentation, labelling, inspection and testing, and acceptance;
(d) details of environmental conditions; and
(e) a risk assessment for external service provision resilience and redundancy (see Section 5.7.2).

3.4.3 Scope of work

The scope of work covers three stages: pre-installation, installation and post-installation. A detailed checklist can be found in Annex D.4.

3.5 Quality Plan

As previously stated, the development of the quality plan is the responsibility of the installer. There is a requirement for the quality plan to be agreed with the premises owner or an appointed representative before the installation starts.

The quality plan is required to show how compliance with the following will be demonstrated:

(a) the requirements and recommendations of EN 50174-1;
(b) the requirements of the referenced cabling design standard (EN 50173-6 in most cases); and
(c) the installation specification.

The quality plan is required to detail procedures for:

(a) the transfer of responsibilities between the installer and premises owner or an appointed representative and, if applicable, any other contractors;
(b) the acceptance of cabling components and the cabling installation;
(c) ensuring compatibility between the cabling components to be used during the installation and with any existing installed cabling;
(d) assessing compatibility with the intended operating environment if there are any remote powering objectives; and
(e) addressing the impact of any potential component incompatibilities.

In cases where inspection and/or testing of cabling components or installed cabling is stipulated, there is a requirement for the quality plan to cover:

(a) inspection and test equipment, together with their calibration status;
(b) procedures for ensuring that the cabling test interfaces (for example, test cords and adaptors) are acceptable (namely, that their performance is adequate for the test method and that they are not beyond their operational lifetimes);
(c) sampling plans and measurement procedures; and
(d) treatment of non-compliant or marginal test results.

The quality plan is required to state the competency of the personnel undertaking the installation. It is recommended that installation personnel have relevant national, industry or manufacturer qualifications.

3.6 Management of the building ICT infrastructure project

3.6.1 Governance

In healthcare organizations, almost all staff and departments make use of digital technologies and associated networking. In order to ensure their needs are met, they should be represented as stakeholders in projects involving building infrastructures for ICT.

This Code of Practice strongly recommends that suitable governance arrangements, including a permanent group in which all stakeholders are adequately represented, are put in place. A key issue is how such a group reports and is held accountable. In some organizations, it may be a sub-committee of an IT steering group or capital planning group, whereas in others it might report directly to the board. The decision needs careful consideration, because of the group's highly multi-disciplinary nature. This Code of Practice also recommends that such groups are not disbanded on completion of major projects, but should continue to exist for ongoing infrastructure management, and with a remit to include oversight of projects as they arise.

HTM 06-01 is concerned with electrical services supply and distribution. Chapter 3, entitled Governance and risk management, addresses issues similar to those for a building ICT infrastructure project and, as such, provides helpful guidance.

3.6.2 Stakeholders

A key element of the approach advocated in HTM 06-01 is having an Electrical Safety Group (ESG) which, of necessity, will be highly multi-disciplinary. The HTM suggests a wide range of representation on an ESG and provides a useful list. However, there are pervasive and very different uses of digital technology in healthcare organizations, with consequent demands on the building ICT infrastructure.

Accordingly, the group under consideration in this context may need to be larger than an ESG (or to have one or more sub-groups), to ensure that all key stakeholders are represented.

Some of the key stakeholders to be considered are as follows:

(a) technical and other specialists, together with high-volume users, including:
- **(i)** IT staff;
- **(ii)** estates and facilities staff (several sub-groups);
- **(iii)** voice communications staff;
- **(iv)** clinical engineers, medical physicists, and so on;
- **(v)** Medical IT-Network Risk Manager (as specified in EN 80001-1);
- **(vi)** staff who use medical imaging equipment: in addition to radiology this includes ophthalmology and cardiology departments as well as other clinical specialties which use ultrasound, endoscopy, and so on);
- **(vii)** clinicians with technical responsibilities or expertise, such as chief clinical information officers (CCIOs) and, for imaging system knowledge, radiologists and/or radiographers;
- **(viii)** departments providing telemedicine and/or virtual consultation services;
- **(ix)** security staff (for access control, security cameras and associated video, and so on);
- **(x)** infection control leads; and
- **(xi)** fire officers; and

(b) others, including:
- **(i)** clinicians (as end-users and managers), including doctors (consultants and juniors), nurses, midwives, allied health professionals (AHPs) and trainees or students in at least of some of these professions;
- **(ii)** finance staff;
- **(iii)** supplies/procurement staff;
- **(iv)** academic, research and teaching staff;
- **(v)** press office and communications staff;
- **(vi)** operational managers; and
- **(vii)** patients (users of guest/visitor Wi-Fi and bedside entertainment, and so on).

3.6.3 Referencing standards in contracts and procurements

BS 6701 and the EN 50174 series are drafted such that they reference all required standards. It is therefore not necessary nor, in fact, advisable to reference standards other than these in contractual or procurement documentation. This Code of Practice includes references to certain standards for information and also so that healthcare organizations can cross-check proposal, contractual or other documentation they receive from actual or prospective contractors.

Outside of Europe, standards covering the same areas as EN 50173 and EN 50174 include those developed by the Telecommunications Industry Association (TIA) and the International Organization for Standardization (ISO). TIA standards, which are used mainly in North America, are endorsed by the American National Standards Institute (ANSI); ANSI/TIA-568-C, together with ANSI/TIA-569-B, are particularly well-known.

The requirements of the relevant European, ANSI/TIA and ISO standards are, intentionally, similar or – in some cases – practically identical. Given that there is a global market for telecommunications cabling, this is helpful to manufacturers of cabling and connecting hardware (some cables have markings on their sheaths indicating that they conform to the requirements of several standards bodies).

Nevertheless, with one very minor exception (as explained in Section 4.6), a requirement to conform to standards covering the same areas as the European ones would be inappropriate as doing so renders contractual and procurement documentation meaningless in many respects (and therefore largely unenforceable). This is because the TIA standards in particular, require conformance to related North American standards, for example, for electrical power, which cannot be applied in the UK under any circumstances.

3.6.4 Avoiding 'designed to fail'

Telecommunications cabling and related infrastructure is now a fundamental part of a building. The implications of this are not always understood by those responsible for the initial design of buildings and it is often assumed that telecommunications cabling and related infrastructure can be addressed in the later stages of a construction project. Such assumptions are often incorrect. The risk is not just that the telecommunications cabling and related infrastructure will have serious and potentially unrecoverable shortcomings. In the worst case, because of the increased and critical dependency on digital technology, the whole building could fail to meet its overall purpose adequately.

As previously stated, telecommunications cabling and other ICT infrastructure is heavily reliant upon:

(a) physical space or accommodation in a building;
(b) mechanical and electrical (M&E) services, in particular, power supply and HVAC.

If space or M&E services are insufficient, adverse consequences are inevitable. However, they can also be provided inappropriately. The following text, which is from *Telecommunications Cabling. Guidance on Standards and Best Practice for Construction Projects*, illustrates the point.

"A real example of this lack of early consultation was the decision to ignore an IT department's requirement for cabinets in a 'comms room' to be mounted on plinths – to allow cables to be installed from beneath the cabinets. As a result, cable trays were presented above the cabinets and cables fed down into the cabinets, preventing the installation of the necessary fans to cool the equipment that would be subsequently be installed and in any case disrupting the intended airflow. This resulted in the cabinets only being able to house half the intended quantity of equipment which, in the long term, required additional space to be allocated elsewhere in the building."

Overall, it cannot be overemphasized that input from experts and key stakeholders on the requirements for digital technology in an organization is not only sought from the outset of a construction project, but also acted on throughout.

3.7 Potential risks and issues

3.7.1 'Contractual sieve'

There is often pressure to reduce costs and/or timescales in the types of projects in question and it is not unusual for this to spread down the contractual chain, which as previously mentioned, in large construction projects, can be very long.

A particular risk, termed the 'contractual sieve' by subject matter experts, is the amendment, without the knowledge of the specifier, of the documents comprising the installation specification by those within the sub-contracting chain.

The most successful method of preventing this is to list, in the primary tender and/or contract documentation, the items comprising the installation specification including the:

(a) general specification;
(b) technical specification; and
(c) scope of work.

Each document should be referenced with the issue/revision status and the number of pages.

It is then necessary to place on any contractor the requirement to confirm, in writing, that they have received all of these documents with the relevant issue status and the full number of pages. This prevents contractors from removing parts of the specifications before passing them down the contractual chain.

If changes are made to any of the documents, all contractors are required to re-confirm (in the same way) that they have received the revised versions.

3.7.2 Construction project complexity and priorities

There is a risk that, even if design for the building ICT infrastructure has been taken into account early enough, it will not receive priority because of the complexity of large construction projects.

For example, depending on in-house resources, the prime contractor could call upon the services of firms of architects, structural engineers, mechanical and electrical engineers, civil engineers, planners and surveyors. None of these professional advisors will necessarily have overall responsibility for specifying, planning or overseeing the building ICT infrastructure.

Construction will involve a main building contractor, from which, for example, there could be the following chain:

(a) a general mechanical and electrical services contractor;
(b) an electrical contractor;
(c) a metallic cabling installer; and
(d) an optical fibre cabling installer.

In addition, there can be a large hierarchy of project managers and other professional advisors during construction. Even if the problems with contractual sieve have been addressed, there remains the possibility that an operational decision will be taken, inadvertently or otherwise, with adverse consequences for the installation of the cabling or its subsequent operation. It is therefore essential that the overall project has robust change management processes that ensure that relevant experts and/or stakeholders are suitably involved.

3.7.3 Inappropriate technology or components

Cables, connectors and other components should only be sourced from reputable manufacturers. The market leaders are established international brands with long track records and are well-known in the industry for the quality of their products and supporting services. There is only a handful of them and, as such, they are not difficult to identify.

There is a view, however, that some premium brands do not offer the best value for money. At the other end of the scale, there is a not inconsiderable market for cheap products; these are not necessarily reliable or standards-conformant and are often of uncertain provenance. There is also a major issue with counterfeit goods.

3.7.4 Unqualified contractors and consultants

Cabling that supports the highest performance communications relies on highly sophisticated technology and requires expert installation. Not all contractors have the required levels of expertise and there are no independent certification schemes.

However, the specialist nature of telecommunications cabling is such that the leading manufacturers all offer training in the installation of their products. Seeking evidence that installers have been trained by the manufacturer of the cabling to be installed is therefore recommended by this Code of Practice.

In addition, membership of the Fibreoptic Industry Association (FIA) and/or the Electrical Contractors' Association (ECA) is usually a positive indicator for installers. Both organizations, and hence their memberships, are involved in wider activities than their names initially suggest.

Many consultants have the Registered Communications Distribution Designer® (RCDD®) certification from Building Industry Consulting Service International (BICSI). It should be noted, however, that BICSI certification is based on North American standards, rather than British (or European) ones. As explained in Section 3.6.3, there are some crucial differences between these standards and the North American ones cannot be applied in the UK.

3.7.5 Contractor roles

In hospitals and other healthcare premises, change of use in parts of buildings is not unusual. For example, offices may be turned into consulting rooms for outpatient clinics or large spaces may be subdivided into a series of rooms. From time to time, certain areas will be refurbished or upgraded without any change of use, but often with a requirement for additional network outlets (not to mention extra mains power sockets).

In smaller projects such as these, it is common to appoint a single contractor with a remit to 'wire' or 'rewire' the relevant area. In some cases, the contractor is given little additional information, other than, perhaps, an indication of the ideal number and locations of new or additional outlets or, worse, simply a budget to do as much as possible within its constraints.

This does not, however, mean that the requirements of the standards can be bypassed. In practice, the contractor in these circumstances has to fulfil not only the installer role, but also the roles that are the responsibility of the premises owner. Such an arrangement is not ideal, even if different individuals from the contractor's firm perform the two distinct types of role.

3.7.6 Installations outside buildings

Obtaining new or additional access connections is a potentially complex activity. Lead times are very often not only significant, even in apparently straightforward situations, but also frequently outside the control of the organization requiring the services.

Some of the risks and issues are as follows:

- **(a)** in some instances, new permissions and accompanying legal agreements need to be obtained from public bodies or other third-party land-owners in order to access their land. These processes can be unpredictable in duration, but quite often prolonged and highly time-consuming (although, in most cases, they will be undertaken by providers).
- **(b)** ducts or other parts of an access provider's infrastructure may be at capacity, meaning that apparently minor upgrades for a client require significant investment and time from the provider.
- **(c)** both service providers and access providers can have significant backlogs.
- **(d)** direct contact with access providers and/or installers is often not permitted or not possible. Instead, all communications have to pass through a third party, typically, the service provider. This can cause delays and/or misunderstandings, particularly if the contacts at the third party are not specialists.
- **(e)** terms and conditions are often in standard documents provided by suppliers and are, inevitably, in their favour. There is usually little or no flexibility and, in the event of problems, redress is limited.

(f) during installation works, unexpected obstructions and/or utility infrastructures are often discovered underground. This can happen even if a site has been occupied for an extended period and suitable records have been kept of all construction or related works.

(g) existing ducts into which additional cables are to be installed may have collapsed, but with no detectable effect on the current telecommunications services. The damage is only discovered when installation is attempted.

(h) if a circuit fails because a cable is severed or seriously damaged (for example, during construction or maintenance works), the back-up circuit can also fail at the same time, even though diverse routes for cables have been specified for resilience and/or redundancy. This can happen for a number of reasons, but typically because true diversity has not been achieved, with cables sharing a pathway for some of their length. Although such sharing is sometimes unavoidable, clients are frequently not informed.

Telecommunications service providers are commercial organizations, and this can influence their performance, as the following examples illustrate:

(a) when carrying out repairs that can be recharged to a customer, there is a greater likelihood of cabling or components being replaced than when the cost has to be met by the provider. For example, if an optical fibre cable has been damaged, it may be possible to repair it by jointing at the point that the damage has occurred. In some cases, however, there will be a temptation to replace the cable completely.

(b) when repair costs have to be borne by a telecommunications provider, replacement is less likely to take place, even if a repair is less suitable.

(c) when carrying out repairs, access providers may encounter existing cabling and/or components that have been installed by their competitors. Where compromises have to be made, priority will inevitably not be given to what has been installed by competitors.

(d) as different access providers are usually commercial competitors, they cannot be relied upon to co-operate or co-ordinate with each other when jointly involved in installation, repair or reinstatement works.

Section 4

Logical design and architecture

4.1 Purpose of section

EN 50173-6 is the standard for distributed building services. This section outlines the key requirements and recommendations of EN 50173-6, specifically using Type A generic cabling, that are applicable in the context of this Code of Practice.

4.2 Channels

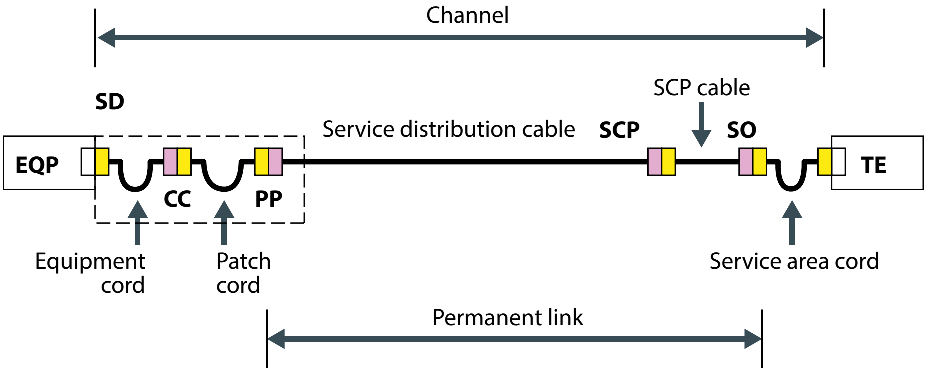
If two items of equipment are connected to each other (for example, a user PC to a network switch), without any other active equipment, there is a 'channel' between them.

Taking a user PC connected to a network switch as an example, a typical channel would consist of the following cables and cords:

(a) a service area cord from the PC or 'terminal equipment' (TE) to the service outlet (SO);
(b) a service concentration point (SCP) cable from the SO to an SCP;
(c) a service distribution cable (a permanent cable) from the SCP to a patch panel (PP) in a service distributor (SD);
(d) a patch cord between the panel presenting the permanent cable to the panel (CC) for connecting to the network switch (EQP); and
(e) an equipment cord between the network switch and a PP.

This is illustrated in Figure 4.1, which, for consistency with the standards, shows the items above from right to left. In addition to showing a channel, the figure shows a 'permanent link', which – as explained in Section 5.11 – is for testing purposes.

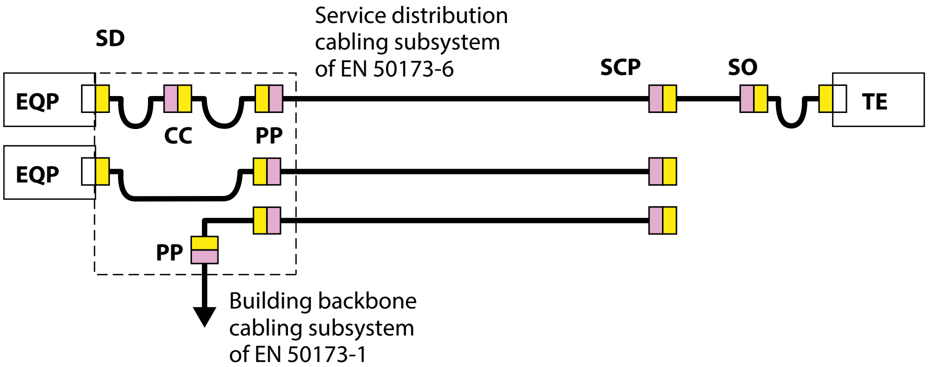
Figure 4.1 Channel and permanent link example



The permanent cable from an SD is required to be continuous to the SCP, if there is one, or to the SO otherwise. The preceding example is one in which the number of connections is the maximum allowed in a channel. More generally, there can be no more than two cords (or jumpers) at each end of a channel.

Figure 4.2 provides examples of additional types of connection in an SD.

Figure 4.2 Examples of connections in an SD



4.3 Transmission performance

The EN 50173 series define the transmission performance of channels in terms of 'Classes'. Components (cables, cords and connecting hardware) are defined in terms of 'Categories'. EN 50173-6 allows for a number of options. The recommendations of this Code of Practice are as follows:

(a) for service distribution cabling:
- **(i)** Class E_A cabling, constructed from unscreened or screened Category 6_A components, which supports 10GBASE-T over distances of up to 100 m; and/or
- **(ii)** optical fibre (this should be considered as a replacement if the cable serves or passes through areas of high electromagnetic interference); and

(b) for backbone cabling:
- **(i)** optical fibre: single-mode – Category OS1a or OS2; and/or
- **(ii)** balanced cabling, constructed from unscreened or screened Category 6_A components, which supports 10GBASE-T over distances of up to 100 m.

These recommendations may seem surprising for those who have previously used unscreened balanced cabling together with multimode optical fibres. The rationale for the recommendations is as follows.

The migration to Category 6_A components has expanded the availability of screened cabling solutions. Unscreened cabling has less demanding installation requirements, but the design solutions required to meet the higher performance of Category 6_A cables have increased both cost and cable diameters. Screened Category 6_A cables are able to exploit simpler design solutions and are typically of smaller diameter (and lower minimum bend radius) than the unscreened equivalents – although termination procedures and bonding requirements remain more complex. There is little difference in overall cost and, as a result, this Code of Practice recommends an option appraisal and does not have a specific preference.

This Code of Practice recommends the use of single-mode rather than multimode optical fibre, except where legacy installations are to be extended or where the networks to be supported are not subject to upgrade. The reason for this is that the rapid increase in network data rates in recent years has reduced the lengths supported by multimode technologies – despite the introduction of the new Categories of multimode optical fibre providing increasing bandwidths. Even the highest performance multimode cables of Category OM4 (or OM5) are limited to 100 m for the higher data rates, and even these may require the use of 'parallel optics' (for example, 20 optical fibres required to support a 100 Gb/s channel), compared with two single-mode optical fibres.

4.4 Channel lengths

The length of a balanced cabling (backbone or service distribution) channel is not permitted to exceed 100 m, which reflects the accepted maximum lengths supported by the IEEE 802.3 standards.

In practice, there are two sources of significant constraints on the distance that can be achieved in the service distribution cabling: cords and temperatures, as shown in Table 4.1.

Table 4.1 Impact of cords and temperature on maximum channel length

	Total length of cords (m)		
	10	15	20
Temperature (°C)	Channel length (m)		
20	100	98	95
25	98	96	93
30	97	94	91
35	95	92	89
40	93	90	87
45	90	87	85
50	86	84	82
55	83	81	79
60	80	78	76

4.5 Distribution and location

4.5.1 Service distributors (SDs)

It is a requirement of EN 50173-6 that SDs are located such that maximum channel lengths can be met.

EN 50173-6 recommends:

(a) a minimum of one SD for 1,000 m^2 of floor space; and
(b) an SD on every floor, unless the floor is sparsely populated (for example, a lobby), in which case an SD on an adjacent floor can be used.

4.5.2 Service concentration points (SCPs)

Where SCPs are used, EN 50173-6 requires them to be located such that each service area is served by one SCP. It recommends that SCPs are located in ceiling voids, under floors or in other permanent positions that are accessible.

EN 50173-6 recommends that there are no more than 36 SOs per SCP. This Code of Practice recommends that SCPs consist of 12- or 24-port panels and that there are equivalents in the SDs.

To enable a high density of service outlets (SOs) in line with the objectives of distributed building services, a grid of SCPs is recommended. Specifically, EN 50173-6 recommends that:

(a) each SCP serves an area of 9 m^2 in a 3 m × 3 m grid;
(b) there is one SCP per room smaller than the grid size; and
(c) in larger rooms or spaces, each SCP covers an area no greater than the grid size.

As previously indicated (see Section 2.3.2), the use of SCPs is optional in EN 50173-6. However, this Code of Practice strongly recommends their use in most cases. This is not only to implement distributed building services effectively, but also because, without SCPs, there is a considerable loss of flexibility. In addition, without SCPs, the ability to handle moves, additions and changes (commonly known as MACs) – particularly if frequent – is compromised. To give an example, it is generally far easier, and more economical, to add an outlet or repair an existing one if there is an SCP in reasonable proximity than to deal with cabling to an SD that could be almost 100 m away in the most extreme case.

4.5.3 Service outlets (SOs)

EN 50173-6 requires that each service area has a minimum of one SO. It recommends that SOs are located taking into account any need to prevent unauthorized access, disconnection and/or reconfiguration.

A major benefit of an SCP grid is the flexibility it provides; decisions about the locations of SOs can be made later in a project than would otherwise be the case. This is advantageous because it allows for last-minute changes to the expected use or configuration of rooms and other spaces.

Provision of SOs in healthcare premises is covered further in Section 8.

4.5.4 Wireless access points (WAPs)

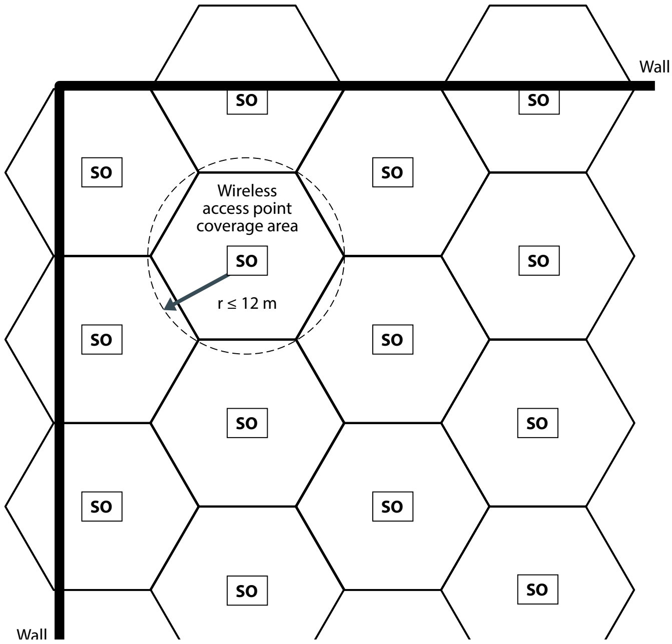
To determine locations for WAPs, and SOs for them, EN 50173-6 recommends carrying out both of the following:

(a) an operating range performance prediction; and
(b) a site survey.

Logical boundaries for areas served by SOs can be determined by considering physical factors such as fixed structural or building boundaries and areas where coverage is not required.

In uniform open spaces, a hexagonal (or 'honeycomb') grid, as shown in Figure 4.3, is recommended (this grid shape provides the most efficient coverage, but others can be used). It is also recommended that SOs are located in the centres of areas they cover and that coverage is restricted to within a 12 m radius (r in Figure 4.3). A lower radius may be needed if the ceiling height exceeds 3 m or if access points are above ceiling material that can attenuate wireless signals.

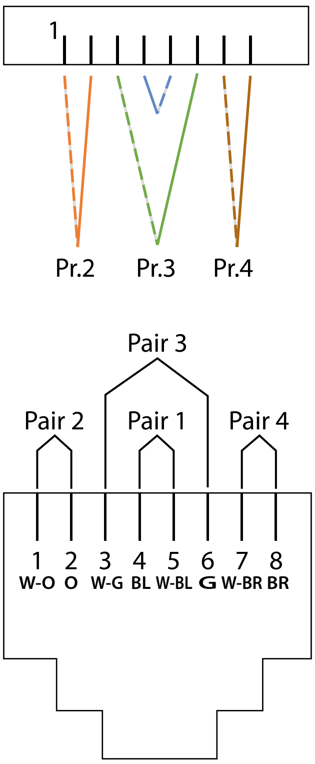
Figure 4.3 Example of SO distribution for WAPs



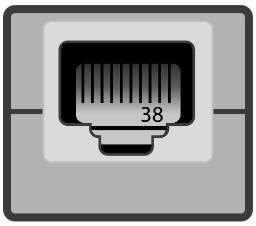
4.6 Cable connection

Figure 4.4 shows (front view) the connection of pairs to an RJ-45 socket. As the EN 50173 standards do not specifically identify this arrangement, it is common to use the designation from ANSI/TIA/EIA-T568-0.D, which is option T568B.

Figure 4.4 Connection of pairs in RJ-45 socket



Pin	Pair	Colour
1	2	Orange/White
2	2	Orange
3	3	Green/White
4	1	Blue
5	1	White/Blue
6	3	Green
7	4	White/Brown
8	4	Brown



4.7 Cords

It is recommended that cords (both for balanced cables and optical fibre) are terminated during manufacture. Where balanced service area cords are unlikely to be flexed or reconnected (for example, to a fixed surveillance camera), there is no requirement for them to be constructed using flexible cables.

4.8 Technology and cabling cautions

4.8.1 Zone or 'cord' cables

Cables based on the specifications for cords rather than those specifically for permanent cables are being marketed. These are technically allowed by the standards and, as they use less copper, are lower cost and smaller sizes than their equivalents. In the industry, they are known as 'zone cables' or 'cord cables'.

However, when tested, these cables do not satisfy all length-dependent requirements. In addition, if used for remote powering, they will generate considerably more heat, as their resistance is higher.

Although these cables can conform to the standards under certain circumstances, and particularly over shorter distances, their use is not recommended by this Code of Practice.

4.8.2 Copper-clad aluminium and steel cables

Cables with conductors that are either copper-clad aluminium (CCA) or steel are increasingly available and can also be marketed as 'zone cables'. Despite possible claims to the contrary, they do not fully meet EN 50173 requirements for any cable Category. In addition, experience has shown various other problems with these types of cable, which typically do not become evident until after installation. Their use is therefore strongly discouraged by this Code of Practice.

4.8.3 Proprietary remote powering systems

As previously stated, the EN 50173 and EN 50174 series are devised to support the relevant IEEE standards. Whilst the vast majority of equipment uses IEEE standards for data transmission, there are a number of proprietary remote powering solutions in existence. These have a number of significant disadvantages and risks associated with them, including the following:

(a) incompatibility, because they do not follow standards.
(b) damage to equipment from other suppliers due to incorrect voltages or other factors.
(c) potential overheating of cables, which may compromise transmission performance not only, at a minimum, of the current-carrying cable, but also of others in proximity to it if their temperature is also raised. In addition, serious overheating is, of course, a fire risk.

Section 5

Implementations in buildings – common principles

5.1 Purpose of section

Many of the requirements and recommendations in the EN 50174 series of standards are repeated for different types of accommodation or other areas. This is an inevitable consequence of the rules for drafting standards and by no means unusual.

This section identifies the key requirements and recommendations that are repeated often or are of particular overall significance. Both this and the following section are primarily for reference and are intended to capture the vast majority of the requirements in the EN 50174 series related to completed implementations in buildings.

5.2 Safety

5.2.1 General

Safety is of paramount importance at all stages of the lifecycle (including planning, installation, operation, maintenance and repair). Safety always takes precedence over other requirements and applies to all personnel including:

(a) patients, visitors and staff (clinical, administrative or otherwise) with no involvement in the a project; and
(b) installers, electrical, building and other sub-contractors, local estates and facilities staff, IT staff, medical engineers, and so on.

5.2.2 Fire

Fire barriers

Because they are routed through a building, it is often necessary for cables and pathway systems to pass through fire barriers. It is imperative that there is no compromise of fire barriers either in the completed installation or during the installation process.

The key requirements of the EN 50174 series relating to fire barriers are essentially as follows:

(a) pathway systems enable the creation and installation of fire barriers where required;
(b) reinstated fire barriers achieve their original fire rating by use of identified fire-stop materials and/or fire-stopping techniques; and
(c) during installation:
  (i) fire barriers are only opened when necessary and when permission has been provided; and
  (ii) there is adequate fire-stopping when the installation is left unattended.

In addition:

(a) Section 5.5.3 contains requirements, for crossing fire barriers, that apply to metallic or composite cable management systems specifically providing electromagnetic screening; and
(b) as indicated in Section 5.10.3, under certain circumstances, segregation distances from power supply cabling can be reduced at fire barriers.

The standards recommend that:

(a) fire barriers are designed to facilitate their refurbishment following cable installation; and
(b) cables passing through fire barriers are segregated and appropriate fire-stopping techniques are applied in order to minimize disruption to fire barriers during any subsequent installation (or removal) of cabling.

Cables

BS 6701 requires certain cables inside buildings to meet EuroClass C_{ca} -s1b,d2,a2 of EN 13501-6. This requirement applies to cables that are intended for installation into pathways that are hidden (below floors, above ceilings or behind walls) or to which access is otherwise limited. It is essential that explicit permission is given by a suitable authority if there is any intention of installing cables that do not meet the requirement.

BS 6701 requires, as a minimum, all other telecommunications cables within a building to be in accordance with either the EuroClass E_{ca} of EN 13501-6 or the recommendations of EN 60332-1-2. In cases where telecommunications cables enter a building and do not meet this requirement, the following is required:

(a) either the cables are terminated in an entrance facility that is outside the external fire barrier of the building; or
(b) the cables are terminated inside the building and:
  (i) either the termination is made within 2 m of the point of internal penetration of the external fire barrier; or
  (ii) any lengths exceeding 2 m are installed within a cable management system that acts as a fire barrier.

Fire systems

Requirements relating to fire extinguishing and suppression are as follows:

(a) details are provided in the installation specification of how circuits for smoke/fire detection and associated controls, as well as fire suppression, have been taken into account;
(b) pathways and pathway systems are neither located nor constructed such that they, or their contents, can cause obstructions during evacuation or fire-fighting activities; and
(c) cabinets, frames and racks are not installed where they can affect fire-hose reels or other fire-extinguishing equipment.

Recommendations relating to fire extinguishing and suppression are as follows:

(a) pathways are not positioned such that they can interfere with facilities, such as sprinkler heads, for fire suppression and, in particular overhead pathway systems are not directly below fire-extinguishing systems; and
(b) pathways do not restrict access (for periodic maintenance) to smoke detectors.

Fire precautions

It is a requirement that details of applicable fire precautions and escape routes are provided in the statement of work, which, as part of its coverage of safe working, also includes participation in fire drills.

Guidance

Section 5.4.1 includes requirements and recommendations for the protection of fire-stop materials where pathway systems and, specifically, conduits (or ducting) protrude from floors.

The FIA publication *Reaction To Fire Performance of Cabling Inside Buildings* provides detailed information not only on cabling, but also on cable management systems. In addition, it provides an explanation of EuroClasses for cables.

BS 8492 is a Code of Practice for fire performance and protection for telecommunications equipment and cabling.

Detailed guidance on fire safety in the design of healthcare premises is provided in HTM 05-02. This is supplemented by the multi-part HTM 05-03, which provides guidance on specific fire safety measures.

5.2.3 Electrical

Note: As previously indicated, only installations where there are LV or low voltage (defined as under 1,000 V AC or 1,500 V DC) power supplies and associated electricity supply cabling are in scope.

For electrical safety, BS 7671 is the primary source of requirements. There is also guidance in HTM 06-01.

It should be noted that in the context of electrical supply systems for healthcare, the term 'medical IT (system)' is frequently used. This can be a source of confusion, as it is not related to information technology at all. Medical IT (isolated terra) systems, formerly known as IPS (isolated power supply) systems, are electrical systems that have specific safety features for medical installations.

As previously indicated, the protection of telecommunications cabling from electricity supply cabling is achieved by separation, which, in turn, increases safety. BS 6701 specifically states that some of its separation requirements are also for safety.

It is a requirement of BS 6701 that telecommunications cabling is not installed in any compartment of a cable management system that contains unenclosed live terminals for LV electricity supply. The EN 50174 series includes a number of requirements for closures in which both telecommunications cables and power supply cabling are terminated. The requirements are essentially that closures are such that the electricity supply cabling cannot be accessed while working on the telecommunications cabling and that there is a barrier between the two types of cabling.

5.2.4 Optical fibres

It is a requirement of the EN 50174 series that a hazard classification of areas containing optical fibre equipment and cabling is undertaken in accordance with EN 60825-2. This standard, which is concerned with the safety of laser products, also contains information on suitable installation and labelling practices. It is a requirement of the EN 50174 series that closures containing optical fibre terminations or joints are labelled in accordance with EN 60825-2 for the relevant hazard classification.

In addition, BS 6701 requires the selection and operation of optical fibre telecommunications equipment, test equipment and cabling to be in accordance with EN 60825-2.

Further information can be found in FIA-TSD-2000-5-1 *Optical Power Safety Levels*.

5.3 Protection principles

The standards effectively require that cabling and any equipment have the necessary physical and climatic protection, during installation and operation, within all of the following:

(a) pathways and pathway systems;
(b) cabinets, frames and racks; and
(c) closures.

Location and/or design features are the required means of ensuring the protection.

Details of physical and climatic protection requirements can be found in the sub-sections that follow.

Specific protection is not required where the cabling can neither have its transmission properties compromised, nor be damaged, because of the wider/overall protection of the location the cabling is in. Examples of such locations given in the standards are connecting ducts, equipment rooms and rising zones.

5.4 Physical protection

5.4.1 Pathway systems

It is a requirement for pathway systems, and a recommendation for conduit (or ducting), that when these protrude from floors, they are terminated at least 50 mm higher than the finished floor surface. It is explained that this is in order to:

(a) prevent construction debris and poured concrete from entering them; and
(b) protect cabling and fire-stop materials from spillage of water or other liquids.

5.4.2 Cables

General

Cables that have been installed in accordance with the standards will not:

(a) be crushed (by weight of other cables or for any other reason);
(b) have any deformation of the cable sheath;
(c) have pressure marks on the sheath or cable elements;
(d) be subject to excessive tension (for example, because of long vertical runs); or
(e) have any bends with a radius less than the required minimum.

Pathway systems are required to:

(a) have smooth surfaces, including, in cable fill areas, non-scratching coverings on threaded rod or other abrasive supports;
(b) be without burrs, sharp edges or corners or projections that can cause damage; and
(c) be without pressure points that can compromise transmission performance.

It is a requirement that cable management systems allow for the installation and removal of a cable without risk of damage to it. It is a recommendation of the EN 50174 series that, where applicable, it is possible to remove cables from pathway systems without causing damage to any cabling that remains.

It is a requirement that cleats, pulling wheels or temporary structures to assist cabling installation are fitted in pathways where necessary.

Strain relief is required at the entrance to a closure, unless separate fixtures within it are performing this function. In closures, it is a requirement that mechanical or fusion splices (in optical fibres) are fixed and supported. This also applies to their strain relief mechanisms.

Minimum bend radius

If they are bent excessively, whether permanently or temporarily during installation, the transmission properties of both metallic telecommunications cables and optical fibre cables can be compromised, or there can be other damage.

There are therefore the following parameters for cables:

(a) minimum bend radius during operation – static: applies when a cable is in its final position after installation;
(b) minimum bend radius during operation – dynamic: applies to cabling that is subject to movement; and
(c) minimum bend radius during installation.

The values are normally specified by the manufacturer. Although the EN 50174 series include requirements for minimum bend radii where the information is not available from the manufacturer (or supplier), this Code of Practice does not recommend the installation of such cables.

The largest minimum bend radius applies to cable bundles and in other cases where there are different cable types or different specifications.

The following are requirements to ensure that minimum bend radius requirements are met:

(a) suitable pathways, entry points to them and pathway systems are chosen;
(b) cabinets, frames and racks are of suitable design and have adequate dimensions, not only for cable installation initially, but also for any additional cables (as set out in the installation specification) that are installed subsequently. Adequate clearances in the relevant directions are also required.

As stated in other sections, there are related requirements for the minimum bending radius of pathway systems generally and conduit in particular.

Maximum stacking height for cables

The maximum stacking height in pathway systems is provided by manufacturers' instructions. If there are no such instructions, the requirements in EN 50174-2 for the maximum stacking heights for cables are:

(a) for pathway systems such as trays that provide continuous support: 150 mm; and
(b) for pathway systems such as basket, ladder or hooks that provide non-continuous support, the following formula applies:

$$h = 150/(1 + L \times 0.002)$$

where:

h is the maximum stacking height, in mm; and
L is the distance between points of support, in mm.

The distance between points of support (L) is required to be less than 1,500 mm.

Accessible cables

It is recommended that telecommunications cabling less than 2.7 m above finished flooring is installed in a pathway system (such as duct, trunking or conduit) that is secure or that other steps are taken to prevent damage to the cabling.

5.4.3 Security

General

Key security requirements for spaces are effectively as follows:

(a) spaces accommodating cabling (and any associated equipment) are in suitably secure locations and access is controlled;
(b) within those spaces, access is appropriately limited to where it is specifically required (see also guidance on cabinets in the next sub-section);
(c) access to a space allocated to a service provider or an access provider is controlled by the provider or the organization with responsibility for the building, as appropriate; and
(d) termination points are located and designed such that the attached telecommunications equipment is secure (the protection of WAPs is given as an example).

The standards recommend that maintenance holes and hand holes (including drawboxes) in unsecured areas are both:

(a) locked so that they can only be opened with a key (or tool); and
(b) monitored with cameras, remote alarms or both.

Cabinets

This Code of Practice recommends that, unless there is very strict access control to them, all cabinets are secured with digital locks.

The use of locks operated by keys is not recommended. The keys and locks are often not unique, so one key can potentially open several cabinets. In addition, keys are often stored in inconvenient locations and there can be delays in accessing them – even if they are where they should be. Keys can easily be misplaced or accidentally left in locks. Retrieving missing keys can be time-consuming and inevitably, is not always successful. To obviate these perceived problems, at some sites considerable – if not pervasive – use of master keys is not uncommon, but is ultimately self-defeating.

An additional disadvantage of keys is that, if any are lost, replacements will often be needed and it may be necessary to change locks as well. Loss of a master key is, clearly, particularly serious.

5.5 Environmental protection

5.5.1 Ingress of contaminants

To prevent ingress of contaminants (including water or moisture and other liquids, dust and gases), or to reduce their impact, requirements are effectively as follows:

(a) pathway systems entering buildings can be sealed;
(b) cable management systems do not allow liquids (including water) to collect;
(c) in locations where it is necessary (for example, in a closed pathway system running through a 'wet' area), sections of cable management systems are suitably jointed; and
(d) termination points are suitably designed, located and oriented.

The EN 50174 series also recommends that pathway systems do not allow liquids (including water) to collect.

A number of specific requirements and recommendations concerning contaminants are noted later in this Code of Practice.

5.5.2 Climatic

It is a requirement that pathways, pathway systems and closures provide adequate climatic protection both during operation and installation.

There is an effective requirement that, in spaces or structures where there is active equipment, the temperature and humidity are maintained at levels such that the equipment can operate continuously.

The EN 50174 series recommends that airflow is not blocked by cabling or pathway systems:

(a) to environmental control systems;
(b) under access floors, if the spaces form part of a ventilation or cooling system; or
(c) in cabinets, racks and frames.

5.5.3 Electromagnetic

It is a requirement that pathways, cables, cabinets, frames, racks, closures and termination points are located to minimize the effects of electromagnetic disturbances. Locations also have to be such that segregation requirements are satisfied.

In cases where a metallic or composite cable management system is specifically providing electromagnetic screening for the telecommunications cables within it, there are requirements that:

(a) if multiple sections are used, continuity is maintained by interconnecting them with suitable bonds;
(b) suitable bonds are used to interrupt the cable management system, if it crosses a wall that is a fire barrier and there are no other permitted means of meeting fire safety requirements;
(c) all bonding, including in the two special cases above, is in accordance with the relevant requirements of EN 50310; and
(d) electromagnetic performance is maintained when any changes take place (so, for example, plastic sections are not used to replace metallic ones).

If any metallic beams or other metallic structural members in a building are used in a pathway, the standards recommend that cables are located in the inner corners.

Where cable tray is used, inner corners are also the best locations for electromagnetic screening. Deeper and narrower tray is more effective for electromagnetic screening than tray that has the same cross-sectional area (CSA) but is wider and shallower. However, cable tray, particularly if it is deep, restricts ventilation. As indicated in Section 5.11, this can have implications for remote powering.

5.5.4 Electrostatic discharge

Electrostatic discharge (ESD) can seriously damage digital equipment. Various well-known precautions can be taken against ESD and the EN 50174 series outlines these for information.

The only requirement is that, if a risk of ESD has been established, anti-static or conductive flooring materials are bonded in accordance with the requirements of EN 50310. Recommendations of the EN 50174 series are that:

(a) relative humidity levels are maintained in the range 40 % – 60 %; and
(b) anti-static products are used where there is carpeting and any acrylic or vinyl materials are avoided.

5.5.5 Acoustic noise

The standards recommend that possible transmission of acoustic noise is taken into consideration when selecting pathway systems and that cable management systems are installed to minimize noise transmission.

5.6 Locations

5.6.1 General

Selection of locations has to take into account previously stated protection requirements and recommendations.

In addition, the standards recommend that pathways avoid localized sources of heat, humidity or vibration, if there is risk of performance reduction or damage to the construction of the cabling. The standards recommend that spaces are central to the areas served.

5.6.2 Access

There are common requirements for access to all of the following:

(a) entry points to pathways, including drawboxes;
(b) cabinets, frames and racks;
(c) closures; and
(d) termination points.

The requirements are effectively that, without risk to personnel or equipment, the locations allow access for:

(a) installation;
(b) operation;
(c) measurement;
(d) repair;
(e) maintenance; and
(f) future expansion or extension.

The requirements apply to cabling and, where relevant, to equipment that is to be installed. The requirements also apply to items needed during installation, such as cable drums and drum stands.

It is a requirement that access provider and service provider spaces are accessible via common use corridors.

5.6.3 Inappropriate locations

It is a requirement of the EN 50174 series that cabinets, frames and racks are not located in:

(a) toilet facilities;
(b) kitchens;
(c) emergency escape ways;
(d) ceiling spaces;
(e) sub-floor spaces;
(f) cabinets or other enclosures containing fire-extinguishing equipment, including hose reels; or
(g) spaces that are at risk of flooding.

There is also a requirement that cabinets, frames and racks are not under piping systems (in case there is leakage or condensation aggregates).

The EN 50174 series recommends that pathways are not located:

(a) in lift shafts;
(b) in lightning conductor voids; or
(c) where they could interfere with the intended operation of fire suppression systems such as sprinkler heads.

5.7 Resilience and redundancy

5.7.1 Distributors and internal pathways

The EN 50174 series recommends considering protection against failures in the cabling infrastructure by having the following:

(a) multiple areas of distribution (with suitable fire compartmentation) with different power supplies and environmental control systems;
(b) multiple pathways between each area of distribution (maximum channel lengths permitting); and
(c) different pathways for cables that have been installed for redundancy.

5.7.2 External services

A risk assessment to determine the need for more than one of each of the following is required:

(a) access and/or service providers;
(b) access and/or service provider premises (i.e. operator sites or central offices);
(c) building entrance facilities (BEFs); and
(d) entrance rooms.

Assessment of the need for diverse pathways from each of the access provider premises is part of the same requirement. Where multiple access providers are required, there is a recommendation in the standards that the pathways to the premises are diversely routed.

The standards also recommend:

(a) multiple entrance pathways between the boundary of the premises and the entrance room(s);
(b) locating entrance pathways underground (because of the vulnerability of aerial entrance pathways, which are not recommended);
(c) separating entrance pathways between the boundary of the premises and the points of entry into buildings by a minimum of 20 m;
(d) the provision of at least two pathways for each access provider; and
(e) consideration of pathways between entrance rooms.

5.8 Sizing and future-proofing

5.8.1 General

The standards have a number of recommendations relating to initial capacity and for subsequent additions, growth or expansion.

In effect, they recommend that the design, dimensions and locations of pathways, pathway systems, cable management systems, cabinets, frames and racks are such that cables can be installed while ensuring that:

(a) minimum bend radius requirements are met; and
(b) neither the cabling being installed nor any existing cabling is damaged or has its performance compromised.

As well as having the ability to handle growth, the standards make specific recommendations for the following:

(a) entrance pathways – capacity for additional access providers; and
(b) building entrance facilities (BEFs) – capacity for additional external service providers.

There is a requirement for adequate clearances for installation of termination points in closures. There is also a requirement to supply documentation that enables the subsequent installation of cabling into closures.

5.8.2 Pathway systems

General

The standards recommend that pathways have capacity for the maximum predicted amount of cabling and note that this can be achieved either by installing pathway systems in sufficient sizes and quantities initially or by planning and reserving space for additional pathway systems.

Cable bundle sizes

It is a requirement of the standards that there are no more than 24 cables in a bundle. This Code of Practice recommends a maximum of 12.

Filling limits

It is a requirement that the following are taken into account in order to determine the useable cross-sectional area (CSA):

(a) cables having to be lower than the side walls in open or openable pathway systems;
(b) unless it is non-metallic, electromagnetic screening requirements may limit the height and distribution of cables within a pathway system;
(c) the thermal effects of any remote powering may limit the number and distribution of cables within a pathway system; and
(d) the minimum available area surrounding a non-enclosed pathway system is the CSA.

In addition, minimum bend radius requirements for cables may result in restrictions at bends in pathway systems.

Subject to the previous points, the recommended maxima for useable CSA are as follows:

(a) for pathway systems during initial planning: 40 %;
(b) for open and openable pathway systems during subsequent planning: 50 %; and
(c) for conduit: 40 % (unless there are empty sub-conduits).

Planning tools

Many suppliers of telecommunications cabling and other organizations provide tools that purport to calculate required pathway sizes from input of the number and type of cables. Some of these tools are based on spreadsheets, (which have to be downloaded) whereas others are directly accessed on a web page.

It is very important to note that many of these tools provide misleading results. Some do not allow for maximum bundle sizes and/or separation that is needed if remote powering is going to be used. In the worst cases, the tools calculate on the basis that the space taken up by a cable is the same as its cross-section. Since cables are circular and therefore cannot be arranged without a certain amount of empty space around each one, such tools seriously underestimate required pathway sizes.

5.8.3 Power supplies

It is a requirement that spaces in which active equipment is housed (including entrance rooms, as well as spaces for access providers and service providers) have adequate power supplies.

5.9 Dimensions, clearances and loadings

5.9.1 Rooms and spaces

Table 5.1 lists the dimensions and clearances that are included as requirements or recommendations in the EN 50174 series for rooms and spaces.

Table 5.1 Dimensions and clearances for rooms and spaces

Dimension/clearance	Minimum required	Minimum recommended	Notes
Clearance for cabinets, frames and racks on faces where access is required	1.2 m		
Height of spaces	2.6 m unobstructed	3 m	1, 2
Maximum height of cabinets, frames and racks if overhead pathway systems are used	75 % of unobstructed height between finished floor and any overhead objects		3
Underfloor depth for raised floors	200 mm	300 mm	4
Room doors		1 m wide 2.13 m high	
Entrance room area		3 m × 3 m	
Access provider space		1.5 m × 2.0 m	
Service provider space		1.5 m × 2.0 m	
Rooms with up to 500 termination points containing cabinets, frames or racks housing cabling components only	3.2 m (length) × 2.2 m (width)		5
Rooms with over 500 termination points containing cabinets, frames or racks housing cabling components only	For each additional group of up to 500 termination points: + 0.8 m along the line of cabinets		5
Rooms with up to 500 termination points containing cabinets, frames or racks housing active equipment in addition to cabling components	3.2 m (length) × 3.0 m (width)		5
Rooms with over 500 termination points containing cabinets, frames or racks housing active equipment in addition to cabling components	For each additional group of up to 500 termination points: + 1.6 m along the line of cabinets		5

Number	Note
1	Minimum of 2.6 m unobstructed required, unless cabinets, frames and racks have their heights restricted.
2	Greater unobstructed height requirements may be needed if overhead pathway systems are used or cabinets, frames or racks are higher than 2.13 m.
3	Examples of overhead objects: lighting fixtures, cameras, sprinklers.
4	Values apply to spaces where there are underfloor pathways to cabinets, frames or racks.
5	Requirements in the standards are based on the use of industry standard 800 mm × 800 mm cabinets in which sufficient cord management in fully cabled cabinets or racks has been allowed. Whilst cabinets and racks are usually 800 mm wide, some organizations opt for depths greater than 800 mm.

5.9.2 Loadings

It is a requirement that flooring can withstand distributed and concentrated loads from equipment and cabling once installed. The standards also recommend considering floor loading when items are being moved. Table 5.2 lists the loading capacities that are included as requirements or recommendations in the EN 50174 series for rooms and spaces.

Table 5.2 Loading requirements and recommendations

Load	Minimum required (tonnes per m^2)	Minimum recommended (tonnes per m^2)
Hanging capacity of overhead structures supporting pathway systems	0.12	0.24
Distributed floor loading capacity (except computer room spaces)	0.50	-
Distributed floor loading capacity in computer room spaces	0.72	1.2

5.10 Separation distances

5.10.1 General

Requirements for separation for the protection of telecommunications cabling and any equipment take precedence over requirements for segregation for preventing electromagnetic interference (EMI). However, the most stringent requirements apply.

5.10.2 Protection

The separation requirements of BS 6701 for protection of telecommunications cabling and equipment from LV power supply cabling are shown in Table 5.3.

Table 5.3 Separation distances for protection

Distance	Conditions
at least 150 mm	Default, if none of the following applies.
at least 50 mm	Separation is provided and maintained by a partition as specified in BS 7671.
50 mm	The LV cables are at least one of the following: **(a)** enclosed in a separate conduit or trunking – if metallic, bonded in accordance with BS 7671 requirements; **(b)** mineral-insulated type; **(c)** earthed armoured construction; or **(d)** flexible, insulated and sheathed (e.g. 'kettle leads').

5.10.3 Segregation from power supply cabling

General

Provided the electromagnetic environment is otherwise benign, no segregation is required between telecommunications cabling and power supply cabling where the power conductors form only single-phase circuits of less than 32 A and are close together (for example, in an overall sheath or twisted, taped or bundled together).

The standards consider other circumstances in some detail and the following is a simplified summary. The separation distances are consistent with those of BS 7671:2018 (and, in particular, Section A444), but they are not expressed in the same way.

The required separation distance can be calculated by multiplying the applicable separation factor in Table 5.4 by the relevant power cabling factor from Table 5.5. The power cabling factor is for single-phase 20 A circuits at 230 V. Table 5.6 lists the treatments that apply if circuits are of a different type. For the purposes of these calculations, a 'ring main' consists of two circuits.

Table 5.4 Separation factors

Metallic containment	Separation factor	Notes
Solid	0 mm	Separation specified is in addition to that provided by any divider/barrier. Screening equivalent to a steel conduit of 1.5 mm wall thickness (see 'Guidance' paragraph further in Section 5.10.3). Required performance is not provided by stainless steel, aluminium and non-magnetic materials (product of the permeability and conductivity is required to be greater than 38 H·S/m^2).
Perforated	150 mm	Upper surface of installed cables is required to be at least 10 mm below the top of the barrier. Screening equivalent to steel tray (trunking without cover) of at least 1.0 mm wall thickness and no more than 20 % equally distributed perforated area. Screening performance is also achieved with screened power cables that do not meet the performance above (for solid containment).
Open	225 mm	Screening equivalent to welded mesh steel basket of mesh size 50 mm × 100 mm (excluding ladders). Screening performance is also achieved with steel tray (trunking without cover) of less than 1.0 mm wall thickness and/or more than 20 % equally distributed perforated area.
None	300 mm	

Table 5.5 Power cabling factor for 20 A circuits

Quantity of circuits	Power cabling factor
1 to 3	0.2
4 to 6	0.4
7 to 9	0.6
10 to 12	0.8
13 to 15	1.0
16 to 30	2
31 to 45	3
46 to 60	4
61 to 75	5
> 75	6

Table 5.6 Additional conditions for separation calculations

Condition	Treatment
3-phase cables	As for 3 single-phase cables.
Currents greater than 20 A	Use multiples of 20 A (for example, 100 A is the equivalent of 5 × 20 A cables and the power cabling factor is therefore 0.4).
Lower voltage AC or DC power supply cables	Use of the current rating at the lower voltage (for example, 100 A at 50 V DC is also 0.4).

The minimum separation requirements apply in all directions, but there is an exception if telecommunications and power supply cables have to cross and the minimum separation requirements cannot be achieved. In such cases, the cables are required to cross at 90° and for a distance on each side of at least the minimum separation requirement that would otherwise apply.

It is a requirement that, unless there is the required physical separation, telecommunications cables can neither be in the same bundle nor in the same compartment of a pathway or pathway system where there are power supply cables or cables of what the standard terms 'other trades'.

The separation requirements can be reduced if power supply cables pass through a fire barrier, provided that:

(a) the total distance over which the reduction takes place is not greater than the thickness of the fire barrier plus 0.5 m on each side;
(b) the telecommunications and power supply cables are enclosed in separate trunking or conduit;
(c) the cables are not single-core operating at greater than AC 600 V; and
(d) the relevant requirements in BS 7671 and the requirements for fire barriers are met.

Guidance

As stated in Table 5.4, 1.5 mm is the recommended thickness for solid metallic containment. However, this is a value derived by calculation and, in practice, steel dividers of such thickness are not readily available. A practical way of addressing this is to place two thinner dividers adjacent to each other.

5.10.4 Other potential sources of electromagnetic interference (EMI)

The EN 50174 series list other general sources of EMI, of which the most relevant are: fluorescent; neon; mercury vapour; and high-intensity discharge lamps.

For all of these, the minimum required separation from metallic cabling is 130 mm.

In healthcare, there are numerous potential sources of EMI; these are discussed in Section 8.

5.11 Remote powering

5.11.1 General

EN 50174-1 defines three 'categories' for installations to support remote powering: RP1, RP2 and RP3. It explicitly states the disadvantages of the first two compared with RP3, which has the least restrictions on power and requires less administration. RP3 allows currents of up to 500 mA per conductor in balanced cabling that is in accordance with the EN 50173 standards. In line with the preference stated in the EN 50174-1, this Code of Practice recommends Category RP3 exclusively and neither RP1 nor RP2 is considered further here.

Remote powering can provide substantial benefits, but is not without complications. Current flowing through cables generate heat and, if not dissipated, causes the temperatures of the cables to rise. As temperatures increase, the transmission performance of cables (and connecting hardware) decreases and maximum channel lengths have to be reduced to compensate.

In addition, remote powering has other major implications for building ICT infrastructure. These can be grouped into the following areas: building environment, mains electrical power and 'de-mating' (or disconnection) under load. These issues are covered in the following subsection.

5.11.2 Consequences of remote powering

Cable heating

Table 4.1 in Section 4.4 illustrates the extent to which channel lengths are affected by temperature. Table 5.7, which is a summary of material in EN 50174-2, shows the temperature rises that can occur under different installation conditions in circular cable bundles of different sizes.

Increases that result in cable temperatures greater than 60 °C are marked as unacceptable. Cables typically cool radially: however, lengths of cable less than 1 m cool axially and the figures in Table 5.7 do not apply in such circumstances.

Table 5.7 Temperature rises for Category 6A cables for various bundle sizes (Category RP3)

Number of cables	6	12	24	48	72	96	144	216
Installation condition	**Temperature rise °C**							
Ventilated	2.0	3.0	4.5	7.0	9.5	12.0	16.0	22.0
Open perforated tray	2.5	3.5	5.5	8.5	11.5	14.0	18.5	25.0
Trunking/conduit	3.5	5.0	7.5	12.0	15.0	18.5	24.0	32.0
Insulation	7.5	10.5	15.5	23.0	29.0	34.0	unacceptable	

As stated in the subsection on cable bundle sizes in 5.8.2, the maximum bundle size permitted by the standards is 24 (and this Code of Practice recommends 12). However, as there is a similar lack of ventilation, the entries in Table 5.7 for larger total numbers of cables are indicative of the temperature rises that can occur when bundles of 24 cables are in close proximity.

Building environment and cable accommodation

Providing remote power results in heat being generated not only within the cables through which the associated current is flowing, but also in the equipment from which the power is being supplied. The heat that is generated can, in turn, affect other cables (together with connecting hardware) and the pathways they are in, as well as the contents of cabinets, frames and racks. The overall environment in parts, if not all, of a building can also be affected.

The deployment of remote power can thus have a significant impact on ventilation, cooling and overall environmental control in a building. Furthermore, additional building space may be needed, not only for additional mechanical and electrical (M&E) services, but also for cable and equipment accommodation.

A related complication of heating effects is that the measures for ventilation and cooling of cables are in many cases not consistent with certain measures used to protect from environmental conditions other than overheating (see Section 2.7). For example, a fully enclosed cable management system (such as conduit or trunking) is advantageous for mechanical protection, but not for ventilation.

Mains electrical power

In order for equipment to provide remote powering, mains electrical power is needed. However, in locations (normally, in distributors and specifically SDs) where such equipment is accommodated, it may be necessary to provide additional HVAC, which, in turn, will increase mains electrical power requirements.

De-mating under load

Although it is not desirable and, ideally, precautions should be taken to prevent it from happening, cables are sometimes disconnected while current is flowing through them. If 'de-mating' takes place 'under load', there is a risk of sparking, which can damage contacts in connecting hardware. Repeated de-mating can degrade transmission performance and reduce the operating life of the hardware.

Mitigations and cautions

Specific steps that can be taken to mitigate heating effects include:

(a) reductions in bundle sizes;
(b) separation of bundles to improve ventilation;
(c) selection of pathways with lower ambient temperatures and avoidance of pathways where there is greater than 1 m of insulation; and
(d) use of cable management systems that provide the most ventilation (subject to the caveat that there is a potential trade-off with protection against other environmental conditions).

Particularly in the context of remote powering, and for reasons explained in Section 4.8, this Code of Practice strongly discourages the use of:

(a) cables using copper-clad aluminium (CCA) or other non-standard conductor materials;
(b) zone or 'cord' cables; and
(c) non-standard or proprietary remote powering solutions.

5.11.3 Requirements

The key requirements of the EN 50174 series for remote powering are as follows:

(a) equipment supplying remote power conforms to EN 62368-3 and does not supply more than 500 mA per conductor;
(b) new installations have been planned on the assumption that all cables providing remote power support 500 mA per conductor and have allowed for possible reductions in maximum channel lengths as the result of temperature rises;
(c) the capacity of mains power supplies meets stated objectives;
(d) the impact on environmental control systems from dissipated heat has been considered;
(e) cabinets, frames and racks in distributors are labelled to indicate that the remote powering is Category RP3; and
(f) there are suitable warning labels in close proximity to wherever de-mating under load presents a risk of "technical damage or contractual liability".

5.11.4 Bundle separation

EN 50174-2 recommends that bundles of cables are separated at their sides by vertical 'chimneys', which have the effect of improving cooling by convection. The standard states that, for 24-cable bundles, the chimney width can be determined by applying a factor of 0.3 to the diameter of an individual bundle. When bundles of 24 cables arranged in a single layer are separated by that width, cooling is the same as for an individual bundle on its own. Figure 5.1, which assumes a bundle diameter of 50 mm, shows chimneys for a single layer.

Figure 5.2 shows how multiple layers can be arranged with chimneys between them. However, cooling is not as effective as when bundles are in a single layer. For layers, the standard states that double the temperature rise that would occur in an individual bundle on its own should be assumed.

Figure 5.1 Separation of cable bundles in a single layer

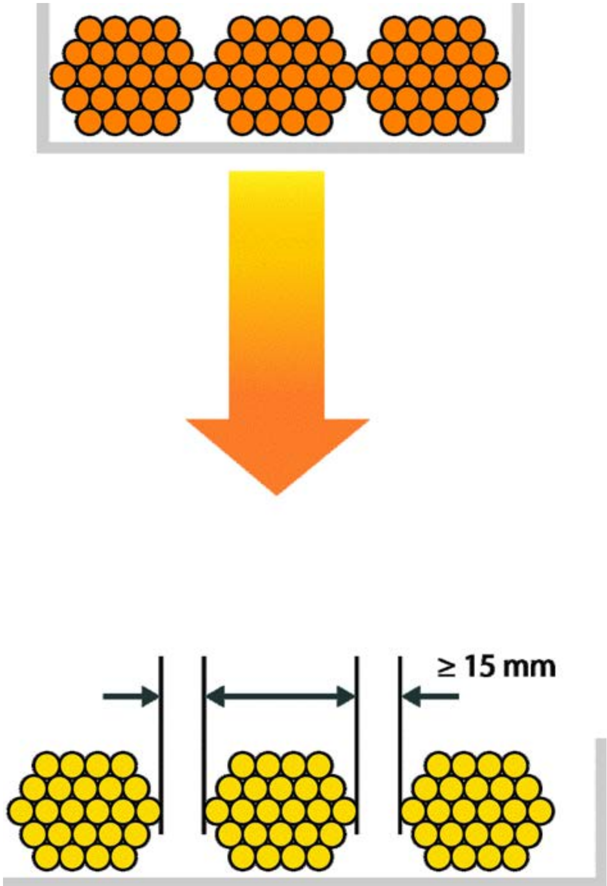
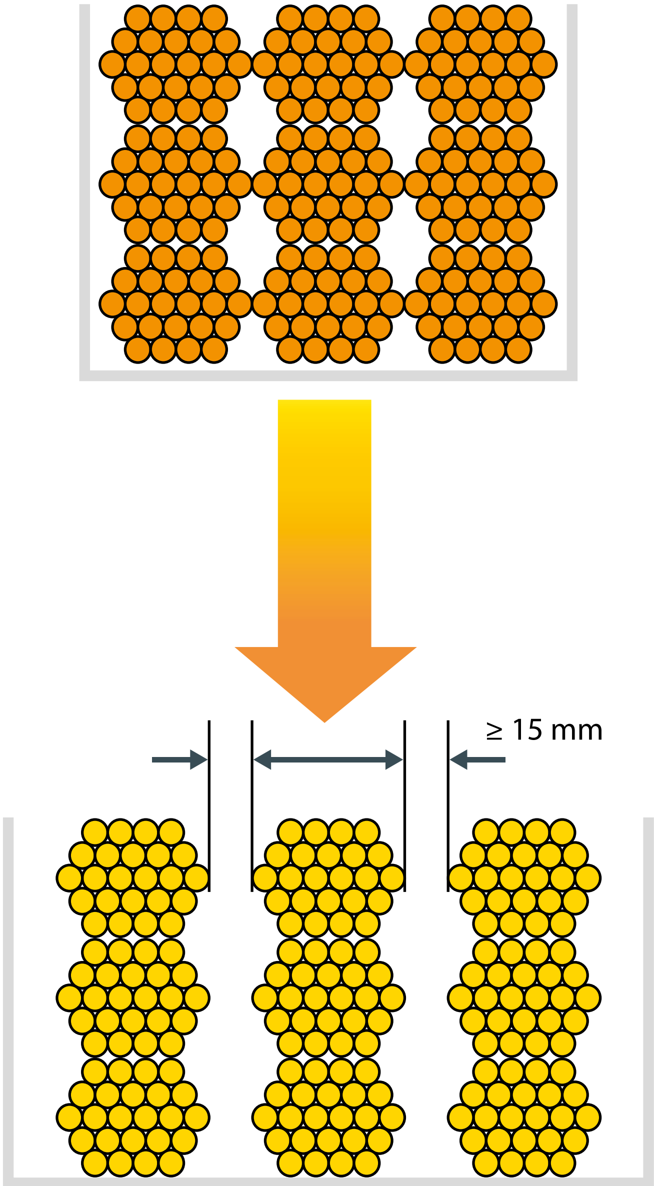


Figure 5.2 Separation of cable bundles in multiple layers



5.12 Testing

5.12.1 General

As the example of Figure 4.1 in Section 4.2 shows, channels consist of 'permanent links' and cords. The EN 50173 standards are such that permanent link requirements have sufficient margins to allow for the predictable variability of the cords added to links in order to create channels. EN 50174-1 therefore recommends that, in installation specifications, acceptance testing of permanent links is required. Whilst EN 50174-1 does include requirements and recommendations for testing channels, these are not covered in this Code of Practice. However, a key point to note is that results are only valid for a channel as tested and do not apply if cords are changed.

The following subsections are concerned with testing balanced and optical fibre cabling that is in accordance with the EN 50173 standards.

5.12.2 Calibration and normalization

There are requirements that:

(a) at the time tests are performed, the equipment has a valid calibration certificate or equivalent (and the test operator can provide evidence of this); and
(b) before tests are performed, the test system is normalized in accordance with the appropriate inspection or testing standard or the instructions of the test equipment manufacturer.

As stated in Section 3.5, it is a requirement that quality plans have procedures for ensuring that cabling test interfaces (such as test cords and adaptors) are acceptable.

5.12.3 Documentation

It is a requirement that test documentation includes:

(a) test equipment details: type and manufacturer, serial number, calibration status and software version;
(b) details of test cords and adaptors: type, reference numbers and manufacturer;
(c) the configuration of cabling (for example, link or channel);
(d) the test method;
(e) the test date (and optionally time) and test operator;
(f) the identifier of the cabling under test;
(g) details of the cabling under test, for example, length, cable and connectivity information; and
(h) required and measured results.

5.12.4 Balanced cabling

Test parameters

EN 50174-1 includes various transmission parameters for testing of balanced cabling. These are to ensure that connections are correct and performance is as required. Resistance, signal loss, delay, distortion and crosstalk (signal disturbance from other sources) are measured to test performance.

Crosstalk in a pair can arise from one or more other pairs within a cable. Crosstalk that arises from other cables is 'alien crosstalk', also known as 'exogenous crosstalk'. There are several different parameters for crosstalk from within a cable and that which is alien. However, every parameter is based on one of two concepts: 'near-end cross talk' (NEXT) or 'attenuation (the decrease of power in a signal) to crosstalk ratio' (ACR).

Parameter groups

The transmission parameters for testing of balanced cabling are in three 'parameter groups':

(a) 'verification';
(b) 'internal transmission'; and
(c) 'alien crosstalk'.

The verification group checks:

(a) wire-map (ensuring that the connection of individual conductors to pins at each end of a cable is consistent); and
(b) continuity, using DC, for:
  (i) signal conductors;
  (ii) screen conductors, if present (there is a requirement to ensure that continuity is not provided by other means, such as protective earth conductors); and
  (iii) short circuits or open circuits.

The internal transmission group includes tests of signal loss, delay and distortion, as well as resistance (including consistency within pairs and between pairs). It also consists of the NEXT and ACR parameters that apply to the group.

The alien (or exogenous) crosstalk group consists (only) of its own NEXT and ACR parameters.

Sample levels and equipment

Table 5.8 shows the recommended sample levels for testing of links.

It should be noted that lengths of links and channels are not themselves used to determine whether a test is passed or failed. However, measured lengths may be useful for other purposes.

For links and channels of Class E_A (which are the ones this Code of Practice recommends), it is a requirement that test equipment is in accordance with EN 61935-1. That standard also specifies test procedures. EN 50174-1 does not recommend testing of individual parameters within the groups.

Table 5.8 Sample levels for testing balanced cabling

Parameter group	Sample levels for links
Verification	100 % recommended in EN 50174-1, irrespective of installation specification requirements.
Internal transmission	100 % recommended if the installation specification specifies acceptance testing of these parameters.
Alien (or exogenous) crosstalk	If testing of this group is required: **(a)** 100 % for populations of less than 30; or **(b)** 30 % for populations of 30 or above. Following the selection procedure in EN 61935-1 for samples is a requirement. EN 61935-1 allows fewer tests, provided there is evidence that measured performance shows an adequate margin against the specified limits.

5.12.5 Optical fibre cabling

The transmission parameters, parameter groups and sample levels for testing optical fibre cabling are shown in Table 5.9.

Table 5.9 Parameters and sample levels for testing optical fibre cabling

Parameter group	Transmission parameters	Sample levels for links
Verification	Continuity	100 % recommended in EN 50174-1, irrespective of installation specification requirements.
	Polarity	
Transmission	Attenuation	100 % recommended if equipment also automatically tests verification parameters. Unless otherwise specified, testing of multimode optical fibre can be limited to 850 nm.
	Length (propagation delay)	100 % recommended if equipment also automatically tests verification parameters.

It is a requirement that test equipment is in accordance with EN 61280-4-1 (multimode) or EN 61280-4-2 (single-mode). These standards also specify test procedures.

5.12.6 Marginal results

Suitable cable test equipment is – of necessity – sophisticated and, as stated in Section 5.12.2, has to be calibrated and normalized. Nevertheless, there are limits to the accuracy of measurements. The result of testing a transmission parameter is 'marginal' if the measurement is close to the value specified by the standards but within the accuracy range of the test equipment.

It is a requirement that quality plans select from one of the following:

(a) the recommended option, which is accepting marginal pass results but not marginal fail results;
(b) not accepting any marginal results (it is recommended that the installation specification covers 're-specification' in such cases); or
(c) accepting all marginal results (this has the effect of reducing the stringency of the overall test limits).

To minimize the number of marginal results, the quality plan is required to specify the properties of the field test equipment. There is also a requirement to consider the use of test equipment with greater accuracy.

5.12.7 Non-compliant results

Possible ways of addressing results that are not in accordance with the installation specification are re-verification of the normalization of the test equipment or the use of more accurate equipment. It is a requirement that remediated cabling, together with any that is affected by the work, is retested in accordance with the quality plan. Procedures (such as labelling) are required in quality plans for instances where it is not possible to obtain compliant results.

5.13 Administration

5.13.1 General

It is critically important for cabling infrastructures to be properly administered. Otherwise, there is a significant risk of them becoming unmaintainable and inoperable.

Administration systems are therefore a requirement of the EN 50174 series. There are general requirements that:

(a) all information produced for or by an administration system is dated;
(b) change control takes place; and
(c) records are retained for a minimum specified period.

5.13.2 Identifiers and labels

It is a requirement that, unless otherwise noted, all the items in Table 5.10 have identifiers and are labelled. Each identifier is required to be unique to the administration system and to be subject to an identifier scheme.

It is recommended that the identifier scheme for cabinets, frames and racks uses a co-ordinate system based on the access floor grid or, where there is none, a grid created by aisles together with cabinets, frames and racks.

Table 5.10 Identifier and label requirements

Items	Notes
Bonds	Labels are not required. Identifiers are not required in installations with less than 20,000 cable elements in total.
Cabinets/frames	Default requirements (identifiers and labels).
Cables	Labels are required at both ends of a cable, but labels are not required in installations with less than 20,000 cable elements in total.
Closures	Default requirements (identifiers and labels).
Pathways	No identifiers (or labels) are required in installations with less than 20,000 cable elements in total.
Spaces	Default requirements (identifiers and labels).
Termination points including joints	Default requirements (identifiers and labels).
Cords/jumpers	Labels (which can either be fixed to an item or be part of it) or other means of identification are required at both ends. No identifiers (or labels) are required in installations with less than 5,000 ports in total.

5.13.3 Records

Table 5.11 summarizes the requirements for administration records.

Table 5.11 Requirements for administration records

Items	Notes
Fixed cabling	Electronic records are required, except in installations with less than 20,000 cable elements in total, where manual records can be used.
Cord connections	Electronic records are required, except in installations with less than: **(a)** 5,000 ports, where manual records can be used; or **(b)** 100 ports, where no records are required.

Electronic records can be maintained in spreadsheets, databases, and so on. Manual records include paper-based systems.

Automated infrastructure management (AIM) systems can detect the presence of discoverable equipment on a network as well as the connection and/or disconnection of cords. It is a requirement that, where used, AIM systems are in accordance with EN 50667.

5.13.4 Physical labelling

Labels are required to be:

(a) legible and located such that they can be read without affecting transmission performance;
(b) for the anticipated lifetime of the cabling: permanently attached, accessible and, where necessary, modifiable;
(c) resistant to environmental conditions (such as ultraviolet (UV) light, heat and moisture);
(d) designed to have a life at least as long as that of the objects being labelled;
(e) printed, machine-generated or manufactured as part of the objects; and
(f) in cases where machine-readable labels are used, located such that each can be read individually.

5.14 Overriding requirements

5.14.1 General

Although the EN 50174 series contains large numbers of requirements, there are other sources of obligations, some of which are mandatory. For example, the EN 50174 series states that for installations to conform, "local regulations shall be met". In practice, such regulations range from national standards to site-specific procedures.

There are also many requirements and recommendations to follow manufacturers' and/or suppliers' instructions. As a general principle, the installation work should be carried out in accordance with the installation specification. However, there are several instances where particular aspects are highlighted.

5.14.2 Regulations

Examples of references to regulations, many of which concern safety, include the following:

(a) fire safety;
(b) hazardous areas;
(c) escape routes;
(d) safe working practices;
(e) electrical power and installations;
(f) building regulations;
(g) site-specific regulations; and
(h) the disposal of optical fibre waste fragments.

5.14.3 Manufacturers' instructions

Examples of areas where manufacturers' instructions are referenced include the following:

(a) installation of pathway systems, including associated fixtures and fittings;
(b) installation of cables;
(c) minimum bend radii;
(d) maximum stacking height of cables in pathway systems;
(e) mixing of unscreened and screened components within a channel;
(f) positioning of cables and the location of closures in cable management systems;
(g) cable termination and jointing;
(h) termination of cable screens;
(i) protection and retention of the optical fibres within joints;
(j) bonding of surge protection devices; and
(k) test methods (where applicable).

5.14.4 Installation specification

Examples of areas where there are explicit references to the installation specification include the following:

(a) labelling identification of closures;
(b) securing of cables in cable management systems;
(c) treatment of cable elements not terminated within connecting hardware;
(d) presentation of cable elements within joints, terminating and connecting hardware and closures; and
(e) bonding of screens.

Section 6

Implementation in buildings – additional factors

6.1 Purpose of section

The previous section outlined some common principles applicable to cabling installed in accordance with the requirements of BS 6701 and the EN 50174 series. This section is concerned with the requirements and recommendations of the standards that are specific to particular aspects of an installation. These apply in addition to those in the previous section.

6.2 Pathways

6.2.1 Requirements

Requirements that apply to pathways include the following:

(a) elements of other supply systems, such as water, heating, HVAC or sprinklers, are not used as pathways or support for pathway systems (although there is an exception if the telecommunications cabling directly serves a device of the supply system, such as a water meter);
(b) grids of suspended ceilings are not used to support pathway systems (although the grids can be used as pathways for individual cables serving devices within the suspended ceiling); and
(c) entry points to pathways, including drawboxes, are accessible and not covered with permanent building installations.

6.2.2 Recommendations

The standards recommend that pathways do not:

(a) block airflow to or from environmental control equipment; or
(b) restrict access to other items of building infrastructure, such as smoke detectors, that require periodic maintenance or access.

If hidden pathways have to be used, the standards recommend that they are either horizontal or vertical.

6.3 Pathway systems

6.3.1 General

Requirements that apply to pathway systems include the following:

(a) the allocation of appropriate space to drawboxes and the storage of cable loops (service loops); and
(b) the support of loads from the:
  (i) installation process;
  (ii) weight of the proposed quantities of cable; and
  (iii) any additional loads being applied by other services or third parties.

Recommendations in the standards that apply to pathway systems include the following:

(a) the use of access (i.e. raised) floors for cabinets, frames or racks that are cabled from underneath; and
(b) separate pathway systems to segregate permanently installed cabling from equipment cords, patch cords and other cables that are not permanent.

6.3.2 Overhead pathway systems

The standards state that overhead pathway systems can be:

(a) stacked to provide additional capacity; and
(b) attached to the tops of cabinets, frames and racks, provided the cabinets, frames and racks are both:
  (i) at a uniform height; and
  (ii) capable of supporting the additional loads of the cable management systems and the installed cables.

The standards recommend that overhead pathway systems are suspended from overhead structures in locations where cabinets, frames and racks either have various heights or where there could be changes such as additions or removals.

The standards recommend that structures used to suspend pathways have a minimum hanging capacity of 2.4 kPa (roughly 0.24 tonnes per square metre).

6.4 Cable management systems

6.4.1 Requirements

The consideration of the following together is a requirement when choosing a cable management system:

(a) the cabling products to be contained;
(b) the electromagnetic performance of the cable management system; and
(c) segregation requirements.

In cases where metallic or composite cable management systems are specifically for electromagnetic screening, and are constructed from multiple sections, it is a requirement that they are interconnected and that the bonds are in accordance with EN 50310.

It is a requirement that the following types of cable management system meet the associated standards in Table 6.1.

Table 6.1 Standards for cable management systems

System	Standards
Conduit	EN 61386-1 and the relevant Part 2
Cable trunking Cable ducting	EN 50085-1 and the relevant Part 2
Cable tray Cable ladder	EN 61537

6.4.2 Recommendations

A non-metallic cable management system is recommended when electromagnetic screening is not required for the cables inside it.

6.4.3 Guidance

In order to make cable attachment easier, some trays have slots. Trays in which the slots are parallel to the length of the tray are acceptable. By contrast, use of trays with slots that are perpendicular to the length of the tray is not recommended, as they provide less electromagnetic protection to installed cables.

Although powertrack systems are referred to in the standards, their use for telecommunications cable management is not recommended by this Code of Practice.

6.5 Conduit

Between pulling points (for example outlets, telecommunications rooms, or pull boxes) bending of conduits is restricted by the following requirements:

(a) there cannot be more than two bends and these cannot exceed 90°; and
(b) there cannot be cumulative change of direction exceeding 180°

Bends in conduits are required to:

(a) be accessible and usable as pulling points, unless:
  (i) there will be no additional installations after the initial one; and
  (ii) cables are removed before any additional installation;
(b) have an inside bend radius at least six times the internal conduit diameter; and
(c) be free from any kinks or other discontinuities that might have a detrimental effect on the cable sheath during cable pulling operations.

The standards recommend that, where there are no bends (and unless appropriate cables or installation methods are used), the distance between pulling points does not exceed 50 m. In practice, this distance is too great; this Code of Practice recommends that pulling points are significantly closer together.

6.6 Cabinets, frames and racks

It is a requirement that cabinets, frames and racks and/or the spaces they are in have atmospheric control, if necessary.

It is recommended that the layout of cabinets, frames and racks, together with the closures and equipment within them, is such that:

(a) the length of cords is optimized and the routing of cords is simplified; and
(b) there is adequate space for:
  (i) the provision of horizontal and vertical routing and dressing fixtures for cables and cords; and
  (ii) the management of lengths of cords and service loops of incoming cable without causing obstruction.

It is recommended that:

(a) insulation displacement connections are used to terminate jumpers; and
(b) termination points served by cabinets, frames and racks are grouped into zones where each zone is served by a single cable bundle and each bundle is served by a single closure within the frame or cabinet.

6.7 Rooms, spaces and structures

6.7.1 General

It is a requirement that spaces intended to contain metallic cabling are located away from identified sources of electromagnetic interference (EMI). Examples given of such sources include electrical power supply transformers, motors and generators, x-ray equipment, radio or radar transmitters, and induction sealing devices.

Recommendations are that:

(a) there is a water detection and notification system where there is a risk of ingress of water (for example, from leaks);
(b) positive air pressure systems (including appropriate filters) are used to prevent ingress of dust and other contamination; and
(c) floor coverings comprising anti-static material are considered.

6.7.2 Piping systems

It is a requirement that there are no piping systems unless they are providing services, such as cooling or sprinkler systems, to a space.

Where the services are provided, it is recommended that any water and drainpipes that pass through the space are located away from cabling or equipment and not directly above.

6.7.3 Doors

The standards recommend that doors to rooms:

(a) have no doorsill;
(b) are lockable; and
(c) have no centre post or have one that is removable.

6.7.4 Raised floors

It is a requirement that areas of access floor tile openings are at least twice the cross-sectional area (CSA) of the installed cables when the cabinets or frames are at full capacity.

6.7.5 Lighting

When cabinets, frames or racks are being accessed, lighting providing a minimum of 500 lux is required; measurement is 1 m above the finished floor in front (and at the rear, if applicable) of them. The standards recommend that lighting is above aisles, but not above cabinets, frames, racks or overhead pathways.

6.7.6 Building entrance facilities (BEFs)

The spaces for BEFs can be rooms or open areas, depending on:

(a) security;
(b) environmental factors:
  (i) entrance facilities are required to be in dry areas that are not subject to flooding; and
  (ii) to prevent ingress of water, fluids or gases, the sealing of pathway systems (including blown cabling media conduits) is enabled; and
(c) the required volume, taking into account foreseen requirements for:
  (i) external network interfaces (ENIs) and associated equipment; and
  (ii) equipment for lightning and over-voltage protection.

The standards recommend allowing for additional external service providers.

6.7.7 Entrance rooms

It is a requirement that the number and size of entrance rooms is determined by taking into consideration:

(a) cabling lengths for access and/or service providers' circuits;
(b) redundancy requirements;
(c) requirements for compartmentation between different access and/or service providers; and
(d) predicted requirements for:
  (i) entrance pathways for access provider and premises cabling;
  (ii) space for termination of access provider and premises cabling;
  (iii) cabinets and racks for access providers and/or service providers;
  (iv) space for the presentation of the cable terminations of the access providers and the presentation of equipment ports; and
  (v) surge protection devices.

It is recommended that floors, walls and ceilings are selected and treated to minimize the generation of dust.

6.7.8 Access provider spaces

Recommendations for access provider spaces include the following:

(a) location in close proximity to a primary building distribution space;
(b) selection such that the area can be expanded;
(c) wireless access provider spaces as close as possible to the wireless equipment; and
(d) if wireless access providers share space, the use of partitions to segregate them.

6.8 Closures

Closures are required:

(a) to provide adequate strain relief and cable support, both at their entrances and at termination points within them; and
(b) to have entrances that do not compromise their environmental performance and are capable of accepting suitable glands.

There are requirements that within closures:

(a) cables are arranged so that access to them, and to connectors and any joints, is possible with minimal disruption, to enable repair and future expansion; and
(b) optical fibre adapters are either fixed or fitted with caps, to prevent ingress of contaminants.

6.9 Cabling

6.9.1 Balanced cabling

In order to minimize signal impairment at terminations, it is a requirement that wire pair twists and conductor separation are maintained as far as possible. Removing a minimum of the cable sheath in accordance with the manufacturer's instructions is also a requirement.

It is a requirement that a combination of unscreened and screened components in a channel is only undertaken following manufacturers' or suppliers' instructions. Such combinations are not recommended by this Code of Practice.

Where screened cabling is used, requirements are as follows:

(a) along its entire length, the screen is continuous and totally surrounds the cable;
(b) the effect that the bonding of the cabling screen to the protective earthing system has on the electromagnetic performance of the screened cabling has been considered; and
(c) at each termination point, intended performance is maintained.

There are also requirements for cases where instructions for termination of a specific cable are not available from the manufacturer or supplier. This Code of Practice does not recommend installation in such cases. Nevertheless, some of the requirements are summarized here, as they include important considerations and issues:

(a) screen contact is to be applied over 360° (according to the Faraday cage principle);
(b) screening is to continue through an appropriate screen connection and not through normal pin contacts alone;
(c) there are to be no discontinuities in the screening – not even small holes in the screen, pigtails or loops (discontinuities with a size of 1 % to 5 % of the wavelength can reduce the overall screening effectiveness);
(d) screens are bonded in accordance with the installation specification and additional planning information; and
(e) screen connections are to be safeguarded against corrosion and a good electrical contact between all parts is to be ensured (maintenance periods can be dependent upon the environment).

6.9.2 Optical fibre cabling

If vertical runs are too long, excessive stress is placed on optical fibres. Preventing this is a requirement and can be achieved with short horizontal runs or loops at distances as specified by the manufacturer.

Section 7

Implementations outside buildings

7.1 Purpose of section

This section summarizes the physical attributes of external cabling that has been installed in accordance with the requirements of the EN 50174 series. It is primarily for reference and is intended to capture the vast majority of the requirements and recommendations in the EN 50174 series related to completed implementations outside buildings.

7.2 General

There are several areas where the requirements and recommendations of EN 50174-3 are very similar, if not identical, to those of EN 50174-2. In addition, there are parts of EN 50174-1 that apply to installation both inside and outside buildings.

The following sections of this Code of Practice also apply outside buildings:

(a) much of Section 5.2 on safety and, in particular, the subsection entitled 'Cables', which includes requirements for external cables entering buildings;
(b) the subsection entitled 'General' in 5.4.2 which covers general cable installation;
(c) the subsection entitled 'Minimum bend radius' in 5.4.2;
(d) Section 5.5.3, which covers protection from electromagnetic interference (EMI);
(e) Section 5.7.2, which is concerned with the resilience and redundancy of external services; and
(f) Section 6.8, which is concerned with closures.

Sections 5 and 6 also include details of various requirements and recommendations related to entering buildings, covering, in particular, BEFs, entrance rooms as well as spaces for access providers and service providers.

7.3 Pathways

7.3.1 Requirements

It is a requirement of EN 50174-3 that pathways protect installed cabling from damage or adverse effects on transmission performance, unless there is no risk in the first place. There is an explicit requirement to increase protection where rodent damage is a risk or has previously occurred.

EN 50174-3 does not permit the use of the outside of existing piping for the installation of pathway systems or the direct attachment of cables.

7.3.2 Recommendations

EN 50174-3 recommends the avoidance of areas in which there could be an adverse impact on telecommunications cabling from environmental factors. Examples include areas where there can be EMI, high temperatures from steam pipes, flooding, chemical contamination or mechanical disturbance from roads or railway lines.

7.4 Pathway systems

7.4.1 General

Requirements and recommendations in EN 50174-2 and EN 50174-3 that apply to all pathway systems (rather than the various specific indoor or outdoor types) are in most respects almost identical. As the details have been provided in previous sections of this Code of Practice, they are not repeated here.

7.4.2 Maximum stacking height for cables

EN 50174-2 and EN 50174-3 each contain requirements for the maximum stacking height for cables, where this has not been specified by the manufacturer. However, the requirements are different: EN 50174-2 reflects the latest understanding of cable crush resistance and is more up-to-date. Accordingly, this Code of Practice recommends following the requirements of EN 50174-2, which are as stated in the subsection of 5.4.2 entitled `Maximum stacking height for cables'.

7.5 Spaces and structures

7.5.1 General

Requirements in EN 50174-3 for spaces and structures include the following:

(a) siting in locations that enable safe access with minimal disruption for routine activities and future installations;
(b) design and construction to withstand likely risks;
(c) the use of construction materials that resist deterioration from exposure to sunlight; and
(d) appropriate security for cabling and any equipment inside.

In spaces and structures intended to contain active equipment, adequate power supplies are required. In addition, temperature and humidity have to be maintained (within suitable limits) so that continuous operation is possible.

7.5.2 Telecommunications cabinets

Requirements

Requirements for telecommunications cabinets include:

(a) following the design guidelines of EN 61969-1 and EN 61969-2;
(b) locations that minimize the impact on the surrounding environment and are as distant as possible from possible sources of interference; and
(c) the prevention of vandalism (when accessible and sited outside).

Where telecommunications cabinets are not for core or access networks, there is a design requirement to consider any need for accommodation of:

(a) climate control equipment;
(b) uninterruptible power supplies (UPSs) and alarms systems for security; and
(c) connections for power supplies and earthing.

Recommendations

EN 50174-3 recommends installation of telecommunications cabinets next to walls, for better protection. An additional recommendation is that, if they are accessible, telecommunications cabinets have locks.

7.6 Closures

Among the requirements in EN 50174-3 for closures (except direct burial types) is that their locations enable safe access with minimal disruption for routine activities and future installations. There is also a requirement to limit access appropriately.

It is a requirement of EN 50174-3 that closures for optical fibre splices meet European Standards where applicable. Examples given are EN 50411-2-2, EN 50411-2-3 and EN 50411-2-4 for the pan, inline and dome types, respectively. It is also a requirement that closures for air-blown optical fibre microducts meet standards such as EN 50411-2-5 and EN 50411-2-9, where applicable.

7.7 Underground installations

7.7.1 General

Underground pathways can be shared with other services (for example, in tunnels for electricity, water or other utilities) and, in such cases, it may be possible to use indoor pathway systems in accordance with EN 50174-2.

The rest of this section considers dedicated underground pathways.

In addition to the requirements and recommendations of EN 50174-1, a considerable amount of guidance (covering both optical fibre and metallic telecommunications cabling) can be found in the FIA publications listed in Annex C.2 of this Code of Practice.

7.7.2 Future-proofing

Excavation

Digging for installation of underground cabling is costly, time-consuming and potentially disruptive. In many instances, there is an overwhelming case for installing extra capacity/ducts, particularly when digging for the first time. Accordingly, EN 50174-3 requires that consideration is given to installing pathway systems in excess of those initially required.

It recommends that – for any installation phase – additional pathway systems are provided such that, if extra cables subsequently need to be installed, further excavation is:

(a) minimized; or
(b) specifically for pathway systems other than those owned by access providers, not necessary at all.

Cable loops

Cable loops, also known as service loops, facilitate future repairs. It is a requirement that appropriate space is allocated for the storage of cable loops.

7.7.3 Underground conditions

Water

Water is an inevitable source of problems in underground installations.

EN 50174-3 includes a requirement to assume that, unless preventative measures have been taken, underground pathways can be filled – at least to some extent, if not fully – by water from leaks or condensation.

Other key requirements are as follows:

(a) access points provide effective drainage;
(b) neither pathway systems nor ducts connected to maintenance holes act as drains (although it is recognized that water will flow through them under some circumstances); and
(c) to prevent water ingress:
  (i) sections of conduit are jointed; and
  (ii) unless installation is about to take place, ends of conduits or sub-conduits are sealed.

It is recommended that all cable management systems used underground are made from non-porous materials.

Other protection

Requirements for other protection are effectively as follows:

(a) the location and materials used in the construction of pathway systems are compatible with their environment; and
(b) pathway systems are protected from damage by the surrounding materials.

It is recommended that soil conditions are carefully considered when the intention is to bury cables directly. EN 50174-3 recommends consulting cable suppliers if, for example, subsoil conditions are corrosive, as additional protection may be necessary.

7.7.4 Burial depths

General

As explained in Section 5.14.1, the EN 50174 series states that "local regulations, including safety, shall be met". Street Works UK is the source of the regulations for cable burial in the UK and, for particular locations, specifies depths of telecommunications cabling infrastructures as well as separation from other utility infrastructures.

Street Works UK was previously known as the National Joint Utilities Group (NJUG). Despite its renaming, references to the NJUG Guidelines remain common. The major telecommunications providers issue guidance, which is freely available, on their own installation practices. This guidance is consistent with the Street Works UK guidelines.

Section 7 – Implementations outside buildings

Requirements

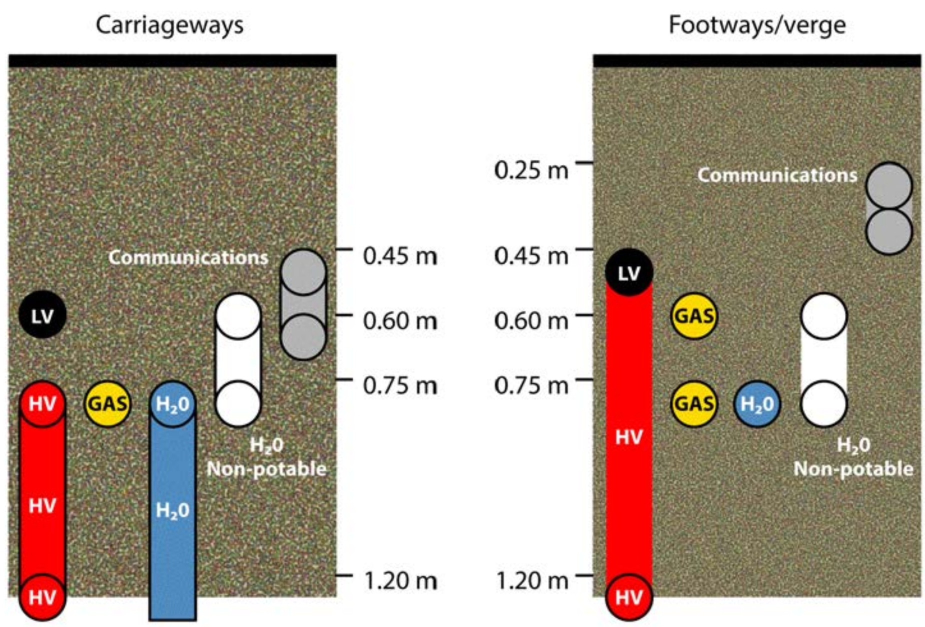
Volume 1 of the *Street Works UK Guidelines* specifies the following minimum depths for telecommunications cables in certain locations (in fact, it provides ranges). The depths are measured from the highest points of the buried item and are listed in Table 7.1.

Table 7.1 NJUG/Street Works UK burial depths

Location	Recommended minimum depths (m)
Footway, verge	0.25 – 0.35
Carriageway	0.45 – 0.60

The requirements for the two cases are illustrated in Figure 7.1, which also shows depths for other utilities.

Figure 7.1 Depth of underground utilities: NJUG/Street Works UK guidelines



For locations other than those covered by NJUG, the burial depths in EN 50174-3 apply, as shown in Table 7.2.

Table 7.2 EN 50174-3 burial depths

Location of pathway	Requirement	Recommendation
Agricultural land	0.9 m	0.9 m
Uncultivated or landscaped land	0.5 m	0.9 m

The depth is to the top of the installed cables. The requirements do not have to be met if additional steps to protect the cables are taken.

Guidance

EN 50174-3 states that pathways without effective mitigation that do not meet the requirements are considered to be 'sacrificial'. It is always necessary to dig further than the depth requirements, because they are to the top of buried items. In addition, EN 50174-3 notes that dig depths may be considerably greater than the requirements if any protective layers are to be installed below the cables.

7.7.5 Identification and marking

Avoiding conduit that has the same colour as that used exclusively by other services is a requirement of EN 50174-3. There is also a requirement for marker tapes or equivalent to comply with national or local regulations.

The NJUG regulations specify the identification and marking of telecommunications cabling infrastructures and other utility infrastructures. Details of colours for ducts, pipes and marker systems can be found in Annex E of this Code of Practice.

7.7.6 Marker tapes

EN 50174-3 requires marker tape, in accordance with EN 12613, between 0.1 m and 0.2 m above directly buried cable. The alternative to this requirement is to document the location of the cable on a site plan instead.

EN 50174-3 recommends marker tape, in accordance with EN 12613, between 0.1 m and 0.2 m above each buried conduit or group of conduits.

The NJUG guidance (which applies to all utilities) recommends that "appropriate marker systems are laid some distance above the plant".

7.7.7 Ducts and conduit

General

Installation of cables where public roads (or railways) are involved is outside the scope of this Code of Practice. However, there is a requirement in EN 50174-3 that cables are installed inside protective conduits at crossings with roads or railways and this therefore applies to any private roads in healthcare premises.

It is a requirement that once installation, including backfill, has been completed, the integrity of a conduit's diameter and its inner surface are confirmed by appropriate techniques. It is a recommendation that such techniques also remove any foreign matter that may have entered the conduit.

It is recommended that all underground conduit is non-porous and has smooth internal walls.

Bends

The requirements and recommendations in this subsection apply to pathway systems that are not owned by access providers.

Requirements for conduit are as follows:

(a) the inside bend radius is at least 6 times the internal conduit diameter;
(b) bends within conduit are accessible; and

(c) bends can be used as pulling points unless:
  (i) once initial cable installation has taken place, there is no subsequent installation; or
  (ii) cables are to be removed before any additional installation takes place.

It is recommended that conduit is in straight lines with maintenance holes or hand holes wherever deviations are greater than 3° horizontally or 1.5° vertically.

Pathways between premises boundaries and BEFs

This subsection applies to pathway systems that are not owned by access providers.

Requirements for pathways between premises boundaries and BEFs are as follows:

(a) conduits without sub-conduits have an internal diameter of at least 90 mm; and
(b) between any two access points, including the premises boundary and the BEF:
  (i) deviations do not exceed a total of 90°;
  (ii) there is at most one pre-formed bend (which cannot exceed 90°);
  (iii) bends have a radius of at least 600 mm; and
  (iv) there are no kinks or other discontinuities in bends that could adversely affect cable sheaths during cable pulling operations.

7.7.8 Blown fibre installation

Blown 'cable' installation techniques represent a solution that may be considered in certain situations. Blown fibre, in which empty tubes are installed instead of cables and into which optical fibre(s) are blown once detailed requirements are known, was historically of interest because it offered the opportunity to:

(a) defer cost from the installation phase to an operational phase; and
(b) evolve the installed media to reflect improvements in transmission performance (by blowing out existing optical fibres and blowing in new ones).

However, these potential advantages are no longer so clear, as:

(a) the difference in installation cost is simply the cost of the optical fibres themselves and that continues to decrease;
(b) clear and well-defined service level agreements are necessary to deliver any effective cost deferment;
(c) installed tubes can be subject to damage that may occur to the pathways; and
(d) transmission performance specifications have matured to the point where there is little need for the replacement of media.

This Code of Practice recommends that a technical analysis is undertaken to determine if the blown solution offers real technical and/or financial advantages compared with conventional cable installation.

7.7.9 Access points

Maintenance holes, hand holes and buried closures are examples of access points.

The maximum tensile load of the cable, and the installation method, are among the requirements of EN 50174-3 that have to be taken into account when planning the location and separation of access points.

7.7.10 Maintenance holes and hand holes

General

Many of the requirements for maintenance holes and hand holes are for sizing, cable protection and future-proofing and are not covered in detail here.

Maintenance holes (or chambers) present various safety risks. Addressing these is not within the scope of the standards but EN 50174-3 does highlight the particular risk of asphyxiating, toxic or explosive gases being trapped in maintenance holes. Detailed guidance, including information on legislation concerning confined spaces, is available from the Health and Safety Executive (HSE).

Requirements

Maintenance holes and hand holes are required to ease the installation or removal of cables, as well as where pathway systems change direction. Location and separation of both types of hole has to be established from installation instructions and the proposed installation technique.

Maintenance holes are required where there are changes in depth, volume or quantity of underground pathway systems.

Analysis of ground water table conditions is required to determine the appropriate type of maintenance hole.

Recommendations

EN 50174-3 recommends a maintenance hole or hand hole:

(a) at each end of a conduit route;
(b) within 5 m and preferably as close as possible to any external building wall on a pathway; and
(c) adjacent to an equipment room in which cables terminate.

EN 50174-3 recommends that pathway selection allows for the subsequent construction of maintenance holes, hand holes or structures when these are for other than core and access networks.

Appropriate sleeving is recommended for cabling that is not in a cable management system.

Guidance

Maintenance holes are more commonly termed 'chambers'.

Chambers can be cast in concrete, built from brickwork or constructed by other means. However, plastic mouldings are frequently adequate and are also cost-effective. For telecommunications, the most commonly used chamber sizes are:

(a) 450 × 450 mm;
(b) 450 × 600 mm;
(c) 450 × 900 mm;
(d) 600 × 900 mm; and
(e) 600 × 1,300 mm.

The location and dimensions of any given maintenance chamber have to take into account its purpose. A chamber can be used for:

(a) pulling: with dimensions and port configuration in line with the predicted requirements of installation practice;
(b) in-line jointing: for which dimensions need to allow for the predicted number and type of joint closures (in-line or dome type); and
(c) changes in direction: for which dimensions need to allow for the minimum bend radii of the installed cables.

In all cases, the dimensions of maintenance chambers have to take account of needs for service loops of cables. If service loops are to be installed at a maintenance chamber, they should be created below the entry/exit ports of the chamber. This prevents congestion and enables the objective of the maintenance chamber to be achieved.

If a maintenance chamber is to be used as a storage location for cables that will serve future network extension (for example, for a building that is not yet constructed), it is critical that the dimensions and location are matched to the length of stored cable necessary to facilitate the desired extension.

Failure to provide an appropriate chamber may restrict its use or force the insertion of unwanted joints.

To deliver external services to customers' premises, access providers may require dedicated maintenance chambers. These are generally not shared with other access providers.

Further information on chambers and related matters can be found in the *FIA Shortform Guidance on External Installations: Specification of Pathways, Spaces and Structures*.

7.7.11 Covers for maintenance and hand holes

Requirements

Covers for manholes are required to conform to EN 124 and to be sized for the maximum foreseeable load. For both maintenance and hand holes, there is a requirement to consider armoured cover plates with security locks where prevention of unauthorized access is desirable.

Guidance

EN 50174-3 does not include any other requirements or recommendations for hand hole covers, but indicates that they are specified in EN 124.

Maintenance hole covers vary significantly in design, construction and materials. EN 124 is a multi-part standard that defines a number of classes for different loads and environments. In practice, the vast majority of covers in use are those shown in Table 7.3.

Table 7.3 Commonly used maintenance hole covers

Class	Test load (tonnes per m^2)	Group	Environment
B125	12.5	2	For use in car parks and pedestrian areas where only occasional vehicular access is likely.
D400	40	4	For use in areas where cars and lorries have access, including carriageways, hard shoulders and pedestrian areas.

Use of one or the other of these is recommended.

There is a class/group of cover for areas where there is only pedestrian access. However, pedestrian areas can be subjected to heavy loads from unauthorized motor vehicles (whether parking or otherwise) or from mobile elevating work platforms (MEWPs), such as cherry pickers and scissor lifts. As a result, it is not uncommon for 'pedestrian only' covers to be damaged. Cost savings from using such covers are insignificant in the wider context and the use of them is therefore not recommended by this Code of Practice.

As their use becomes more frequent, MEWPs are an increasing source of damage to maintenance hole covers. In addition MEWPs can be very compact, so it should not be assumed that narrow pathways, where pedestrian-only covers might otherwise be considered, are inaccessible to them.

7.8 Aerial pathways

Overhead cabling follows 'aerial pathways'. EN 50174-3 covers both dedicated aerial pathways and those shared with overhead power supply infrastructures. Such shared arrangements are not considered further in this Code of Practice because their direct commissioning by healthcare organizations is likely to be very rare.

Examples of factors that need to be considered in relation to dedicated aerial pathways are:

(a) maintaining tension and preventing unwanted sag;
(b) potential effects of wind, rain and temperature variations, including conditions where ice can form;
(c) loads on supporting structures;
(d) increased risks associated with lightning (see Section 7.9);
(e) corrosion of fixings;
(f) degradation of cable sheaths from exposure to environmental conditions, including sunlight and air-borne pollution;
(g) risk of accidental or malicious damage, especially if the pathway is not particularly high up;
(h) precautions against decay, if poles are used;
(i) bonding;
(j) avoiding contact with any other overhead telecommunications cabling; and
(k) segregation from any overhead power supply cabling.

There is too much detail in EN 50174-3 to cover in this Code of Practice: the standard itself should therefore be consulted for the relevant requirements, recommendations and guidance.

Because of their vulnerability, due to physical exposure, EN 50174-1 does not recommend aerial entrance pathways. EN 50174-3 recommends that:

(a) aerial pathways are not used to cross roads; and
(b) catenary wires are only attached to a building if the load on the fixing point will not exceed its design strength and the building structure can sustain the load with a safety factor.

This Code of Practice recommends an option appraisal, in which detailed consideration is given to other possible solutions, if aerial pathways are being considered. This Code of Practice also strongly recommends that metallic cabling is not used in aerial pathways.

7.9 Outdoor cables

7.9.1 General

Premises cabling between buildings can comprise:

(a) optical fibre cables (which may have metallic elements for tensile strength or crush resistance – these are treated as extraneous metal in EN 50174-3); and
(b) metallic cables, including twisted pair and coaxial designs.

This Code of Practice recommends that use of metallic cabling is only considered where:

(a) the risk of damage to the cables and connected equipment from lightning strikes is mitigated (for example, by the use of underground pathways);
(b) the impact of different electrical systems and earth potentials in the connected buildings is mitigated by appropriate isolation devices; and
(c) the transmission distances are limited in cases where networks are operating at high bit rates (note that the use of the isolation devices as mentioned in the previous point may further restrict the possible data rates).

For these reasons, the interconnection of buildings to provide high bit rate networks is generally assumed to use optical fibre. However, equipment installed on external structures (such as security gates and surveillance cameras) may be connected using a range of metallic cables, provided they have the relevant mitigation as outlined.

7.9.2 Optical fibre cables

EN 50174-3 requires outdoor optical fibre cables to be in accordance with EN 60794-3 and the appropriate specifications as shown in Table 7.4.

Table 7.4 Family and detailed specifications for outdoor optical fibre cables

Environment	Family specification	Product/detailed specification	Detailed aspect
Conduit (duct)	EN 60794-3-10	EN 60794-3-11	Single-mode telecommunications
		EN 60794-3-12	Premises cabling
Direct burial	EN 60794-3-10	EN 60794-3-11	Single-mode telecommunications
		EN 60794-3-12	Premises cabling
Lashed aerial	EN 60794-3-10	-	-
Self-supporting aerial	EN 60794-3-20	EN 60794-3-21	Premises cabling

7.9.3 Metallic cables

EN 50174-3 requires outdoor metallic cables to be in accordance with European Standards where applicable. These include the EN 50406 and EN 50407 series of standards for aerial and duct/buried cables, respectively.

7.9.4 External cables entering buildings

Fire safety requirements for external cables entering buildings can be found in Section 5.2.2.

Section 8

Healthcare building considerations

8.1 Purpose of section

As indicated in Section 1.3 of this Code of Practice, the material in the Sections 5 to 7 is primarily intended for staff in healthcare and related organisations who do not have a telecommunications cabling background.

This section is primarily for telecommunications cabling professionals – such as consultants, specifiers and installers – who are not familiar with healthcare. Although there are many aspects of healthcare premises and other buildings that are similar, there are some crucial differences and this section covers key considerations.

8.2 Safety

8.2.1 General

As previously stated, safety is of paramount importance at all stages of the lifecycle (including planning, installation, operation, maintenance and repair). Safety always takes precedence over other requirements and applies to all personnel including:

(a) patients, visitors and staff (clinical, administrative or otherwise) with no involvement in a project; and
(b) installers, electrical, building and other sub-contractors, local estates and facilities staff, IT staff, medical engineers, and so on.

At various stages in the lifecycle of an installation there are certain sources of risk and other issues which are discussed in the rest of this section (8). It should be noted that most healthcare organisations have staff with considerable expertise (and officially designated responsibilities) in areas such as fire safety, infection control, radiation protection, asbestos control, premises security and so on.

It is imperative that they are all suitably involved, and have authorised works where necessary, throughout telecommunications cabling projects. This is in addition to the need for authorisation for works from IT, estates and facilities, and medical engineering (or equivalent) departments.

8.2.2 Performance of the ICT infrastructure

Healthcare services are increasingly reliant upon the networking of diverse types of imaging and non-imaging medical devices used in the diagnosis, monitoring and treatment of patients. Devices may be networked for various purposes including the collection and distribution of patient data (such as diagnostic results, vital signs monitoring, medical images and so on), the archiving and future retrieval of patient data, the integration of device data into clinical information systems and electronic patient records, device status/condition monitoring and the remote programming of devices.

Particular requirements vary according to the application. For example, it is critical that patient monitoring data is transmitted in real time. Another example is that large amounts of data can be transmitted by imaging equipment such as computed tomography (CT) and magnetic resonance imaging (MRI) scanners as well as picture archiving and communication systems (PACS). It should be noted that, in addition to the demands from healthcare systems - which naturally have to take priority - patient entertainment systems can place significant demands on hospital networks.

Safe, effective and efficient healthcare is critically dependent on digital systems and services. These systems and services must deliver the required performance (including low latency and high throughput in networks) reliably and consistently. It is essential that the underlying building infrastructure for ICT is able to support both existing and future demand.

8.2.3 Design for resilience and redundancy

Adequate resilience and redundancy are essential in building infrastructures for ICT. It must be emphasized that this objective cannot be achieved by taking into account only telecommunications cabling and equipment; the associated mechanical and electrical (M&E) services are also critical. Networking and other IT equipment as well as telecommunications cabling all have to be operated under specific environmental conditions. As a result, cooling is often required in locations where there is any significant quantity of equipment.

If the heating, ventilation and air-conditioning (HVAC) that is required for IT, networking or other digital equipment fails, that equipment will not operate as intended. To reduce risk, it follows that resilience and redundancy are necessary in the HVAC services on which digital systems and services rely.

Another source of risk associated with HVAC is power outages. It is necessary, but not sufficient, for critical digital equipment to be connected to uninterruptible power supplies (UPSs). The HVAC required for the digital equipment also has to be on a suitable back-up power supply. Otherwise, during a power outage, HVAC services will not be provided, and - consequently - the digital equipment will not be able to operate as intended, despite having UPS protection of its own. This type of shortcoming is known to be a relatively common problem in hospitals.

8.2.4 Operational and business continuity during installations

Disconnections

During installation and maintenance, it is often necessary to disconnect telecommunications cables and cords and/or to power down network equipment. Mains electrical power may also need to be switched off or disconnected.

These actions are not always undertaken with adequate planning or preparation, and sometimes disconnections are unintentional. As a result, during cabling installation projects, it is not uncommon for healthcare organisations to experience unexpected interruptions, in parts of their premises, to network communications and/or to the supply of electrical power.

These interruptions may not just affect services in the area being worked on. This is because, in some premises, good practice has not always been followed and mains electrical circuits extend to apparently unrelated areas or to equipment that should be independently served. The consequences of isolating a circuit can therefore be quite unpredictable.

Unauthorised or unscheduled interruptions, however brief they are, can be highly disruptive and recovery from them may be prolonged. In the most serious cases, the safety of patients can be put at risk. Detailed planning, with robust contingency arrangements, of interruptions to network services or electrical power supplies is therefore essential.

Pre-existing telecommunications cabling

During refurbishment projects, old telecommunications cabling of various types is often encountered. It is frequently undocumented and may, or may not, show any signs that it is connected to anything. Experience has shown that it is often impossible to determine whether any such cabling is still necessary; this is particularly the case if its use is intermittent, occasional or only for certain emergencies. Therefore during refurbishment or similar work, any decision to remove or disconnect (temporarily or otherwise) old cabling, needs careful consideration.

8.3 Infection control

The importance of infection control cannot be overemphasized. Patients have been seriously harmed in UK hospitals, as a result of being infected when in proximity to areas where cabling installation or similar construction-related activities were taking place.

One source of risk during an installation in any building is mould, and this is well-known in the cabling installation and construction industries. However, in healthcare, an additional risk factor is that there are many patients who are particularly vulnerable due to their weakened immune systems.

Because they can be contaminated, tools, equipment and other items used during installation can be a source of infection. Therefore, they have to be decontaminated as required by relevant instructions and/or the applicable infection control policies and procedures.

Of necessity there are very strict infection control measures in healthcare premises. Installers may have to attend briefings on the topic before starting work in some organizations, and - in certain cases - formal training or certification may also be a requirement.

Infection control is covered extensively elsewhere and therefore it is not discussed further in this Code of Practice. However, it should be noted, that – although all healthcare organizations should meet the required standards – local policies, procedures and requirements vary. It should also be noted that there are some differences between the national requirements in Scotland and England for example.

8.4 Ionizing radiation

Ionizing radiation can be used in hospitals and other healthcare premises for diagnosis and treatment. Due consideration is needed in the design and installation of the building infrastructure for ICT in locations where ionizing radiation can be present.

8.4.1 Imaging using x-rays

In hospitals the most common types of imaging based on x-rays are as follows:

(a) digital radiography (DR) – direct conversion of x-rays into a digital image;
(b) computed radiography (CR) – a technology which replaced film in x-ray equipment but which has largely been superseded by DR;
(c) computerised tomography (CT) – uses x-rays to acquire a series of cross-sectional images (or 'slices') that can be visualised in 2D or 3D and is sometimes termed computerised axial tomography (CAT);
(d) fluoroscopy – real time x-ray imaging (often used for interventional radiology);
(e) mammography – use of x-rays of the breast for diagnosis and cancer screening; and
(f) dual energy x-ray absorptiometry (DEXA) – used to determine bone density.

Equipment using x -rays is not confined to radiology departments; it is often permanently installed in those operating theatres in which imaging is routinely needed and catheterisation laboratories (where cardiac tests and procedures take place). Other locations include emergency departments, and - less commonly - mortuaries. X -ray imaging is also used extensively in dentistry. Mobile x -ray units are used for patients who cannot be moved, and who are in locations, such as intensive care units, where there is no permanently installed equipment.

8.4.2 Nuclear medicine

Nuclear medicine utilises unsealed radioactive substances, administered to the patient, in the diagnosis and treatment of disease.

In diagnostic imaging a patient is given, usually by injection, a radiopharmaceutical (a formulation of a radionuclide bound to a compound selected for its affinity to specific tissues or organ functions). The radiopharmaceutical depends on the study being performed and what organ or tissue type is under investigation but the gamma rays emanating from where it has been absorbed in the patient's body are used to create the medical images.

Equipment used in nuclear medicine includes 'gamma cameras' which produce 2D images whereas positron emission tomography (PET) scanners and single -photon emission computed tomography (SPECT) scanners provide 3D information.

X-ray and MRI scans primarily provide anatomical information, whereas nuclear medicine provides information on organ and tissue function.

8.4.3 Radiotherapy

Radiotherapy is the treatment of disease, most commonly (but not exclusively) cancer, using ionizing radiation to preferentially kill unwanted cells. In the majority of cases the radiation is generated by a machine, normally a linear accelerator, and delivered to the patient externally. This is termed teletherapy.

Internal radiotherapy may be by brachytherapy, by which a solid (sealed) radioactive source is placed inside a patient's body either in or next to a tumour, or by radiopharmaceutical therapy using liquid (unsealed) radioactive sources which target particular cells.

8.4.4 Installation of cabling in affected locations

All locations intended to contain sources of ionizing radiation need to be shielded. Requirements vary, but have to be strictly followed and can apply to floors, ceilings and walls as well as doors and any windows that are required for observation of patients.

It should be noted that the various requirements apply not only to areas where there is equipment or material that produces ionizing radiation but also to rooms for those patients who have to be isolated after certain procedures.

In general, mechanical and electrical services entering rooms designed to contain radiation have to be routed through specially-designed access ports so that shielding is not compromised. It may also be necessary to incorporate changes in the direction of ductwork, pipework and cable management systems to provide protection against radiation breakout.

8.5 Electrical installations

Many areas within healthcare premises will constitute 'medical locations' under the 'special installations or locations' section of BS 7671; in this context, the following groups are defined:

(a) Group 0: medical location where no medical device applied parts are intended to be used and where discontinuity (failure) of the supply cannot cause danger to life;
(b) Group 1: medical location where discontinuity (failure) of the supply does not represent a threat to the safety of the patient and medical device applied parts are intended to be used, externally or invasively (except where Group 2 applies); and
(c) Group 2: medical location where applied parts are intended to be used, and where discontinuity (failure) of the supply can cause danger to life, in applications such as intracardiac procedures, vital treatments and surgical operations.

According to a location's Group designation, special requirements for the electrical installation will apply, to provide for electrical safely of susceptible patients and for security (continuity) of essential power supplies under fault conditions.

Designers and installers of telecommunication systems need to give these requirements due consideration to ensure that telecommunication systems introduced to medical locations do not compromise local electrical installation safety measures (such as, for example, the stringent equipotential bonding requirements in patient environments). Additional guidance is available in HTM 06 -01.

Additionally, it should be noted that, if any non -medical electronic equipment is introduced to a 'patient environment', then it should meet the requirement in EN 60601 -1 for electrical safety of medical equipment. EN 60601 -1 defines the patient environment to be that volume within which a patient, or somebody touching the patient, can make contact, intentionally or unintentionally, with the equipment.

8.6 Electromagnetic interference (EMI)

8.6.1 Sources of EMI

Any electrical installation or equipment may cause EMI and there are often high densities of electrical systems in healthcare premises.

Well-known sources of EMI that are not specific to healthcare include:

(a) mains power supply cables carrying high currents (see Section 5.10.3);
(b) electrical equipment such as transformers, motors and generators;
(c) particular types of lighting (see Section 5.10.4);
(d) switched-mode power supplies (often used in ICT equipment); and
(e) digital devices (whether fixed such as wireless access points or portable) which use one or more of: mobile phone services, Wi-Fi, digital enhanced cordless telecommunications (DECT) or Bluetooth.

In healthcare premises additional sources of electromagnetic interference can include:

(a) surgical diathermy (electro-surgery) equipment;
(b) MRI scanners (if their shielding is faulty);
(c) emergency services radio (both from handsets and vehicles); and
(d) outside broadcast equipment (when media organizations are present).

There can also be sources of interference, such as the following, from outside premises:

(a) trains or trams;
(b) marine radar (from ports or vessels);
(c) radio and television transmitters; and
(d) mobile phone base stations.

8.6.2 Susceptible devices and equipment

General prevention of electromagnetic interference has been addressed earlier in this Code of Practice. However there are medical and scientific devices that are particularly susceptible to electromagnetic interference and for which special measures may be needed. Patient monitors and electrodiagnostic devices which measure low-level electrophysiological signals are inherently sensitive and hence amongst those that can be affected. Examples of the parts of the body for which electrodiagnostic devices are used and the associated term include:

(a) heart – electrocardiography (ECG);
(b) brain – electroencephalography (EEG); and
(c) muscles – electromyography (EMG).

8.7 Medical IT-Networks

An information technology network to which one or more medical devices is connected is defined as a 'medical IT-network' in EN 80001-1. This standard provides guidance for healthcare establishments, as the 'responsible organisations', on how such networks should be risk-managed.

Additionally, before connecting any medical electrical equipment (ME equipment) to an IT network, healthcare establishments need to be aware of their responsibility to meet the patient electrical safety requirements for medical electrical equipment systems (ME systems), as specified in EN 60601-1. The measures which have to be taken to meet the ME system requirements should be stipulated by each medical equipment manufacturer, and implemented by the responsible organization accordingly. ('Medical network isolators' are marketed but not necessarily required for medical equipment connections to IT networks; each equipment manufacturer will advise, should such additional electrical separation devices be needed for their own products.)

As noted in Section 5.2.3, the term medical IT -network should not be confused with 'medical IT system'. Medical IT (isolated terra) systems, formerly known as IPS (isolated power supply) systems, are electrical systems that have specific safety features for medical installations.

8.8 Bedhead services including nurse call systems

Certain services need to be provided in locations where there are patient beds or trolleys. These 'bedhead services' are for both patients and staff. In addition to their clinical uses, bedhead services typically include telephone, TV, radio and often other types of 'patient entertainment' system such as internet access and on-demand films. Patients normally have a handset and/or other device which enables them to operate these facilities as well as providing a bed-light control and a nurse-call button.

Bedhead units depend on the clinical activity and type of patient but, in most cases, include the following:

(a) electrical power outlets;
(b) nurse call and related systems (some of which run over a hospital network);
(c) network outlets; and
(d) medical gas outlets (these are typically for oxygen, 'medical air' and so on but medical vacuum also falls into this category).

Bedhead services are a type of 'medical supply unit'. EN ISO 11197, which is based on EN 60601-1, is the standard for medical supply units and it defines them to be ME equipment. Accordingly, the requirements for ME Systems, as noted earlier for medical IT-networks, are applicable.

Background information on bedhead services can be found in HTM 08-03 (2013 version) but it has not been updated to reflect the latest version of EN ISO 11197 and, because of its age, most of the guidance on ICT is no longer applicable.

8.9 Other considerations

8.9.1 Access constraints during installations

Arranging for access to locations in order to install or work on telecommunications cabling can be complex and often needs a considerable amount of co-ordination.

At one extreme, there is unrestricted public access to many spaces in healthcare premises and, in some cases such as EDs, this applies continuously (i.e. all 24 hours of every day of the year). At the other extreme, there is very high security (for a range of reasons) in some locations and access to them is very tightly controlled at all times.

To take another example, many other parts of hospitals – particularly those used for outpatients clinics – will be in continuous use for extended periods during weekdays and sometimes in the evenings or at weekends. It should also be noted that, in many such areas, sessions can overrun and by quite some time. Accordingly, scheduling of works in those areas needs to take possible access delays into account.

8.9.2 Accessible network outlets

A key issue in healthcare premises is that there can be many network outlets in areas which are accessible to the public and not secure.

There is a risk of physical damage to such outlets. Patients and visitors can be of all ages and some may have learning disabilities or mental health conditions. Some adults with these conditions and younger children may be accidentally or intentionally destructive. Network outlets are particularly vulnerable to the insertion of inappropriate objects or substances by children.

Network outlets in insecure locations can also be used to attempt unauthorized network access.

8.9.3 Ligature points

Healthcare organizations have to prevent ligature risks in psychiatric facilities and other locations where there may be patients with mental health conditions. Safeguards cannot be compromised either during a cabling installation project or after its completion. It may also be necessary to take precautions in areas where patients with life -limiting diseases are treated.

8.9.4 Asbestos

There is known to be asbestos in many (older) healthcare premises and this presents a potentially serious risk during all stages of an installation project. However, the topic is covered extensively elsewhere and therefore it is not discussed further in this Code of Practice.

8.9.5 Ultraviolet Radiation (UV)

UV is used to treat some medical conditions (particularly of the skin). Standard cleaning practices can be supplemented by UV decontamination systems.

As UV can affect cables, precautions may need to be taken to protect cables from sources of it, including sunlight.

8.9.6 Temporary connections outside buildings

Healthcare premises can have imaging (for example MRI and CT) or other clinical services provided on a temporary basis from mobile units. Disaster recovery (for IT) services may also be provided from mobile units.

It may be advisable to plan for or make allowance for these possibilities but there is no specific coverage of them in the standards.

8.10 Services, systems and equipment in healthcare

Considerable numbers of devices and items of equipment that rely on digital technology are used in healthcare organizations. It is not possible to itemize all the possible types but the following (which is not exhaustive) is a high-level checklist.

(a) ICT and telecommunications equipment;
- **(i)** active or powered ICT hardware, such as servers, storage area networks (SANs) and network equipment including switches, routers and firewalls;
- **(ii)** wireless access points (WAPs) and other equipment supporting Wi-Fi or mobile phone services for users ranging from staff to patients and members of the public;
- **(iii)** voice/telephone systems: fixed, DECT, voice over internet protocol (VoIP) and mobile;
- **(iv)** digital dictation equipment; and
- **(v)** end-user devices (desktops, laptops, tablets and smart phones) provided by the healthcare organization, as well as mobile devices that are the personal property of staff, patients or visitors;

(b) Equipment and devices for patient care or treatment;
- **(i)** diagnostic and monitoring medical equipment (imaging systems, PoCT devices, patient monitors, etc.);
- **(ii)** interventional medical equipment (robotic surgery, anaesthetic machines, endoscopy, cardiology, etc.);
- **(iii)** therapeutic medical equipment, (radiotherapy systems, haemodialysis machines, infusion devices, etc.);
- **(iv)** medical imaging monitors (for viewing radiology images);
- **(v)** nurse call and other patient care services located at the bedhead or place of treatment (patient environment);
- **(vi)** medical gas alarms;
- **(vii)** systems for monitoring refrigerated or temperature-controlled storage (for example for drugs, blood products, pathology samples and human tissues);

- **(viii)** mobile health and fitness monitoring equipment which may be owned by health organizations or patients;
- **(ix)** patient kiosks; and
- **(x)** patient entertainment and information systems;

(c) tracking or monitoring (using RFID, bar codes or other technology) of assets, drugs, consumables and personnel;
(d) robotic pharmacy dispensary systems located in pharmacy departments or retail pharmacies, ward-based automated drug storage systems;
(e) autoclaves and other equipment for sterilization or decontamination;
(f) surveillance systems, access control, security alarms and other security services including baby-tagging;
(g) body-worn cameras (for staff safety);
(h) sensors and alarm systems for fire and smoke;
(i) environmental control including HVAC and monitoring (for example of temperature, humidity and airflow);
(j) building information and management systems;
(k) energy management systems including those for power distribution monitoring and control, lighting controls and utility metering;
(l) audio-visual (AV) and video-conferencing (VC) equipment/systems;
(m) electronic signage; and
(n) readers for credit/debit or contactless cards and electronic point of sale (EPoS) equipment.

In many organisations the use of pagers by clinical and other staff is being reduced. However, the devices are still quite common for various reasons. One technical factor is that, in some buildings and environments, there can be locations where replacement devices cannot receive any signals whereas pagers can.

In hospitals there can be a considerable amount of waiting and/or queuing and particularly in outpatient departments. In some places, patients are given devices that are used to alert them when it is their turn to receive attention. Examples of these devices are so -called 'consumer pagers', 'coaster pagers' and 'recall pagers'. These types of device are often used in other settings, such as restaurants. Depending on the type, they can flash lights, emit sounds, and/or vibrate. Some have small alpha-numeric displays.

8.11 Environments in healthcare premises

There can be an extremely wide range of environments in premises where healthcare is delivered. It is not feasible to list all of these but examples, in no particular order, include the following:

(a) wards of different types (such as surgical, maternity and secure);
(b) single rooms (for patient accommodation);
(c) operating theatres and related areas;
(d) intensive care units;
(e) high dependency units;
(f) emergency departments (EDs) – formerly known as accident and emergency departments (A&E);
(g) minor injuries units;
(h) private patient units;
(i) pharmacy departments and associated retail units;
(j) outpatient clinics;
(k) consulting rooms;
(l) physiotherapy facilities including gyms and hydrotherapy pools;
(m) imaging and radiotherapy suites;

(n) pathology and research laboratories;
(o) sterile services departments (SSDs);
(p) plant rooms for example for water treatment, electrical generation or distribution, medical suction, etc.;
(q) workshops for medical equipment services, facility maintenance, and so on;
(r) mortuaries;
(s) health records departments and storage;
(t) lecture theatres and other teaching facilities;
(u) offices together with meeting and conference rooms;
(v) public waiting areas;
(w) staff accommodation;
(x) catering facilities together with related food preparation and storage areas;
(y) areas where refreshments or vending machines are provided; and
(z) retail spaces.

Annex A

Definitions and abbreviations

A.1 Terms

The following list contains brief explanations, but not necessarily the formal definitions, of key terms. Official definitions of terms in standards can be found in the IEC and ISO terminological databases as follows:
IEC Electropedia: http://www.electropedia.org/
ISO Online browsing platform: https://www.iso.org/obp

Term	Explanation
acceptance test	contractual test to prove installed cabling meets the specific conditions of its specification
access network	network owned by an access provider
access point	location in a *pathway* where access is specifically provided. Examples include *maintenance holes*, *hand holes* and *drawboxes*; see also *wireless access point*
access provider	provider of facilities for a service provider
balanced cable	cable consisting of one or more symmetrical metallic cable elements (normally twisted pairs)
bedhead services	various patient care services, piped or cabled, which may be housed, routed and/or displayed in surface fix containment known as a *medical supply unit*
bonding	electrical connection of *exposed-conductive-parts* and *extraneous-conductive-parts* to maintain them at the same potential
building entrance facility	facility where all necessary mechanical and electrical services for the entry of telecommunications cables into a building are provided. Building entrance facilities (BEF) can allow for transition from outdoor to indoor cable
cabinet	enclosed construction for housing closures and other information technology equipment (see also *telecommunications cabinet*, as well as *frame* and *rack*)
cable	cables are enclosed in an overall sheath and, for the transmission of signals, contain metallic conductors or at least one optical fibre
cable element	the smallest construction unit in a cable: for example, a twisted pair (which can be screened) or a single optical fibre
cable loop	see *service loop*
cable management system	provides one or more of: support, containment, retention or protection for all types of cabling. Can be open, openable or closed
cabling component	any physical item associated with the cabling installation, including cables, connecting hardware, closures, cabinets, frames, racks and pathway systems, as well as items providing earth connections for the installation
cabling subsystem	In EN 50173-6 a cabling system consists of up to three cabling subsystems: a campus backbone subsystem, a building backbone subsystem and a service distribution *subsystem*
campus	premises with one or more buildings
category	specifies transmission performance for cables and components (see also *class*); remote powering designation
channel	transmission path, consisting only of passive cabling components between two items of equipment (see also *permanent link*)
class	specifies *channels* (see also *category*)
closed pathway system	cable management system (such as duct or conduit) where the installation of cables requires a tensile load (see also *open pathway system* and *openable pathway system*)
closure	closures house *termination points*. Examples include faceplates and (patch) panels for metallic or optical fibre cables

Annex A – Definitions and abbreviations

Term	Explanation
comms room	informal term for a room in which there is active and/or passive telecommunications equipment
conduit	a type of duct that is usually circular
cord	cable (such as a *patch cord* and *equipment cord*) that is not permanently installed; balanced cable cords are usually stranded for flexibility
cord cable	see *zone cable*
cross-connect	passive connection using a patch cord or jumper between cabling subsystems (see also *interconnect*)
distributor	where termination and connection of cabling subsystems to other cabling subsystems and/or equipment takes place
drawbox	a type of *hand hole* in buildings
earthing	connection of the *exposed-conductive-parts* of an installation or an item of equipment to earth (see also *bonding*)
entrance room	space within, or at the boundary of, a building housing the demarcation point where facilities owned by access and/or *service providers* interface with the premises cabling
equipment cord	connects equipment to a cabling subsystem in a distributor
EuroClass	classification system for the fire performance of building products
exogenous (crosstalk)	alternative term for alien crosstalk
exposed-conductive-part	part of an electrical installation or item of equipment that is conductive and can be touched, but is not live except under fault conditions (see also *extraneous-conductive-part* and *bonding*)
external network interface	interface between premises cabling and an access network
extraneous-conductive-part	conductive part that is not part of an electrical installation or item of equipment: for example, a structural member such as a beam (see also *exposed-conductive-part* and bonding)
frame	open construction, typically wall-mounted, for housing closures and other information technology equipment (see also *cabinet* and *rack*)
hand hole	*access point* that is too small for a person to enter to perform work (see also *mainte-nance hole*)
interconnect	passive connection to a cabling subsystem without the use of a patch cord or jumper (see also *cross-connect*)
jumper	cable or cable element(s) without connectors used to make a connection (see also *cord*)
link	transmission path between two specified test interfaces of generic cabling (see also *permanent link*)
maintenance hole	access point that is large enough for a person to enter in order to work (see also *hand hole*). In practice, the term 'chamber' is more often used
medical IT-network	information technology network that incorporates at least one medical device (not to be confused with a *medical IT system*)
medical IT system	isolated terra system, formerly known as isolated power supply (IPS) system, fulfilling specific requirements for medical applications (not to be confused with *medical IT-network*)
medical supply unit	permanently installed ME equipment intended to supply electric power, communica-tion means (telephone, call systems, etc.), data transmission, lighting, and/or medical gases and/or liquids, an anaesthetic gas scavenging system and/or a plume evacuation system to medical areas of a healthcare facility – for full definition see EN ISO 11197
open pathway system	pathway system (such as tray or basket) into which cables can be installed without a tensile load
openable pathway system	cable management system (such as trunking) that restricts access to installed cables but which can be opened for installation of cables without a tensile load
outlet	see *telecommunications outlet*
patch cord	cord used to *cross-connect*

Annex A – Definitions and abbreviations

Term	Explanation
patch panel	panel at a distributor, presenting the interface(s) of cabling subsystems, to facilitate administrative moves, adds and changes using patch cords or jumpers
pathway	defined route of a cable between *termination points*, for example, under a floor or above a ceiling
pathway system	*cable management system*, or other area or volume defined by markings
permanent link	transmission path between the two test interfaces at the ends of a *cabling subsystem*, including the connecting hardware at those interfaces; *channels* consist of permanent *links* and *cords*
protective (earth) conductor	conductor provided for purposes of safety, for example, for protection against electric shock
rack	open construction, typically self-supporting and floor-mounted, for housing *closures* and other information technology equipment (see also *cabinet* and *frame*)
segregation	use of earthed electrically conductive barriers or physical separation to prevent electromagnetic interference
service area cord	cord connecting terminal equipment to a service outlet
service loop	excess length of cable (often intentionally allocated for future repairs), also known as a *cable loop*
service outlet	outlet at which service distribution cabling terminates
service provider	delivers telecommunications content (transmissions) over *access provider* facilities
space	a defined volume allocated to telecommunications cabling infrastructure; examples include a cage or just a designated area in a larger room
subsystem	see *cabling subsystem*
surge protective device	device for protection from high transient over-voltages and for restricting the duration (and frequently the amplitude) of the follow-on current
telecommunications cabinet	*cabinet* for use outside buildings
telecommunications outlet	fixed connector (typically RJ-45 for balanced cabling), providing connection to terminal equipment
terminal equipment	active equipment (such as a PC), distinct from the network equipment on which it depends to communicate, connected via an outlet
termination point	connector (such as a plug or socket) fitted to an installed cable
tie cable	cable that connects *distributors* of the same hierarchical level (EN 50173 series of standards)
wireless access point	device that provides access via Wi-Fi (see also *access point*)
zone cable	industry term for a cable constructed in accordance with a *cord* specification but intended for permanent installation. Also known as a *cord cable*

A.2 Abbreviations and acronyms

Abbreviations and acronyms (other than for frequently used units such as V and Hz) that occur more than once or that are of particular significance follow.

Abbreviation/acronym	Expansion
A&E	accident & emergency department: superseded by *ED*
AC	alternating current
ACR	attenuation to crosstalk ratio
AHP	allied health professional
AIM	automated infrastructure management
ANSI	American National Standards Institute
AP	access point (for Wi-Fi)
AV	audio visual
BD	building distributor
BEF	building entrance facility
BICSI	Building Industry Consulting Service International
BS	British Standard
BSI	British Standards Institution
CC	cross connect
CCA	copper-clad aluminium (cable)
CCIO	chief clinical information officer
CCTV	closed-circuit television
CD	campus distributor
CR	computed radiography (X-ray imaging)
CSA	cross-sectional area
CT	computed tomography (X-ray imaging)
DC	direct current
DECT	digital enhanced cordless telecommunications
DR	digital radiography (X-ray imaging)
DTC	diagnostic and treatment centre
ECA	Electrical Contractors' Association
ED	emergency department (supersedes A&E department)
EMI	electromagnetic interference
EN	European Standard (norm)
ENI	external network interface
EPoS	electronic point of sale
EQP	equipment
ESD	electrostatic discharge
ESG	electrical safety group (HTM 06-01)
FIA	Fibreoptic Industry Association
GP	general practitioner
HSCN	Health and Social Care Network (NHS in England)
HSE	Health and Safety Executive
HTM	health technical memorandum
HV	high voltage
HVAC	heating, ventilation and air-conditioning

Annex A – Definitions and abbreviations

Abbreviation/acronym	Expansion
ICT	information and communications technology
IEEE	Institute of Electrical and Electronics Engineers (USA)
IoT	Internet of Things
IP	Internet protocol
IPS	isolated power supply (now known as *medical IT* (isolated terra)
ISO	International Organization for Standardization
IT	information technology (contrast with *medical IT*)
JANET	Joint Academic Network
kPa	kilopascal (unit of pressure)
LV	low voltage (see also *HV*)
M&E	mechanical and electrical
MAC	moves, adds and changes (of cabling)
(Medical) IT	isolated terra (previously known as *IPS*)
ME equipment	medical electrical equipment
ME system	medical electrical system
MEWP	mobile elevating work platform
MICE	mechanical, ingress, climatic and electromagnetic (environmental classification)
MRI	magnetic resonance imaging
NEXT	near-end cross talk
NHS	National Health Service
NJUG	National Joint Utilities Group (renamed Street Works UK)
NTP	network termination point
OM4, OM5	category of multimode optical fibre
OS1a, OS2	category of single-mode optical fibre
PACS	picture archiving and communication system
PC	personal computer
PEN	protective earthed-neutral (conductor)
PET	positron emission tomography (medical imaging)
PoCT	point-of-care testing
PoE	Power over Ethernet
PP	patch panel
RCDD®	Registered Communications Distribution Designer® (BICSI)
RFID	radio frequency identification
RP1, RP2, RP3	category of remote powering
SCP	service concentration point
SD	service distributor
SO	service outlet
TE	terminal equipment
TIA	Telecommunications Industry Association (USA)
UPS	uninterruptible power supply
UV	ultraviolet (light)
VC	video conferencing
VoIP	Voice over IP (telephony)
WAP	wireless access point

Annex B

Standards

B.1 Key standards

Reference	Title
BS 6701:2016 + A1:2017	Telecommunications equipment and telecommunications cabling – Specification for installation, operation and maintenance
BS 7671:2018	Requirements for Electrical Installations: IET Wiring Regulations: 18th edition
BS EN 50173-1:2018	Information technology – Generic cabling systems – General requirements
BS EN 50173-2:2018	Information technology – Generic cabling systems – Office premises
BS EN 50173-6:2018	Information technology – Generic cabling systems – Distributed building services
BS EN 50310:2016	Information technology – Telecommunications bonding networks for buildings and other structures
BS EN 50174-1:2018	Information technology – Cabling installation – Part 1: Installation specification and quality assurance
BS EN 50174-2:2018	Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings
BS EN 50174-3:2013 + A1:2017	Information technology – Cabling installation – Part 3: Installation planning and practices outside buildings

B.2 Additional standards

Reference	Title
BS 8492	Telecommunications equipment and telecommunications cabling. Code of practice for fire performance and protection. Code of practice for fire performance and protection
EN 124	Gully tops and manhole tops for vehicular and pedestrian areas – Design requirements, type testing, marking, quality control
EN 12613	Plastics warning devices for underground cables and pipelines with visual characteristics
EN 13501-6	Fire classification of construction products and building elements. Classification using data from reaction to fire tests on electric cables
EN 50085-1	Cable trunking systems and cable ducting systems for electrical installations – Part 1: General requirements
EN 50085-2-X (all parts)	Cable trunking systems and cable ducting systems for electrical installations
EN 50406	End user multi-pair cables used in high bit rate telecommunication networks
EN 50407	Multi-pair cables used in high bit rate digital access telecommunication networks
EN 50411-2-2	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications - Part 2-2: Sealed pan fibre splice closures Type 1, for category S & A
EN 50411-2-3	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications - Part 2-3: Sealed inline fibre splice closures Type 1, for category S & A
EN 50411-2-4	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications – Part 2-4: Sealed dome fibre splice closures Type 1, for category S & A
EN 50411-2-5	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications – Part 2-5: Sealed closures for air blown fibre microduct, type 1, for category S & A
EN 50411-2-9	Fibre organisers and closures to be used in optical fibre communication systems. Product specifications – Part 2-9: Non-sealed closures for air blown fibre microduct cable, for category S&A
EN 50667	Information technology – Automated infrastructure management (AIM) systems – Requirements, data exchange and applications
EN 60332 1-2	Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame (IEC 60332-1-2)

Annex B – Standards

Reference	Title
EN 60601-1	Medical electrical equipment. General requirements for basic safety and essential performance
EN 60794-3	Optical fibre cables – Part 3: Sectional specification – Outdoor cables (IEC 60794-3)
EN 60794-3-10	Optical fibre cables – Part 3-10: Outdoor cables – Family specification for duct, directly buried and lashed aerial optical telecommunication cables (IEC 60794-3-10)
EN 60794-3-11	Optical fibre cables – Part 3-11: Outdoor cables – Product specification for duct, directly buried and lashed aerial single-mode optical fibre telecommunication cables (IEC 60794-3-11)
EN 60794-3-12	Optical fibre cables – Part 3-12: Outdoor cables – Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling (IEC 60794-3-12)
EN 60794-3-20	Optical fibre cables – Part 3-20: Outdoor cables – Family specification for self-supporting aerial telecommunication cables (IEC 60794-3-20)
EN 60794-3-21	Optical fibre cables – Part 3-21: Outdoor cables – Detailed specification for optical self-supporting aerial telecommunication cables for use in premises cabling (IEC 60794-3-21)
EN 60825 2	Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS) (IEC 60825-2)
EN 61280-4-1	Fibre optic communication subsystem test procedures – Part 4-1: Installed cable plant – Multimode attenuation measurement
EN 61280-4-2	Fibre-optic communication subsystem test procedures – Part 4-2: Installed cable plant – Single-mode attenuation and optical return loss measurement
EN 61386-1	Conduit systems for cable management - Part 1: General requirements (IEC 61386-1)
EN 61386-2X (all parts)	Conduit systems for cable management - Part 2X: Particular requirements (IEC 61386-2X series)
EN 61537	Cable management – Cable tray systems and cable ladder systems (IEC 61537)
EN 61935-1	Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in the standards series EN 50173 (IEC 61935-1:2009, modified)
EN 61969-1	Mechanical structures for electronic equipment - Outdoor enclosures - Part 1: Design guidelines (IEC 61969-1)
EN 61969-2	Mechanical structures for electronic equipment – Outdoor enclosures – Part 2: Coordination dimensions (IEC 61969-2)
EN 62368-3	Audio/video, information and communication technology equipment – Safety – Part 3: DC power transfer through information technology communication cabling (IEC 62368-3)
EN 62949	Particular safety requirements for equipment to be connected to information and communication networks (IEC 62949)
EN 80001 series	Application of risk management for IT-networks incorporating medical devices. Roles, responsibilities and activities
EN ISO 1117	Medical supply units
IEEE P802.3bt	IEEE Standard for Ethernet Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs

Annex C

Bibliography

C.1 Health Technical Memoranda (HTMs)

Although the technical content is very similar, different versions of HTMs are produced by each of the relevant bodies in England, Scotland (SHTMs) and Wales (WHTMs). HTMs are freely available from the following locations.

England: https://www.gov.uk/government/collections/health-technical-memorandum-disinfection-and-sterilization

Scotland: http://www.hfs.scot.nhs.uk/publications-/guidance-publications/

HTM details that follow are for the versions issued in England. All are issued by the Department of Health and Social Care.

Health Technical Memorandum 05-02 *Fire safety in the design of healthcare premises* (2015 edition)

Health Technical Memorandum 06-01 *Electrical services supply and distribution* (2017 edition)

Health Technical Memorandum 08-02 *Lifts* (2016 edition)

Health Technical Memorandum 08-03 *Bedhead services* (2013 edition)

C.2 Fibreoptic Industry Association (FIA)

Note the following:

(a) Despite the organization's name, many FIA guidance documents and other publications also cover metallic telecommunications cabling.
(b) Not all FIA publications have reference numbers.

The following documents are available from https://www.fia-online.co.uk/

Optical Fibre Cabling – Installation – External: BS EN 50174-3 and UK Regulations (FIA-TSD2000441)

FIA Shortform Guidance on External Installations: Interpretation of Standards and 'Regulations'

FIA Shortform Guidance on External Installations: Licences and Wayleaves

FIA Shortform Guidance on External Installations: Specification of Pathways, Spaces and Structures

FIA Shortform Guidance on External Installations: Digging, Reinstatement and Comparative Costs

FIA-TSD-2000-5-1 Optical Power Safety Levels

Reaction To Fire Performance of Cabling Inside Buildings (July 2018)

C.3 Street Works UK (NJUG)

The following are freely available from http://streetworks.org.uk/resources/publications/

Volume 1	*Street Works UK Guidelines on the Positioning and Colour Coding of Underground Utilities' Apparatus*
Volume 2	*Street Works UK Guidelines on the Positioning of Underground Utilities Apparatus for New Development Sites*
Volume 3	*Street Works UK Guidelines on the Management of Third Party Cable Ducting*
Volume 4	*Street Works UK Guidelines for the Planning, Installation and Maintenance of Utility Apparatus in Proximity to Trees*
Volume 5	*Street Works UK Guidelines on Environmental Good Practice*
Volume 6	*Street Works UK Guidelines on Co-ordination, Co-operation & Communication*

C.4 Other

BIP 0123:2012 *Telecommunications Cabling. Guidance on Standards and Best Practice for Construction Projects*. Mani Manivannan and Mike Gilmore

Guidance Note 7: Special Locations (6th Edition, BS 7671:2018): available to purchase from https://shop.theiet.org/guidance-note-7-special-locations-6th-edition

A Guide to Electrical Installations in Medical Locations, Paul Harris: available to purchase from: https://shop.theiet.org/guide-to-electrical-installations-in-medical-locations

Annex D

Installation specification

D.1 Purpose

This annex provides checklists summarizing the requirements and recommendations for installation specifications in the standards. Specific guidance on how to use the checklists in healthcare projects is provided in the main body of this Code of Practice and there has been no tailoring of them in this Annex. This is to ensure maximum flexibility and to allow for as wide a range of installation projects as possible.

Installation specifications are required to consist of a:

(a) technical specification (see D.3); and
(b) scope of work (see D.4).

There are also requirements to provide additional general information (see D.2) – relevant to both the technical specifications and the scope of work – about the site at which installation is to take place.

Unless otherwise indicated, all the items in the following subsections are requirements.

D.2 General

D.2.1 Other infrastructures

Details of how the following infrastructures and any others that are relevant have been taken into account:

(a) building services, such as power supply distribution and earthing systems;
(b) building management systems, including security and access control;
(c) circuits for smoke/fire detection and associated controls;
(d) HVAC; and
(e) piping systems (hot and cold fluid supply and return, waste water, fire suppression).

D.2.2 Statutory, regulatory and other requirements

Details of applicable legislation, regulations and compliance statements, including:

(a) building regulations relevant to the installation;
(b) site-specific site regulations;
(c) safe working practices;
(d) protection of externally provided services; and
(e) contractors' authorization and requirements for installer personnel.

D.2.3 Site contacts

Details of site contacts for:

(a) operational requirements;
(b) site information (such as access and applicable restrictions, relevant hazardous areas);
(c) technical requirements;
(d) documentation of existing cabling, if applicable;

(e) compatibility with any existing cabling;
(f) items to be issued to the cabling installer by, or on behalf of the premises owner or appointed representative;
(g) storage of materials;
(h) removal, disposal and/or recycling of excess and waste material;
(i) occupational health and safety;
(j) installation of cabling by a third party;
(k) main contractor and/or sub-contractors; and
(l) transfer of property and/or responsibility.

D.2.4 Strategy and foreseeable expansion

It is recommended that the installation specification includes:

(a) information on foreseeable expansion (for additional users or network traffic) and predicted lifetime requirements with reference to:
  (i) pathways and pathway systems;
  (ii) cabinets, frames and racks;
  (iii) termination points; and
  (iv) power supplies; and
(b) relevant information from the organization's ICT strategy, including:
  (i) application(s) to be supported;
  (ii) where applicable, current and future compliance with information technology standards;
  (iii) external network service provision and related interfacing;
  (iv) resilience planning; and
  (v) security requirements/access restrictions.

D.3 Technical specification

D.3.1 Safety

Requirements for or details of:

(a) identification and classification of any hazardous areas within the pathways and at termination points; and
(b) boundaries of areas that are hazardous or potentially hazardous.

D.3.2 Performance and configuration

Requirements for or details of:

(a) required transmission performance of the cabling to be installed:
  (i) when subject to the defined operational environment; and
  (ii) in conjunction with any existing cabling.
(b) remote powering objectives (if any);
(c) mitigation products or techniques needed for installation and operation as specified when subjected to the defined environmental conditions;
(d) cable elements:
  (i) presentation at interfaces to the installed cabling; and
  (ii) treatment if not terminated within connecting hardware; and

(e) requirements for:
   (i) the pathways, pathway systems, cables, cabinets, frames, racks, closures and termination points;
   (ii) installation accessories and processes to be used during the installation; and
   (iii) bonding to the protective and functional earthing systems.

D.3.3 Lifetime objectives

Details of:

(a) infrastructure requirements necessary to support planned extensions of the installation; and
(b) requirements for the operational lifetime of the cabling installation, including maintaining the supply of cabling components or suitable alternatives during maintenance, repair and extensions throughout.

D.3.4 Administration, inspection, testing and acceptance

Details of:

(a) the range of documentation to be supplied by the installer (including any requirements to link records to each other and/or to records of other building services);
(b) the format of the documentation (including alignment with the administration system);
(c) the labelling to be undertaken by the installer and the specification of labels;
(d) inspection and testing (including the format of the associated documentation); and
(e) acceptance of the installation (including the format of acceptance of test results, as well as information relating to the testing, such as the type of tester used, the date of test, the operator, the termination point identifier, remedial action taken in the event of a failed test, and re-test results).

D.3.5 Environmental

Details of known installation and operational environmental conditions, including:

(a) mechanical effects:
   (i) shock/bump, vibration, tensile force, crush, impact, bending and flexing;
(b) ingress of contaminants:
   (i) immersion;
(c) climatic and chemical effects:
   (i) ambient temperature range within pathways and spaces;
   (ii) rate of change of temperature;
   (iii) humidity range, including condensation and icing effects;
   (iv) solar radiation;
   (v) liquid or gaseous chemical pollution;
(d) electromagnetic effects; and
(e) others (separately identified in the standards):
   (i) biological attack (for example, mould or fungal growth);
   (ii) accidental or malicious physical damage, including that caused by animals;
   (iii) the presence, or potential presence, of hazards (such as contaminating, toxic or explosive materials);
   (iv) the movement of air (for example, caused by fans or heating and ventilation systems);
   (v) meteorological effects (for example, atmospheric pressure or wind); and
   (vi) the impact of natural events (such as lightning strike and lightning-induced overvoltages).

The standards recommend:

(a) inclusion in the technical specification of a risk assessment that includes abnormal environmental conditions such as flooding and immersion in fluids following the operation of sprinkler systems; and
(b) consideration of the nature and duration of such conditions, as this can have an effect on the requirements for component performance or mitigation.

D.4 Scope of work

Key: ■ = Required; □ = Recommended

Item	Pre-installation	Installation	Post-installation
Responsibilities for: **(a)** identification, design and completion of the works **(b)** obtaining all necessary clearances and permits	■	■	■
Site plans showing required works	□	□	
Facilities (such as telephone and accommodation) for installer use	□	□	
Materials control system	□	□	
Location of storage facilities for cabling components and installation accessories	■		
Disposal system for waste	■		
Building work required, if any, on each pathway	■		
Pathway preparation and pathway system installation	■		
Accommodation of terminating devices for external and internal cables at BEFs	■		
Quantities of cabling components and installation accessories	■		
Additional surveys to be undertaken to supplement information in the scope of work	■		
Locations of: **(a)** spaces; **(b)** pathways; **(c)** cabinets, frames and racks; **(d)** closures; **(e)** termination points; and **(f)** connections to bonding systems and protective earthing systems.		■	
Warning signs and equipment to ensure safe working (including participation in fire drills)		■	
Pathway systems to be used in each pathway		■	
Cables to be installed in each pathway		■	
Means and methods for securing cables within pathway systems		■	
Jointing and/or termination at each termination point		■	
Marking and labelling the cabling components		■	
Quantity and type(s) of inspection and testing		■	
Items to be provided by the installer		■	
Items to be issued to the installer by, or on behalf of, the premises owner or appointed representative		■	
Other works with potential to affect the programme		■	
Access limitations, together with restrictions on personnel movement, vetting and clearance levels		■	
Applicable fire precautions and escape routes		■	

Annex D – Installation specification

Item	Pre-installation	Installation	Post-installation
Site access and security arrangements		■	
Installation programme with key dates, including: **(a)** site-specific safety instructions and training; **(b)** progress meetings; **(c)** attendance at contract inspection points; **(d)** date for supplying installation documentation; **(e)** date for bringing installation into service; and **(f)** handover date(s).		■	
Maintenance and control procedure for final cabling documentation.			■
Training: **(a)** operational training, including safety; **(b)** maintenance training for the premises owner, an appointed representative and/or the designated cabling maintainer; and **(c)** fault analysis training.			□
Repair and maintenance contracts			□
Spares, e.g. cable, cords, closures, connecting hardware, tools, test equipment and test leads.			□

Annex E

Street Works UK colour coding

The following information is summarized from Volume 1 of the Street Works UK (formerly NJUG) guidelines (see Annex C.3).

Utility	Duct	Pipe	Cable	Marker systems
Electricity – HV	Black or red tile	Not applicable	Red or black	Yellow with black and red legend or concrete tiles
Electricity – LV	Black or red	Not applicable	Black or red	Yellow with black legend
Gas (see also below)	Yellow	Yellow or yellow with brown stripe (removable skin revealing white or black pipe)	Not applicable	Yellow with black legend
Oil/fuel pipelines	Not applicable	Black	Not applicable	Various surface markers Marker tape or tiles above red concrete
Sewerage	Black	No distinguishing colour/material (e.g. ductile iron may be red; polyvinylchloride (PVC) may be brown)	Not applicable	Not applicable
Telecommunications	Grey, white, green, black, purple	Not applicable	Black or light grey	Various
Water	Blue or grey	Blue polymer or black/ blue or uncoated iron/glass-reinforced plastic (GRP)	Not applicable	Blue with black legend
Water: firefighting	Not applicable	Black with red stripes or bands	Not applicable	Not applicable
Water: non-potable or grey	Not applicable	Black with green stripes	Not applicable	Not applicable
Water: pipes for special purposes (e.g. contaminated ground)	Not applicable	Blue polymer with brown stripes (non-removable skin)	Not applicable	Blue with brown stripes

Colours and markings for gas pipes depend on the material used.

Material	Colouring
PE (polyethylene)	Pressures up to 2 bars: yellow or yellow with brown stripes (removable skin revealing white or black core pipe) Pressures between 2 to 7 bars: orange
Steel pipes	May have yellow wrap or black tar coating or no coating
Ductile iron	May have plastic wrapping
Asbestos and pit/spun cast iron	No distinguishable colour

Ducts for street or road lighting, traffic control, street furniture and other highway authority services vary, but are most commonly purple, orange or black. Further information can be found in the Street Works UK guidance.

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Code of Practice

Building Infrastructures for Healthcare ICT

Networks in healthcare premises need to support not only IT systems and voice communications but also medical devices including imaging equipment such as CT and MRI scanners, CCTV, security and alarm systems, patient entertainment systems, together with building information and management systems.

There are constant advances in digital and medical technology while the amount of data to be stored, processed or transferred rises continuously and the need to support smart phones, tablets, laptops as well as other mobile devices belonging to staff, patients, carers and the public grows.

As the critical dependency on digital technology increases, the delivery of safe, effective and efficient healthcare requires systems and services to meet the highest standards of availability, reliability and responsiveness.

Within this context the underlying infrastructure needed in buildings to support ICT must be capable of fully meeting not only existing but also future demands. This infrastructure includes network cabling, 'comms' rooms as well as other accommodation for equipment or cabling, and M&E services.

This Code of Practice sets out how to apply relevant network cabling standards in healthcare premises. It covers:

- Project and risk management
- Logical design and architecture
- Implementation (specification, documentation and installation) within buildings and outside them
- Specific healthcare considerations such as infection control

Building Infrastructures for Healthcare ICT is an IET Code of Practice aimed predominantly at the ICT, estates/facilities and clinical engineering departments in healthcare organisations, but will also be of value to healthcare premises owners, developers and landlords, building design and construction professionals and the wider ICT industry.

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